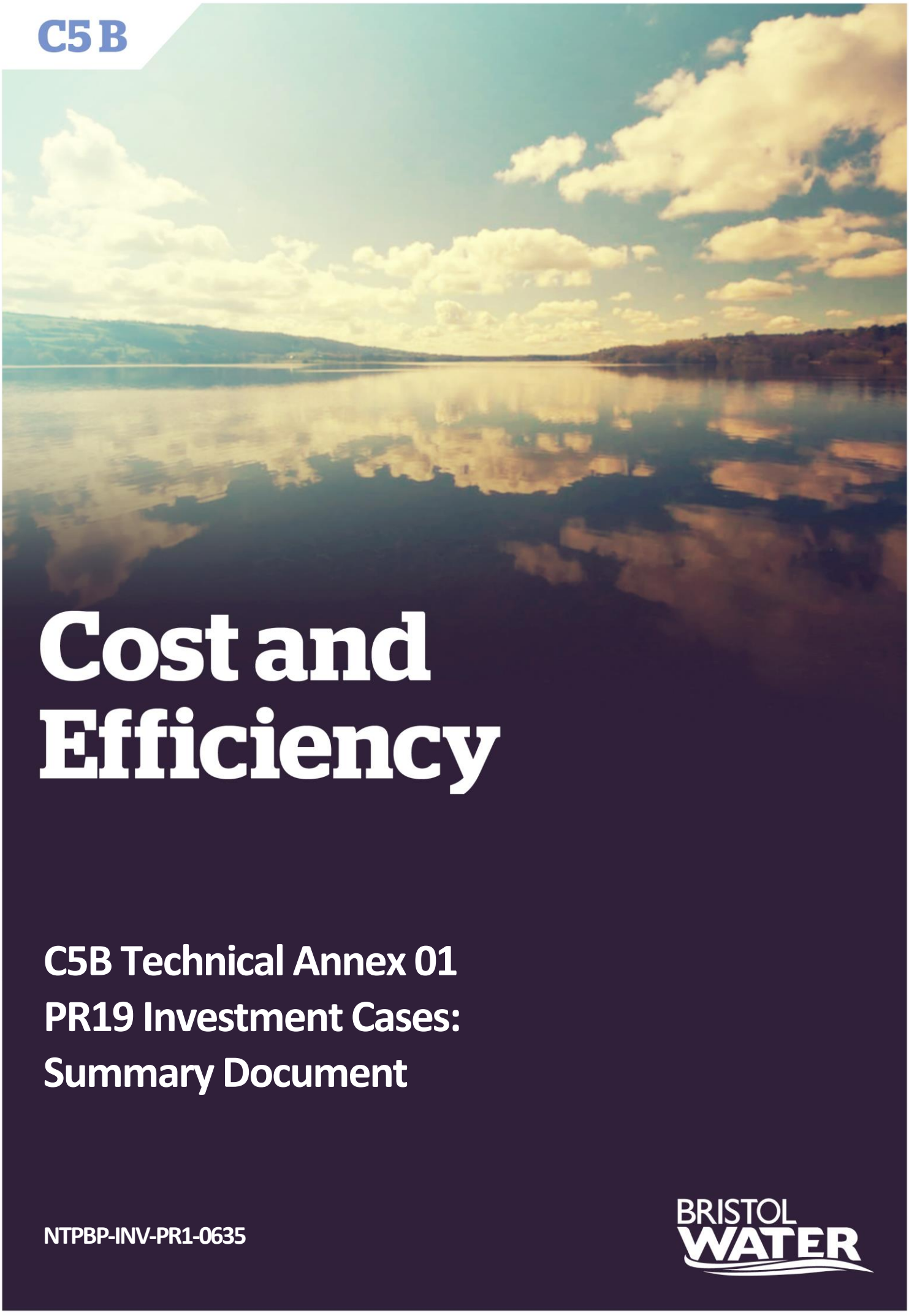
C5 B



Cost and Efficiency

C5B Technical Annex 01
PR19 Investment Cases: Summary Document

NTPBP-INV-PR1-0635

BRISTOL WATER

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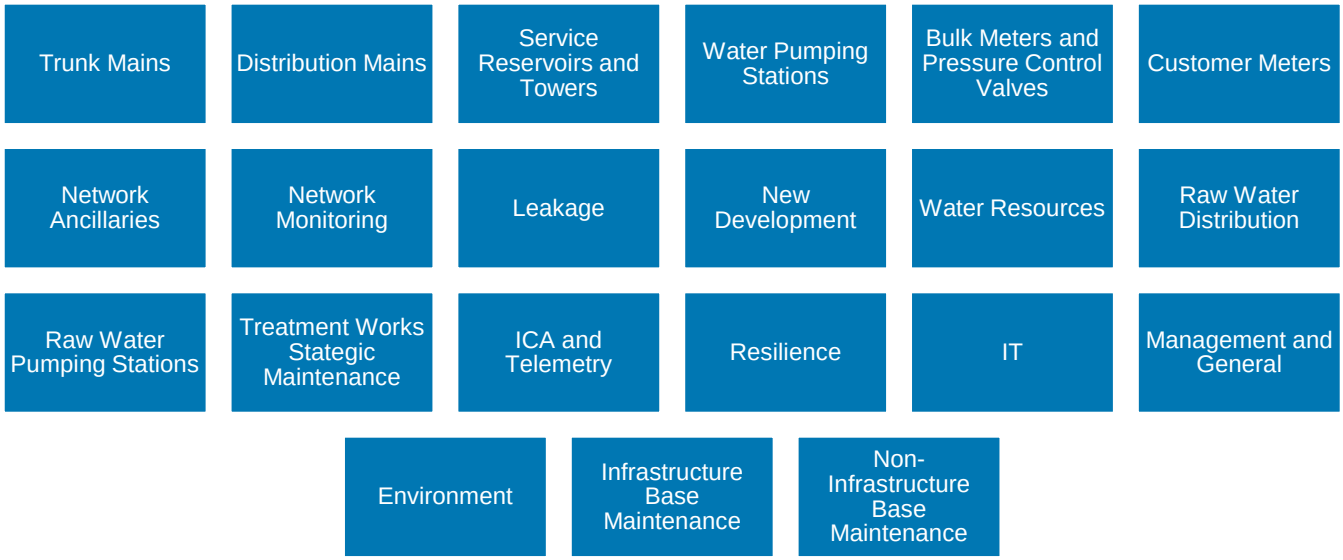
1 Introduction

We have prepared investment cases[1] to outline the investment required in AMP7 within specific asset groupings. Investment cases group together similar asset types, ensuring that all asset types are considered and there is no duplication. There are twenty one investment cases as shown in Figure 1.

Figure 1: The Twenty One Investment Cases



Interventions[2] have been developed for each investment case following a defined process, which is defined in a series of methodologies. These methodologies are described in detail in section 8 of this report.

Individual technical reports have been prepared for each investment case, providing details of the risks associated with a particular asset group, the proposed interventions, the level of investment required, and the resulting performance impact. These technical reports are provided as technical annexes to section C5B of our business plan.

1.1 Purpose of this report

Much of the detail relating to the development of investment cases is applicable to all investment cases. The purpose of this document is to bring together this information into one place, rather than repeat it within each investment case document. This allows the investment case documents to focus on the asset group in question, conveying clear justification for the level of investment proposed.

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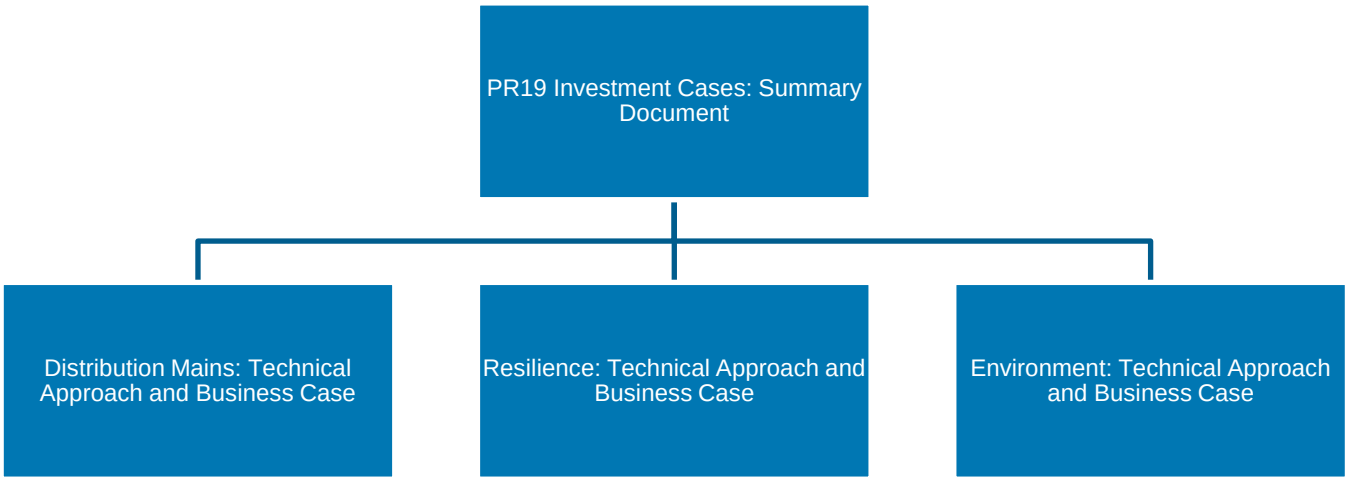
[1] Investment cases have been prepared by a dedicated team, referred as the Investment Planning engineering team.
[2] An activity or activities that are proposed to address a 'need' or mitigate a risk or risks. Such activities include but are not limited to creation of new assets, replacement or rehabilitation of existing assets, studies and changes in operational or maintenance practise.

This summary document sits above the individual investment case documents as shown in Figure 2. A copy of each investment case document can be found in Appendices A-Y.

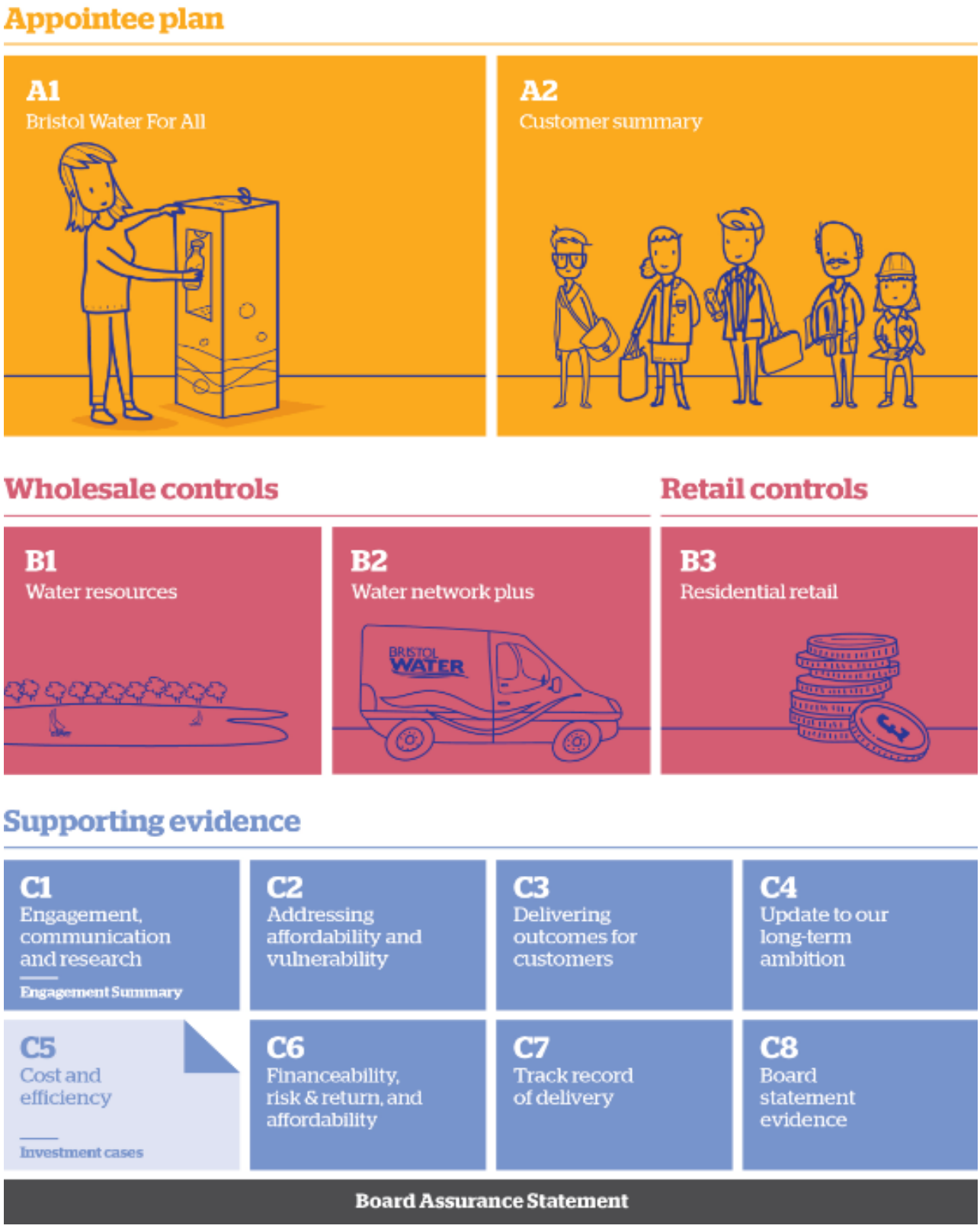
Figure 2: Investment Case Documentation Hierarchy - Example Structure



1.2 How this document fits with other PR19 documentation

This summary document is a technical annex of section C5B of our business plan submission, as illustrated in Figure 3 below.

Figure 3: Overall Business Plan Structure



2 Summary of AMP7 Investment and Contribution to Performance Improvement

2.1 Summary of AMP7 Investment

Our investment plan has a pre-efficiency gross value (including contributions) of £212.457m, and a pre-efficiency net value (excluding contributions) of £197.345m. The split of this investment across our investment cases is shown in Table 1 below.

We have set ourselves a challenging target of reducing our costs by 8% during AMP7. This will be achieved by delivery of our business transformation programme, resulting in a post-efficiency gross investment of £195.460m and net investment of £181.557m.

Table 1: Summary of AMP7 Investment

Investment Case	Investment Pre-Efficiency (£)	Investment With 8% Capex Efficiency (£)	Change in Opex (£)
Trunk Mains and Pipe Bridges	£10,731,755	£9,873,215	£25,000
Distribution Mains	£37,693,780	£34,678,278	-£85,768
Service Reservoirs and Towers	£2,075,000	£1,909,000	£0
Water Pumping Stations	£5,284,883	£4,862,092	-£5,614
Bulk Meters and Pressure Control Valves	£1,177,517	£1,083,316	£0
Customer Meters	£13,469,400	£12,391,848	£35,000
Network Ancillaries	£9,829,515	£9,043,154	£0
Network Monitoring	£2,765,064	£2,543,859	£333,703
Leakage	£5,910,000	£5,437,200	£503,994
New Development	£29,105,000	£26,776,600	£0
Water Resources	£8,025,730	£7,383,672	£150,000
Raw Water Distribution	£252,735	£232,516	£0
Raw Water Pumping Stations	£3,742,986	£3,443,547	-£12,649
Treatment Works Strategic Maintenance	£12,907,974	£11,875,336	-£170,700
ICA and Telemetry	£900,000	£828,000	£0
Resilience	£13,974,300	£12,856,356	£0

Investment Case	Investment Pre-Efficiency (£)	Investment With 8% Capex Efficiency (£)	Change in Opex (£)
IT	£16,126,643	£14,836,512	-£1,156,100
Management and General	£13,905,000	£12,792,600	£0
Environment	£7,716,897	£7,099,545	-£178,911
Infrastructure Base Maintenance	£7,671,000	£7,057,320	£0
Non-Infrastructure Base Maintenance	£9,191,873	£8,456,523	£0
Gross Total Investment	**£212,457,052**	**£195,460,487**	**£562,045**
Contributions	**-£15,112,000**	**-£13,903,040**	**£0**
Net Total Investment	**£197,345,052**	**£181,557,447**	**£562,045**

The breakdown of spend across the water services and business units is summarised in Table 2 below.

Table 2: Water Services and Business Unit Allocation

Wholesale Control	Water Resources	Water Network Plus			Total (Pre-Efficiency)
Business Unit Allocation	***01 Water Resources***	***02 Raw Water Distribution***	***03 Water Treatment***	***04 Treated Water Distribution***	
Total Investment (%)	**11.6%**	**0.5%**	**13.7%**	**74.2%**	**100%**
Total Investment	**£22.904m**	**£0.931m**	**£27.043m**	**£146.466m**	**£197.345m**
Maintaining the long term capability of the assets - infra	£3.612m (1.8%)	£0.136m (0.1%)	£0m (0%)	£65.291m (33.1%)	**£69.039m (35%)**
Maintaining the long term capability of the assets - non-infra	£11.575m (5.9%)	£0.795m (0.4%)	£26.543m (13.5%)	£40.950m (20.8%)	**£79.863m (40.5%)**
Other capital expenditure - infra	£2.765m (1.4%)	£0m (0%)	£0m (0%)	£38.129m (19.3%)	**£40.895m (20.7%)**
Other capital expenditure - non-infra	£4.952m (2.5%)	£0m (0%)	£0.500m (0.3%)	£12.879m (6.5%)	**£18.331m (9.3%)**
Infrastructure network reinforcement	£0m (0%)	£0m (0%)	£0m (0%)	£4.329m (2.2%)	**£4.329m (2.2%)**
Grants & contributions	£0m (0%)	£0m (0%)	£0m (0%)	-£15.112m (-7.7%)	**-£15.112m (-7.7%)**

Source: NTPBP-CAL-INV-0738

2.2 Summary of Proposed Interventions

Table 3 below provides a summary of the total number of interventions being proposed in our investment plan, and within each investment case.

Table 3: Summary of the Number of Proposed Interventions in Each Investment Case

Investment Case	Total No. of Interventions
Trunk Mains and Pipe Bridges	12
Distribution Mains	52
Service Reservoirs and Towers	1
Water Pumping Stations	6
Bulk Meters and Pressure Control Valves	2
Customer Meters	4
Network Ancillaries	4
Network Monitoring	2
Leakage	4
New Development	3
Water Resources	7
Raw Water Distribution	2
Raw Water Pumping Stations	1
Treatment Works Strategic Maintenance	8
ICA and Telemetry	1
Resilience	4
IT	32
Management and General	31
Environment	10
Infrastructure Base Maintenance	3
Non-Infrastructure Base Maintenance	3
Total	**192**

2.3 Contribution to Performance Improvement

Table 4 set outs the percentage contribution to performance commitment improvement provided by our investment cases.

The performance improvements required to meet our performance commitment targets are met entirely through our investment cases for nine out of the fourteen performance commitments that we have measured.

We will not achieve the required performance improvement for five of our performance commitments through implementation of interventions detailed in our investment cases. The reasons for this are described in more detail below.

2.3.1 Per Capita Consumption

In total 26.72% of performance improvement is achieved through interventions within investment cases. The remaining performance improvement will be achieved as a result of a wider customer education programme.

2.3.2 Unplanned Maintenance – Non-Infrastructure

Our investment cases contribute 23.24% towards our AMP7 target. We will achieve the remaining performance improvement through our day to day operational maintenance activities.

2.3.3 Biodiversity Index

Over AMP7, interventions within our Environment investment case will contribute 50% of the biodiversity index performance improvement required in AMP7. Additional biodiversity index points will be achieved over the AMP via the delivery of the site specific management plans, where habitat management proactively influences the quantity and condition of the company's environmental assets. This site specific management delivery is not included as interventions in our investment cases but the work will be delivered via partnership working across the business and with external stakeholders.

2.3.4 Water Quality Compliance

Approximately half of our performance improvement for AMP7 will be achieved through investment in trunk mains, treatment works strategic maintenance and network ancillaries. We will achieve the remaining performance improvement by enhancing management of our assets, reducing risk with proactive interventions (such as flushing mains), and improving operational procedures to quickly resolve problems.

2.3.5 Unplanned Outage

Our AMP7 target for unplanned outage is to sustain our 2019/20 performance level of 1.74%. Our investment in raw water pumping stations, treatment works strategic maintenance and ICA and telemetry will support our ability to sustain this level of performance.

Table 4: Performance Commitment Targets and Percentage Contribution from Treatment Works Strategic Maintenance

Performance Commitment	Unit	2019/20 Baseline	2024/25 Target	Total Targeted Performance Commitment Improvement in AMP7	Trunk Mains and Pipe Bridges % Contribution to Performance Commitment Target	Distribution Mains % Contribution to Performance Commitment Target	Service Reservoirs and Towers % Contribution to Performance Commitment Target	Water Pumping Stations % Contribution to Performance Commitment Target	Bulk Meters and Pressure Control Valves % Contribution to Performance Commitment Target	Customer Meters % Contribution to Performance Commitment Target	Network Ancillaries % Contribution to Performance Commitment Target	Network Monitoring % Contribution to Performance Commitment Target	Leakage % Contribution to Performance Commitment Target	New Development % Contribution to Performance Commitment Target	Water Resources % Contribution to Performance Commitment Target	% Contribution to Performance Commitment Sub Total
Water Quality Compliance	Index	1.27	0.00	-1.27	n/a	-	-	-	-	-	n/a	-	-	-	-	**n/a**
Supply Interruptions	Average mins per property	12.20	1.8	-10.40	46.37%	33.65%	-	3.28%	-	-	-	13.68%	-	-	-	**96.98%**
Mains Bursts	Per 1000km	142	133	-9	0.72%	94.80%	-	-	-	-	-	4.48%	-	-	-	**100%**
Unplanned Outage	%	1.74	1.74	0	-	-	-	-	-	-	-	-	-	-	-	**n/a**
Customer Contacts About Water Quality - Appearance	Contacts per 1,000 population	0.93	0.43	-0.50	10.48%	83.17%	-	-	-	-	-	6.35%	-	-	-	**100%**
Properties at Risk of Receiving Low Pressure	Number of properties	69	60	-9	-	-	-	78.43%	-	-	-	21.57%	-	-	-	**100%**
Unplanned Maintenance – Non-Infrastructure	Number of events	3,976	3,272	-704	-	-	-	7.30%	-	-	-	-	-	-	-	**7.3%**
Population at Risk From Asset Failure	No. of people (population)	832,886	290,000	-542,886	-	-	-	-	-	-	-	-	-	-	-	**0%**
Leakage	Ml/d	43	36.5	-6.5	0.21%	7.33%	-	-	1.49%	-	3.79%	3.13%	84.05%	-	-	**100%**
Per Capita Consumption	Litres/ head/ day (l/h/d)	142	135	-7	-	-	-	-	-	26.43%	-	0.29%	-	-	-	**26.72%**
Meter Penetration	%	65.9	75.0	+9.1	-	-	-	-	-	83.78%	-	-	-	16.22%	-	**100%**
Raw Water Quality of Sources	Kg of phosphorous loss reduction	0	531	+531	-	-	-	-	-	-	-	-	-	-	-	**0%**
Biodiversity Index	Index	17,659	17,711	+52	-	-	-	-	-	-	-	-	-	-	-	**0%**
WINEP Compliance	%	n/a	100	+100	-	-	-	-	10%	-	-	-	-	-	-	**10%**

Performance Commitment	Unit	2019/20 Baseline	2024/25 Target	Total Targeted Performance Commitment Improvement in AMP7	Raw Water Distribution % Contribution to Performance Commitment Target	Raw Water Pumping Stations % Contribution to Performance Commitment Target	Treatment Works Strategic Maintenance % Contribution to Performance Commitment Target	ICA and Telemetry % Contribution to Performance Commitment Target	Resilience % Contribution to Performance Commitment Target	IT % Contribution to Performance Commitment Target	Management and General % Contribution to Performance Commitment Target	Environment % Contribution to Performance Commitment Target	% Contribution to Performance Commitment Sub Total	% Contribution to Performance Commitment Total
Water Quality Compliance	Index	1.27	0.00	-1.27	-	-	n/a	-	-	-	-	-	**n/a**	**n/a**
Supply Interruptions	Average mins per property	12.20	1.8	-10.40	-	-	-	0.24%	2.78%	-	-	-	**3.08%**	**100%**
Mains Bursts	Per 1000km	142	133	-9	-	-	-	-	-	-	-	-	**0%**	**100%**
Unplanned Outage	%	1.74	1.74	0	-	n/a	n/a	n/a	-	-	-	-	**n/a**	**n/a**
Customer Contacts About Water Quality - Appearance	Contacts per 1,000 population	0.93	0.43	-0.50	-	-	-	-	-	-	-	-	**0%**	**100%**
Properties at Risk of Receiving Low Pressure	Number of properties	69	60	-9	-	-	-	-	-	-	-	-	**0%**	**100%**
Unplanned Maintenance – Non-Infrastructure	Number of events	3,976	3,272	-704	-	0.74%	15.20%	-	-	-	-	-	**15.94%**	**23.24%**
Population at Risk From Asset Failure	No. of people (population)	832,886	290,000	-542,886	-	-	-	-	100%	-	-	-	**100%**	**100%**
Leakage	Ml/d	43	36.5	-6.5	-	-	-	-	-	-	-	-	**0%**	**100%**
Per Capita Consumption	Litres/ head/ day (l/h/d)	142	135	-7	-	-	-	-	-	-	-	-	**0%**	**26.72%**
Meter Penetration	%	65.9	75.0	+9.1	-	-	-	-	-	-	-	-	**0%**	**100%**
Raw Water Quality of Sources	Kg of phosphorous loss reduction	0	531	+531	-	-	-	-	-	-	-	100%	**100%**	**100%**
Biodiversity Index	Index	17,659	17,711	+52	-	-	-	-	-	-	-	50%	**50%**	**50%**
WINEP Compliance	%	n/a	100	+100	-	-	-	-	-	-	-	90%	**90%**	**100%**

3 How Customers Have Shaped our Performance Commitments

3.1 Overview

Customer priorities relating to our outcomes, performance commitments and outcome delivery incentives have been determined through our extensive programme of customer engagement and Research. During the development of our business plan, we have engaged with over 37,000 customers and conducted over fifty pieces of research. We have engaged effectively with customers on a variety of topics, including longer-term issues such as resilience. During this process we have taken into account the needs and requirements of our different customer base, including future customers, to develop a plan that reflects their priorities and the services they value. Through this process, our high level objectives that customers value most, known as outcomes, have been identified as:

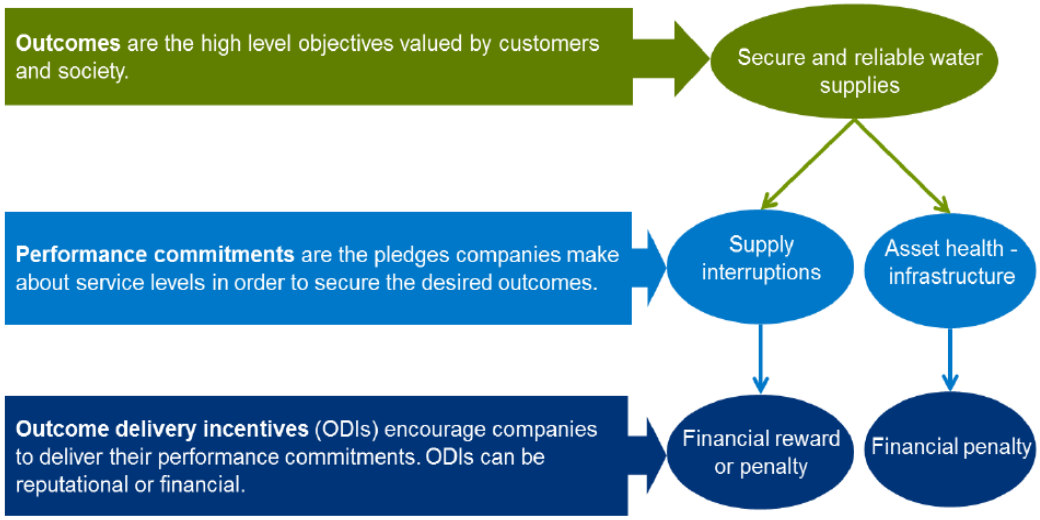
- Excellent Customer Experiences;
- Safe and Reliable Supply of Water;
- Local Community and Environmental Resilience; and
- Corporate Financial Resilience.

To secure these outcomes, and based on the customer priorities, we have developed innovative and sector-leading performance commitments, together with corresponding outcome delivery incentives. The performance commitments are therefore, in effect, a measure of what our customers want.

3.2 Outcomes Framework

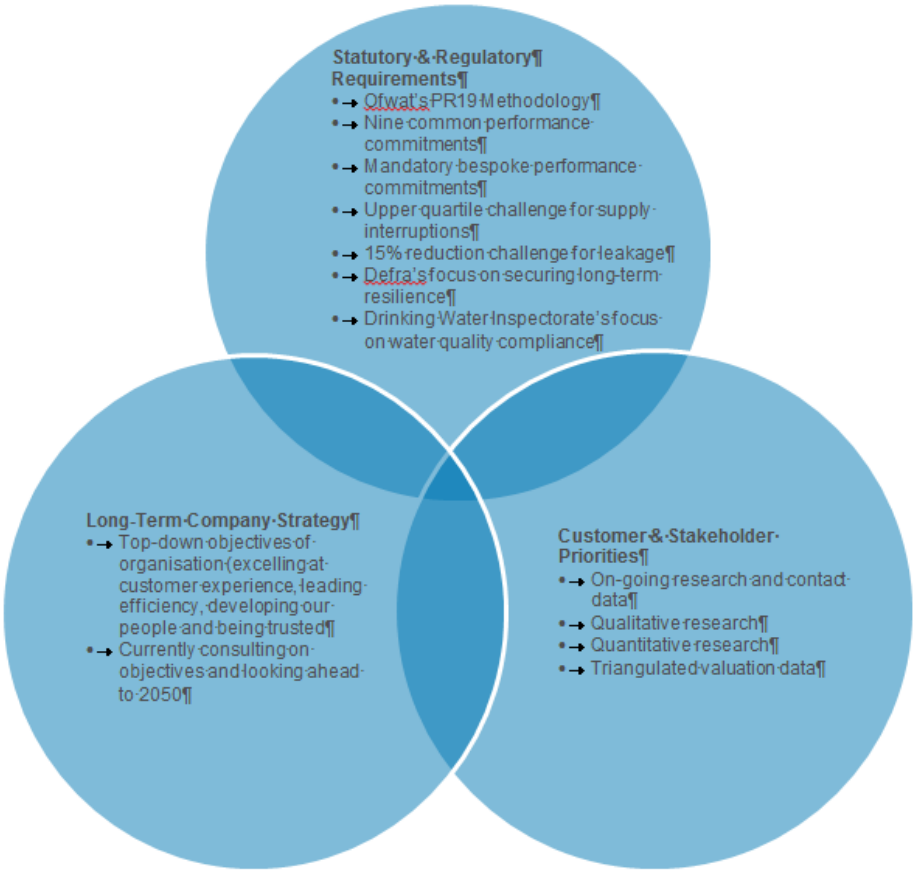
The process described in section 3.1 above is referred to as the Outcomes Framework and is shown visually in Figure 4 below.

Figure 4: Outcomes Framework



Key influences of the Outcomes Framework are shown below in Figure 5.

Figure 5: Key influences of the Outcomes Framework



3.3 How We Have Engaged with our Customers

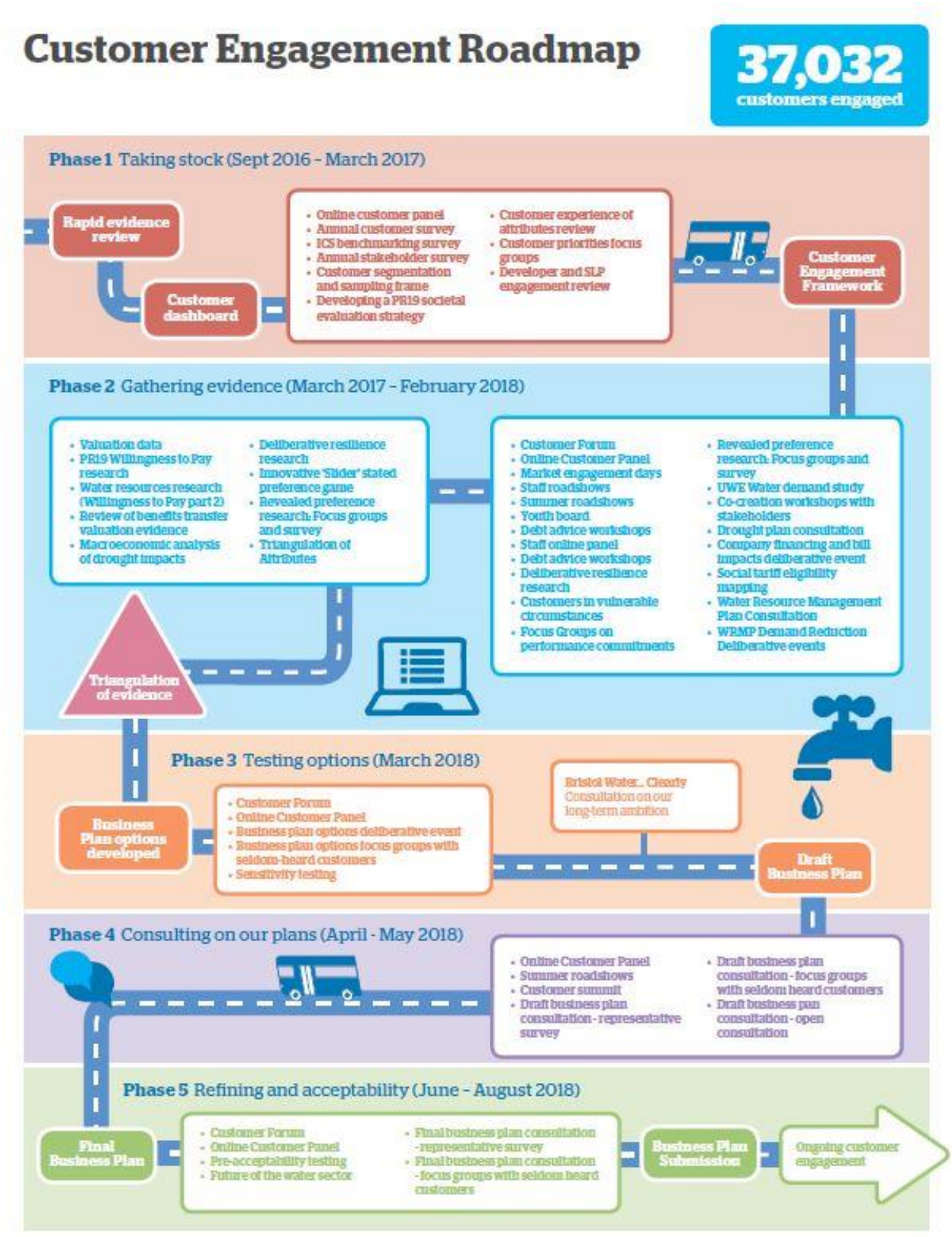
We have taken every opportunity to engage our customers throughout the development of our business plan and we will continue to do so beyond its submission. We have engaged with over 37,000 customers since we started on our journey of preparing our submission (see Figure 6). Our research approach has ensured that we have a robust, balanced and proportional evidence base to really understand our customers' priorities and expectations. We have used a mix of engagement methods and research approaches, including quantitative, qualitative and behavioural research. As well as this, we have drawn on data from a wide range of sources, including customer contacts and complaints[3].

We have taken a phased approach to engagement, during which we have taken stock of our existing understanding, gathered evidence on customer views and opinions, tested our proposed options with customers, consulted on our plans, and then refined our final proposal. Throughout these stages we have sought to ensure that our engagement activities are customer focussed, transparent, accessible, relevant and sustainable.

Throughout the programme, we have made improvements to our business as usual work, as well as developing a business plan that reflects the priorities of our customers and the services they value. We are proud of our customer engagement work and believe it represents a step change in how we as a water company, relate to the communities we serve. Further, this insight has helped to shape the development of our performance commitments, outcome delivery incentives and outcomes. A full description of this research can be found in section C1of our business plan.

[3] A1: Customer dashboard

Figure 6: Customer Engagement Roadmap



3.4 Customer Willingness to Pay

Understanding what our customers believe to be a fair price to pay for our services was an essential part of developing our business plan. We conducted a range of valuation research to ensure that our business plan delivers the outcomes that our customers value, at a price they are willing to pay. Critically, we evaluated and triangulated the findings of all seven valuation studies outlined in Figure 7 below, to give us high, low and central estimates of customer valuations. The breadth of the research techniques used helped to ensure that the resultant valuations provide a robust, balanced and proportional evidence base, triangulated to support the cost benefit analysis for the business plan.

When we compared the valuations of our domestic and non-domestic customers, we found that in most cases, our non-domestic customers (including small and large businesses) are prepared to pay more than individual households, except in the case of metering.

When combined with qualitative insights about customers' expectations for their supply, our research suggested that they want us to do more for less.

For a detailed explanation of how our Outcomes Framework has been driven by the preferences and priorities of our customers, and the service levels that represent the most beneficial option at a cost that customers view as good value, see section C3 of our business plan.

Figure 7: Triangulation of our Valuation Studies

3.5 Customer Priorities and Performance Commitments

Through our Outcome Framework and customer engagement programme, we have developed 17 bespoke performance commitments, to complement the 9 common performance commitments defined by Ofwat. These are shown in Table 5 below. Definitions of each performance commitment are provided in Appendix A.

Table 5: Our Performance Commitments forAMP7

Performance Commitment	Source	Additional Information
Water quality compliance	PR19 Final Methodology, New Measure	Common performance commitment
Supply interruptions	PR19 Final Methodology, Alignment of Industry Standard Measure	Common performance commitment
Mains bursts	PR19 Final Methodology, PR14 Performance Commitment	Common performance commitment
Unplanned Outage	PR19 Final Methodology, New Measure	Common performance commitment
Risk of severe restrictions in a drought	PR19 Final Methodology, New Measure	Common performance commitment
Customer contacts about water quality – appearance	PR19 Final Methodology, PR14 Performance Commitment	Disaggregated from negative water quality contacts performance commitment Included in Ofwat's long-list of asset health performance commitment s
Customer contacts about water quality – taste and smell	PR19 Final Methodology, PR14 Performance Commitment	Disaggregated from negative water quality contacts performance commitment Included in Ofwat's long-list of asset health performance commitment s
Properties at risk of receiving low pressure	PR19 Final Methodology, PR14 Performance Commitment	Disaggregated from asset reliability (infrastructure) Included in Ofwat's long-list of asset health performance commitment s
Turbidity performance at treatment works	PR14 Performance Commitment	Disaggregated from asset reliability (non-infrastructure)
Unplanned maintenance – non-infrastructure	PR19 Final Methodology, PR14 Performance Commitment	Disaggregated from asset reliability (non-infrastructure) Included in Ofwat's long-list of asset health performance commitment s

Performance Commitment	Source	Additional Information
Population at risk from asset failure	PR19 Final Methodology, PR14 Performance Commitment	Mandatory requirement for at least one 'resilience' performance commitment
Customer measure of experience (C-MeX)	PR19 Final Methodology, New Measure	Common performance commitment
Developer services measure of experience (D-MeX)	PR19 Final Methodology, New Measure	Common performance commitment
Percentage of customers in water poverty	PR14 Performance Commitment	-
Value for money	PR14 Performance Commitment	-
Percentage of satisfied vulnerable customers	PR19 Final Methodology, New Measure	Mandatory requirement for at least one 'customer vulnerability' performance commitment
Void properties	PR19 Final Methodology, New Measure	Ofwat expectation that this be included
Leakage	PR19 Final Methodology, PR14 Performance Commitment	Common performance commitment
Per capita consumption (PCC)	PR19 Final Methodology, PR14 Performance Commitment	Common performance commitment
Meter penetration	PR19 Final Methodology, PR14 Performance Commitment	Mandatory requirement for at least one 'environmental' performance commitment
Raw water quality of sources	PR19 Final Methodology, PR14 Performance Commitment	Mandatory requirement for at least one 'environmental' performance commitment
Biodiversity index	PR19 Final Methodology, PR14 Performance Commitment	Mandatory requirement for at least one 'environmental' performance commitment
Waste disposal compliance	PR19 Final Methodology, PR14 Performance Commitment	Mandatory requirement for at least one 'environmental' performance commitment
Water industry national environment programme (WINEP) compliance	New Performance Commitment	-
Abstraction Incentive Mechanism (AIM)	PR19 Final Methodology, New Measure	Mandatory requirement for at least one 'AIM' performance commitment. This measure awaits confirmation from local area Environment Agency
Local community satisfaction	New Measure	-

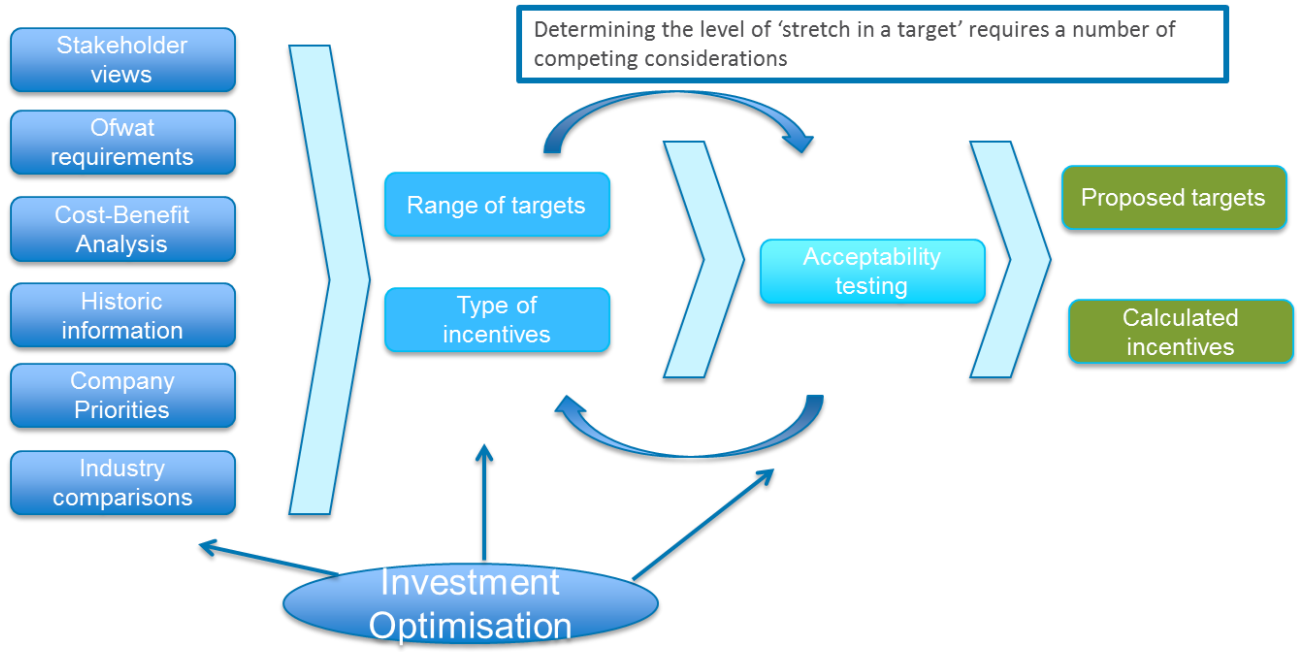
3.6 Performance Commitment Targets for the Suggested Plan

For each performance commitment we have set a target level to be achieved by 2025. Within our App1 data table submission and section C3 of our business plan, we also set out the annual targets from 2020.

Ofwat requires performance targets to be stretching and has mandated targets for some performance commitments.

The approach we have used to set stretching performance target levels is shown in Figure 8 below.

Figure 8: Setting Stretching Performance Target Levels



To set a stretching target for each performance commitment, we have used a number of sources of information. These are described in Table 6 below.

Table 6: Sources of Information for Setting Performance Commitment Targets

Source of information	How the information was used
Customer and Stakeholder Views	Through a management review process, research summaries were used, together with customer valuation results, to develop target options to be tested through our investment planning process.
Legal and Regulatory Requirements	Through a management review process, legal and regulatory requirements were used to identify a minimum programme of activity.
Cost-Benefit Analysis	All target options are analysed in the company's optimisation process, to produce the optimal set of interventions to meet performance targets that, are acceptable to our customers. The avoidance of risk plays a substantial part of this analysis.

Source of information	How the information was used
Comparative Information	Using robust comparative information on other companies' performance (and sometimes other sectors' performance) to inform service levels.
Historical Information	Using information on our previous performance to inform our service level.
Minimum Improvement	Using a minimum improvement based on improvements seen in the past.
Maximum Level Attainable	Using the maximum possible level of performance as the reference point for setting the service level.
Expert Knowledge	Considering expert knowledge about possible improvements that are not captured in the above approaches. For example, asset health performance commitments may be informed by engineering expertise and/ or models about what improvements can be made in the future.

Full details of the approach taken for setting the target for each performance commitment are provided within section C3 of our business plan.

Our final targets for PR19 are shown in Table 7 below.

Table 7: PR19 Performance Commitment Targets

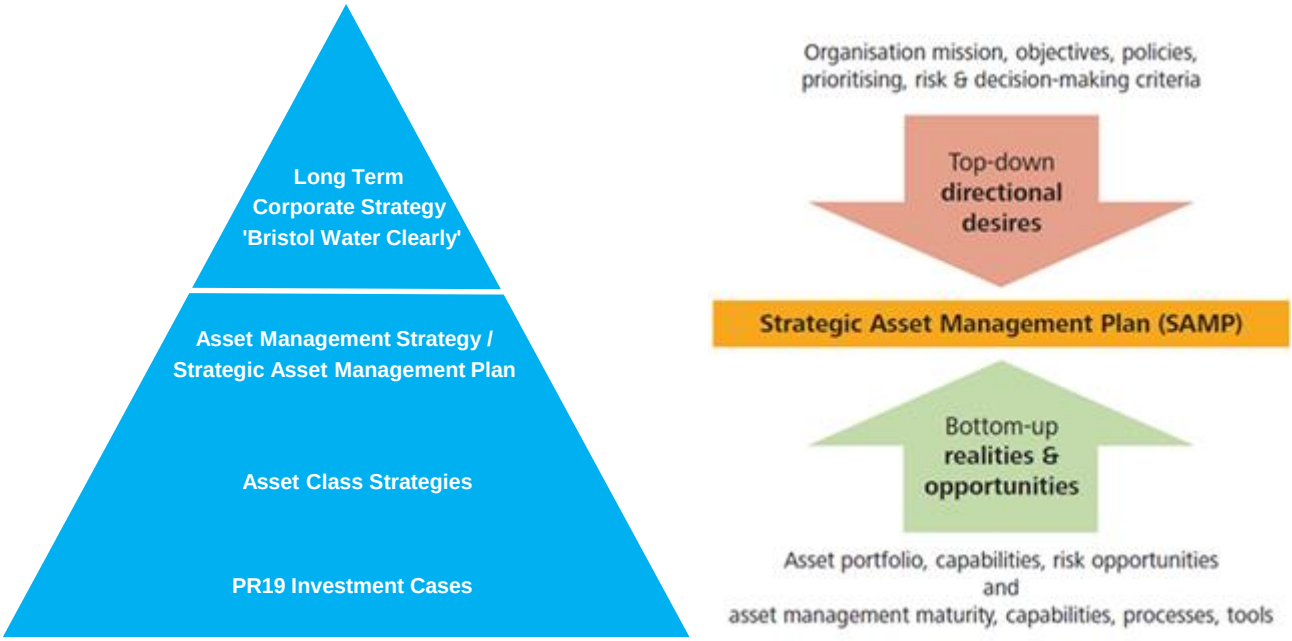
Performance Commitment	Unit	2019/20 Baseline	AMP7 (2024/25) Target
Customer Measure of Experience (C-MeX)	Index	-	TBC
Developer Services Measure of Experience (D-MeX)	Index	-	TBC
Percentage of Customers in Water Poverty	%	1.8	1.0
Value for Money	%	72	83
Percentage of Satisfied Vulnerable Customers	%	85	85
Void Properties	%	1.9	1.8
Water Quality Compliance	Index	1.27	0
Supply Interruptions	Minutes/Property/Year (all interruptions > 3hrs)	12.2	1.8
Mains Bursts	Bursts/1,000km	142	133
Unplanned Outage	Ml/day	1.74	1.74

Performance Commitment	Unit	2019/20 Baseline	AMP7 (2024/25) Target
Risk of Severe Restrictions in a Drought	No. of People	0	0
Customer Contacts About Water Quality – Appearance	No. of Contacts per 1,000 Population	0.93	0.43
Customer Contacts About Water Quality – Taste and Smell	No. of Contacts per 1,000 Population	0.44	0.25
Properties at Risk of Receiving Low Pressure	No. of Properties per 10,000 Connections	69	60
Turbidity Performance at Water Treatment Works	No. of Failures	0	0
Unplanned Maintenance - Non-Infrastructure	No. of Jobs	3,976	3,272
Population at Risk From Asset Failure	No. of People	832,886	290,000
Leakage	Ml/day	43	36.5
Per Capita Consumption (PCC)	Litre Per Head Per Day	142	135
Meter Penetration	%	65.9	75
Raw Water Quality of Sources	Kg of Phosphorous	0	531
Biodiversity Index	Index	17,658	17,711
Waste Disposal Compliance	%	100	100
Water Industry National Environment Programme (WINEP) Compliance	%	100	100
Abstraction Incentive Mechanism (AIM)	%	0	2,843.4
Local Community Satisfaction	%	85	85

4 Strategy

We have developed our business plan ensuring there is a 'line of sight' from our long-term corporate strategy to our customers, through the strategic asset management hierarchy set out in Figure 9 below. The development of this hierarchy and our Asset Management Framework, which is detailed in our Asset Management Strategy, provides a top-down and bottom-up approach to developing our business plan, where we can demonstrate that the individual investment cases are aligned to the delivery of our customer outcomes, achieving the long-term ambitions for our customers, stakeholders and regulators.

Figure 9: Our Strategic Hierarchy



4.1 Our Strategic Vision

In February 2018, we published 'Bristol Water Clearly'[4], our ambition for the future of Bristol Water for the next 25 years. This sets out our established corporate vision, which is '*Trust beyond water – we provide excellent experiences'*, and our corporate mission, which is to be '*A company that communities trust and are proud of. To deliver excellent experiences and create social and economic value*'.

Our ambitions are based on the things that our customers have told us, through customer engagement, are their priorities. A summary of these ambitions is sown in Figure 10.

[4] Bristol Water, 2018. *Bristol Water Clearly - Our long-term ambition for excellent community water experiences 2018*.

Figure 10: A summary of our future ambition set in 'Bristol Water Clearly'

Based on these priorities, we have established four key long-term outcomes to measure our progress against. These outcomes (listed below) set the strategic direction for the company.

- Excellent Customer Experiences – we will transform our customer service to provide an excellent experience at every single interaction with out customers and our communities;
- Safe and Reliable Supply of Water – we look after our assets to provide high quality, reliable supplies for present and future generations;
- Local Community and Environmental Resilience - we make our services robust to what the future may hold, through collaborative working with our communities and through protecting and enhancing our local environment; and
- Corporate and financial resilience – we achieve leading levels of efficiency through innovation. We secure the financing we need to smooth out the cost of our investment. Our bills are affordable for all, by keeping them low in the first instance, but also by helping those who struggle to pay.

At Bristol Water we recognise the importance of adopting good practice asset management and consider it a critical factor in achieving our corporate vision, mission and outcomes.

All of the investment within our business plan supports our long-term ambitions and delivery of our outcomes. This is discussed in detail within each investment case.

4.2 Our Asset Management Vision

Since PR14 we have restructured internally and created an Asset Management Directorate and appointed a dedicated Asset Management Director. This change has refocused the asset management capability here at Bristol Water, allowing us to deliver the outcomes outlined above.

Aligned to, and in direct support of, our corporate vision and mission, we have declared the following vision for Asset Management '*We aspire to leading asset management practices, as we consider this a critical factor in achieving our strategic objectives of excellent customer experience, leading efficiency, and being trusted by our customers, regulators, employees and other stakeholders*'.

We will realise our asset management vision through implementation of our Asset Management Strategy and Strategic Asset Management Plan.

4.2.1 Asset Management Strategy

Our Asset Management Strategy fulfils the requirements of the Strategic Asset Management Plan required by ISO55001. It is an overarching document that sets out the direction of travel for achieving our asset management ambitions and is aligned with our corporate strategic objectives, which in turn are there to deliver the external expectations and requirements placed upon us by our customers, regulators and stakeholders. It covers all of the requirements of a Strategic Asset Management Plan, as required by ISO55001 and documents the high level strategic intent for asset management here at Bristol Water, summarising:

- Where we intend to be, and by when;
- How we intend to operate now, and in the future;
- What high level actions will get us to our long-term position; and
- How achievement is to be monitored, reviewed and acted upon.

In 2018 we embarked upon an ambitious Asset Management Capability Improvement Programme, with the intention of transforming our asset management capability, in readiness for the delivery of AMP7, achieving ISO55001 accreditation in 2023.

Our Asset Management Strategy applies from 2018 until 2030 and will take us through the development and submission of our PR19 business plan, mobilisation and delivery of AMP7, and the development of the business plan submission at PR24 and PR29, in readiness for AMP8 and AMP9 respectively.

The Asset Management Strategy will be reviewed on an annual basis as a minimum, and updated as and when required to reflect major changes in capability requirements, macroeconomic shifts and developments in innovation or technology.

The approaches within our Asset Management Strategy cover the whole asset lifecycle, from the generation of risks through to the creation and maintenance of assets, including operation and day to

day maintenance, to the end of life and disposal. Overall, it provides for the ability to manage our assets to deliver our declared outcomes.

Our Asset Management Strategy is a key document in our strategic hierarchy (see Figure 9) thus enabling 'line of sight' from our long-term corporate strategy through to the development of our investment cases.

Our investment cases articulate the bottom-up asset Interventions that are required in AMP7 to achieve the outcomes that our customers, regulators and other stakeholders have told us they expect.

4.2.2 Asset Management Framework

Our Asset Management Framework is designed to enable the efficient and effective planning and delivery of all our asset related activities to successfully deliver our Asset Management Strategy and business outcomes. Activities that make up our Asset Management Framework are detailed in our Asset Management Strategy document.

As part of the continuing development of our Asset Management Strategy and Framework, we will create Asset Class Strategies, to allow specific approaches and strategies to be developed and applied appropriately. Within each asset class, segregation will breakdown further the commonality of the assets, considering both physical/technical similarities and differences (for example size and materials) and non-physical/technical similarities and differences (for example operating in high /low grit raw water area, or proximity to customers or protected environmental sites).

4.3 Transformation Programme

Our Transformation Programme has been developed throughout 2018. Our Board recognised the ambitious nature of our business plan, and oversaw the development of a Transformation Programme organised independently of the plan preparation in order to ensure it could be delivered.

Since the last Price Review, which resulted in the 'prescribed' status of the company under Ofwat's monitoring framework, we have responded to our challenges by beginning to transform ourselves. We have re-shaped our company to reduce costs, we have a new management team in place, we have a new majority (80%) UK shareholder (iCON Infrastructure), and our Board has also changed and established much stronger corporate governance and assurance of our plans. However, our transformation is by no means complete and we will continue to evolve over the coming years.

We are now embarking on a new phase of our transformation; developed from the ground up and with the right people, processes, and systems to deliver the range of improvements needed. Our transformation will instil a commitment-based performance culture. We are implementing a new field-force management system, changing our supply chain to streamline our processes and bringing more accountability and control back into our organisation. The Transformation Programme will result in a 25% increase in direct employee numbers and improved skills and competencies and place customer experience as a core deliverable. Our investment in end-to-end information technology will provide our customers with better experiences when they contact us. We are also developing our asset management capability (as discussed in section 4.2) and reducing the cost of operating our assets through innovative technical solutions.

4.4 Water Resources Management Plan

Our Water Resources Management Plan presents the analysis required by our regulators and Government to support our long-term plans for water resource management. It includes a full assessment of significant long-term issues such as population growth and climate change, and ensures we have plans in place to enable us to continue providing a reliable supply of water to our customers while supporting a healthy environment and maintaining the level of service our customers expect at an affordable cost. Where we identify a need for action because there is a potential shortfall in available water (known as a supply-demand deficit), we assess a range of options to manage this deficit.

All water companies are required to produce a Water Resources Management Plan and to update it every five years. Each Water Resources Management Plan builds on the one before, updating the plan based on the latest information, technology, regulatory guidance and the views of our customers and stakeholders.

Our business plan and Water Resources Management Plan are closely linked. Any projects and solutions required to address a supply demand deficit are evaluated in the Water Resources Management Plan, but the detailed delivery plans for these projects and solutions are developed as part of the business plan process. The investment that covers the production and implementation of Water Resources Management Plan 24 is discussed in detail within the Water Resources investment case.

4.5 Drinking Water Safety Plan

Drinking Water Safety Plans are risk assessments of water supply systems from source to tap. They identify hazards relating to water quality and sufficiency of supply, and examine a company's operational and maintenance arrangements that could potentially impact on the company's ability to supply wholesome drinking water. We have to complete a Drinking Water Safety Plan for all catchments, abstraction points, treatment works, service reservoirs, water supply zones and bulk supply points that we utilise.

We are required to produce risk assessments according to the Drinking Water Safety Plan approach to comply with Regulation 27 and 28 of the Water Supply (Water Quality) Regulations 2018. These regulations are recognised as current national and international good practice for water supply management. We are required to keep our Drinking Water Safety Plan under continual review and report any updates to the Drinking Water Inspectorate via monthly and annual submissions. Our Drinking Water Safety Plan approach is documented in our Drinking Water Safety Plan Methodology and Drinking Water Safety Plan Risk Review procedures, which outline how we will risk assess our assets, calculate risk scores to assign a risk classification, and the criteria for reviewing risk assessments.

Where a risk assessment identifies an unacceptable or medium risk, the Drinking Water Inspectorate expect us to manage and mitigate the risk within a timely, effective and efficient manner, to the benefit of consumers, by identifying and implementing additional control measures. In order to facilitate this process, we add all unacceptable and medium risks to the Operational Risk Register for investigation and development of potential solutions to address the risks. Where we conclude that a capital scheme is required to manage or mitigate the risk, we consider including these in our submission to the Drinking

Water Inspectorate as part of the periodic review process, with the risk assessment forming an integral part of the justification for the scheme. For the Drinking Water Inspectorate to support a drinking water quality scheme a risk assessment must be submitted alongside the proposal, otherwise it will be rejected. Once a proposal has been supported by the Drinking Water Inspectorate, the Inspectorate issues a 'notice' or 'undertaking' in the form of legal instruments, which confirm the statutory requirements placed upon us to meet drinking water requirements.

Schemes supported by the Drinking Water Inspectorate are discussed in detail in our Network Ancillaries and Treatment Works Strategic Maintenance investment cases.

4.6 Draft Water Efficiency Strategy

This is our outline seven-year plan to provide water efficiency support to household customers over the remaining years of AMP6 and throughout AMP7. The paper proposes a change of approach from the current level of activity in AMP6, moving to a strategic partnership approach with key stakeholders in the West of England in order to build on our unique role at the heart of the local community. Under this proposal, expenditure on household water efficiency activity will return to the level applied in AMP5 (an increase from £50-100k/a). Water efficiency was not identified as a directly cost-beneficial intervention during assessment of water resource management options for WRMP19, but customer preference in this area is clear and shows that customers put a high value on water efficiency as a key mechanism for reducing demand and increasing resilience.

Our approach will involve partnerships with a range of organisations such as local government, the Local Enterprise Partnership, housing developers, other water companies and academic institutions. We have recruited a water efficiency manager to develop existing strategic partnerships and create new partnerships, building on our existing good standing in the West of England and within the UK water industry to provide industry leadership in a new approach to water efficiency.

4.7 Drought Plan

Our Drought Plan is an operational plan which lays out our approach for managing drought events that are outside the scope of normal water resource management. It has been produced in consultation with a wide range of external stakeholders but is not a strategic document. It outlines the framework that we would use for managing a drought if it were to occur under present circumstances and with existing infrastructure. Our response to drought set out in this plan reflects operation under our current company levels of service.

The investment detailed within our business plan to support and ensure delivery of our Drought Plan is discussed in detail within the Water Resources investment case.

5 External Influences and Compliance Obligations

5.1 Water Industry Act 1991

The Water Industry Act 1991 requires every water undertaker to develop and maintain an efficient and economical system of water supply within its area. It is therefore necessary that we ensure our assets are well managed, and repaired or replaced as necessary, to maintain a robust water supply system.

We have a statutory obligation under the Water Industry Act 1991 to ensure that we develop and maintain our water supply system, so that we can make water available to anyone requesting a new connection. Our obligations under this element of the legislation are addressed within our business plan through interventions within the New Development investment case. The broader obligation of this legislation to maintain our water supply system is addressed through all of the interventions proposed within our business plan.

Water Resource Management Plans are produced as part of a statutory process under Section 37 of the Water Industry Act 1991. We are required to provide domestic and non-domestic customers with a reliable supply of water for domestic and business purposes. The Water Act 2003 amended the Water Industry Act 1991, by introducing a statutory requirement for water companies to produce Water Resource Management Plans at least every five years, setting out how they would ensure that they are able to meet the demand for water that is expect to rise in the future. This element of the legislation also requires us to consult with customers and stakeholders on our Water Resource Management Plans. Our obligations relating to the production and implementation of Water Resource Management Plan 24 are addressed within our business plan through interventions within the Water Resources investment case.

5.2 Water Supply (Water Quality) Regulations 2016

We have a statutory obligation under the Water Supply (Water Quality) Regulations 2016 to ensure that all water supplied to our customers meets prescribed Water Quality Concentrations or Values. Within our business plan we are proposing investment that is specifically addressing risks in this area, including risks associated with lead communication pipes within the Network Ancillaries investment case, and the removal of lead from the supplied water at Alderly treatment works within the Treatment Works Strategic Maintenance investment case.

5.3 Drinking Water Inspectorate

The Drinking Water Inspectorate is responsible for ensuring that water companies in England and Wales supply safe drinking water that is acceptable to consumers, and meets the standards set down in law. In turn, we ensure that the water we supply meets these requirements by:

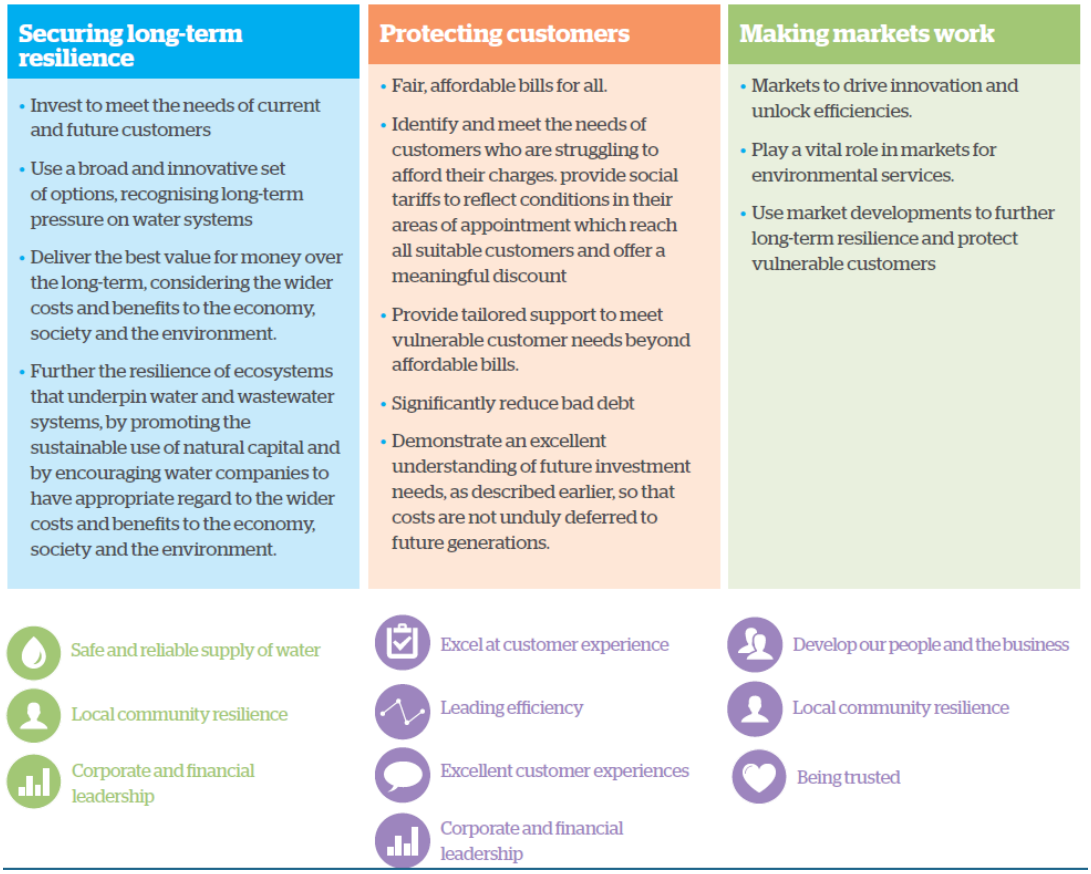
- Maintaining risk assessments that consider all aspects that affect drinking water quality; and
- Through extensive sampling of water quality in the environment, at treatment works, through our network and at customers' taps.

Our objective is to always deliver full compliance of our statutory obligations for drinking water. Our obligations are defined as undertakings for the Drinking Water Inspectorate. These undertakings are addressed within our business plan through interventions within the Environment, Treatment Works Strategic Maintenance and Network Ancillaries investment cases.

5.4 DEFRA's Strategic Policy Statement

DEFRA has published a Strategic Policy Statement for Ofwat which includes their expectations for water companies delivering for customers and the environment. Some of the key messages and expectations from this Strategic Policy Statement and how our objectives and outcomes align to this are shown below in Figure 11.

Figure 11: Alignment of our Objectives and Outcomes with DEFRA's Strategic Policy Statement



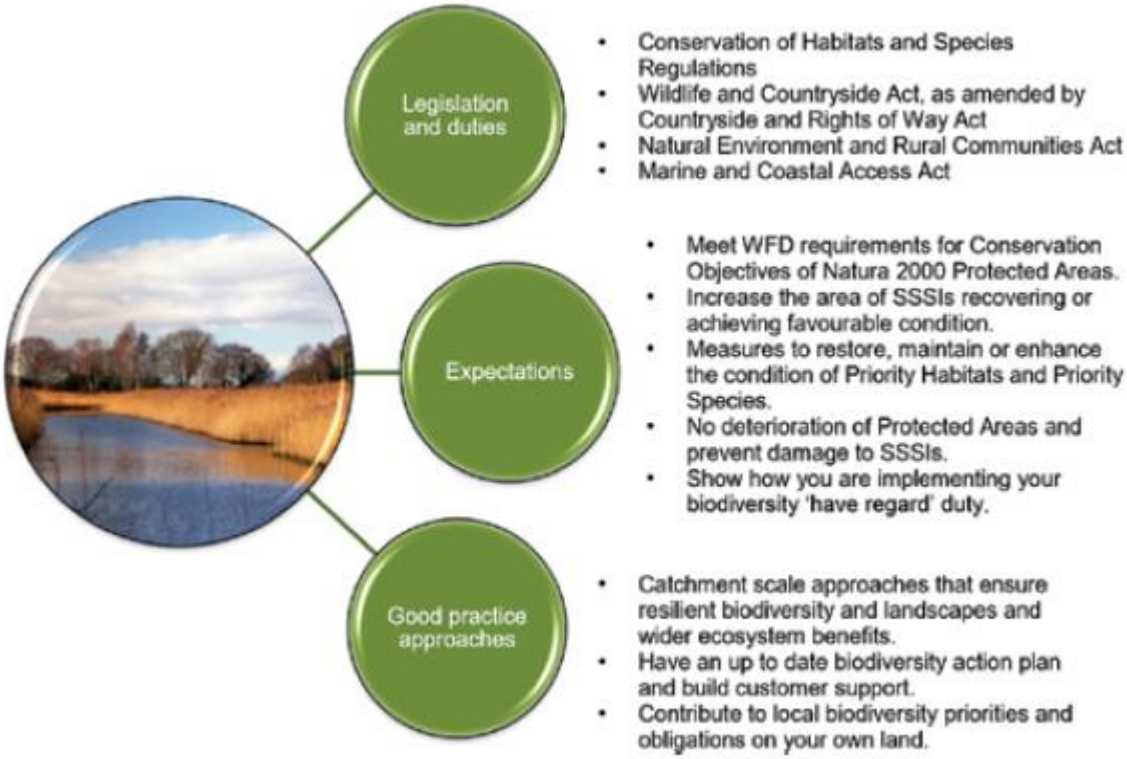
5.5 Environment Agency and the Water Industry National Environmental Programme

DEFRA's Strategic Policy Statement is supported by expectations from Natural England and the Environment Agency. Their priorities for us are listed below and shown visually in Figure 12:

- Enhance the environment;
- Improve resilience; and

- Sustain a high level of performance and operate in a way that best protects people and the environment.

Figure 12: Environmental obligations and expectations of water companies



We have statutory obligations to deliver environmental protection, as set down in the Water Industry Strategic Environmental Requirements document, produced by Natural England and the Environment Agency. The Water Industry Strategic Environmental Requirements document provides water companies with guidance on how to bring these obligations and expectations into the development of their business plans. The Water Industry Strategic Environmental Requirements document encourages companies to aim delivery beyond the statutory minimum and to seek opportunities to work innovatively in partnership with other organisations, to achieve wider benefits. It also promotes the principles of natural capital valuation and incorporation of such values in business plan decision making.

Our obligations are defined in the Water Industry National Environment Programme and as undertakings for the Drinking Water Inspectorate (see section 5.3). We have developed our Water Industry National Environment Programme in consultation with Natural England and the Environment Agency.

Inclusion of projects in the Water Industry National Environment Programme is driven by underlying legislation, including:

- Natural Environment and Rural Communities Act 2006;
- Wildlife and Countryside Act 1981;

- Conservation of Habitats and Species Regulations (Habs Regs) 2017; and the
- Water Framework Directive (WFD) (England and Wales) Regulations 2003 (Statutory Instrument 2003 No. 3242) for England and Wales.

Our Water Industry National Environment Programme obligations are addressed within our business plan through interventions within the Environment, Water Resources and Bulk Meters and Pressure Control Valves investment cases.

5.6 Reservoirs Act 1975

Large raised reservoirs, defined as having a capacity greater than 25,000m^3 sitting above natural ground level, fall under the Reservoirs Act 1975, as amended by Flood and Water Management Act 2010.

This Act identifies those reservoirs presumed to be high risk (greater than 110 years old) and provides a framework of inspection and maintenance to safeguard against failure of the dam and the consequential catastrophic impact on local communities, property and the environment.

Compliance with the Reservoirs Act 1975 is monitored by the EA. The Act requires suitably qualified reservoir engineers from an approved panel to provide mandatory recommendations and/or directions on actions that should be taken to maintain the reservoir and prevent dam failure. We have 14 large raised reservoirs which have been designated as high risk and therefore come under the requirement for inspection and maintenance as defined by this Act. The inspection and maintenance of these raised reservoirs are addressed within the business plan through interventions within the Water Resource investment case.

We have 2 service reservoirs that are covered by this Act and our duties under this element of the legislation are addressed within the business plan through interventions within the Service Reservoirs and Towers investment case.

5.7 Environmental Permitting Regulations 2010

All water companies have a statutory obligation to meet effluent discharge consent conditions for each of its licenced discharges. Our duties under this legislation are addressed within the business plan through interventions within the Bulk Meters and Pressure Control Valves investment case.

5.8 Environmental Protection Act 1990

We have a statutory obligation under the Environmental Protection Act 1990 to ensure that we prevent the release of pollution into the environment. We have specific interventions relating to our duties under this legislation within the Bulk Meters and Pressure Control Valves investment case.

5.9 Groundwater Regulations Act 2009

We have a statutory obligation under the Groundwater Regulations Act 2009, to prevent the discharge of hazardous substances and non-hazardous pollutants into groundwater, unless it is in accordance with permits granted to us by the Environment Agency. Our duties under this legislation are addressed

within the business plan through interventions within the Bulk Meters and Pressure Control Valves investment case.

5.10 Equality Act 2010

We own and manage around 900 hectares of land on and around our raw water reservoirs. We have a statutory obligation under the Equality Act 2010 to provide and maintain appointed access and disabled access to these areas. Our obligations to provide and maintain this access are addressed within our business plan through interventions within the Water Resources investment case.

5.11 Health & Safety Legislation

There are number of pieces of legislation that put a statutory obligation on all employers to protect the health, safety and welfare of their employees and members of the public. This includes a safe working environment for employees (office and field based) and safe assets that may be accessed by members of the public. Examples of such legislation are:

- The Health and Safety at Work Act 1974
- The Management of Health and Safety at Work Regulations 1999
- The Workplace Regulations 1992
- Active Fire Prevention - The Regulatory Reform (Fire Safety) Order 2005
- Asbestos Removal - The Control of Asbestos Regulations 2012
- Working at Height Improvements - The Work at Height Regulations 2005
- Confined Spaces - The Confined Spaces Regulations 1997
- Chemical Plant - Control of Substances Hazardous to Health Regulations 2002
- Electrical Safety - The Electricity at Work Regulations 1989
- Hazard Rectification – The Health and Safety at Work Act 1974

Our duties under health and safety legislation are addressed within the business plan through interventions in the Trunk Mains and Pipe Bridges and Management and General investment cases.

6 Comparison of Historical and AMP7 Investment

A summary of historical investment is provided in Table 8, along with our AMP7 investment in all investment cases. We have re-categorised data used in line with the scope of our investment cases. For historic data we have used the 2016/17 wholesale cost assessment data (data tables 1 and 2). Forecast data has been derived from PR19 data (data tables WS1 and WS2).

A detailed explanation of the varying levels investment between AMPs for each investment case is provided within the individual investment case documents. However, as can be seen from Table 8 and Table 2, we have a smaller capital programme in AMP7 and we will invest in fewer strategic maintenance schemes compared to AMP6 and will focus on capital maintenance.

Table 8: Comparison of Historical Investment and AMP7 Investment

Investment Case	AMP5 Total (£)	AMP6 Total[5] (£)	Investment Pre-Efficiency (£)	Investment With 8% Capex Efficiency (£)
Trunk Mains and Pipe Bridges	£48,539,000	£11,249,142	£10,731,755	£9,873,215
Distribution Mains	£69,562,000	£37,913,044	£37,693,780	£34,678,278
Service Reservoirs and Towers	£1,348,000	£3,107,580	£2,075,000	£1,909,000
Water Pumping Stations	£2,675,000	£939,054	£5,284,883	£4,862,092
Bulk Meters and Pressure Control Valves	£387,000	£403,077	£1,177,517	£1,083,316
Customer Meters	£13,952,000	£24,202,838	£13,469,400	£12,391,848
Network Ancillaries	£10,219,000	£11,337,013	£9,829,515	£9,043,154
Network Monitoring	£-	£227,100	£2,765,064	£2,543,859
Leakage	£2,503,000	£9,328,535	£5,910,000	£5,437,200
New Development	£27,742,000	£47,895,508	£24,776,000	£22,793,920
Water Resources	£10,597,000	£3,012,172	£8,025,730	£7,383,672
Raw Water Distribution	£13,268,000	£1,734,052	£252,735	£232,516
Raw Water Pumping Stations	£4,408,000	£221,726	£3,742,986	£3,443,547

[5] Made up of actuals for 2015/16, 2016/17 and 2017/18, and forecasts for 2018/19 and 2019/20.

Investment Case	AMP5 Total (£)	AMP6 Total[5] (£)	Investment Pre-Efficiency (£)	Investment With 8% Capex Efficiency (£)
Treatment Works Strategic Maintenance	£36,867,000	£24,357,360	£12,907,974	£11,875,336
ICA and Telemetry	£5,694,000	£2,494,482	£900,000	£828,000
Resilience	-£183,000	£20,705,879	£13,974,300	£12,856,356
IT	£9,783,000	£18,519,353	£16,126,643	£14,836,512
Management and General	£43,235,000	£15,442,966	£13,905,000	£12,792,600
Environment	£626,000	£5,678,492	£7,716,897	£7,099,545
Infrastructure Base Maintenance	- *	- *	£7,671,000	£7,057,320
Non-Infrastructure Base Maintenance	£6,859,000	£10,651,951	£9,191,873	£8,456,523
Gross Total Investment	**£327,364,000**	**£283,604,524**	**£212,457,052**	**£195,460,487**
Contributions	**-£19,283,000**	**-£20,040,942**	**-£15,112,000**	**-£13,903,040**
Net Total Investment	**£308,081,000**	**£263,563,582**	**£197,345,052**	**£181,557,447**

* AMP5 and AMP6 infrastructure base maintenance investment is included within the expenditure values for trunk mains, distribution mains, and network ancillaries set out above; these values include our investment in base maintenance asset replacement related activities as well as that related to strategic enhancement schemes.

7 Base Maintenance

Base maintenance covers the level of capital expenditure (capex) required to complete minor repair and rehabilitation works and customer-driven requirements. As such, it supports customer requirements by preserving asset functionality and delivering services. Maintaining our assets helps prevent failures.

Base maintenance relates to the expenditure required in any period to retain a base level of performance. By definition, it does not provide additional performance improvements. However, it is the foundation upon which strategic and enhancement schemes are built.

In the context of the investment cases, the term 'base maintenance' is taken to mean:

> *Minor capital works (with no engineering design and with lower levels of supervision) managed directly by Bristol Water's Operations directorates through simple procurement processes. These works are treated as programmes within the PR19 process, each representing relatively large numbers of small, like for like replacements of, for example, mechanical and electrical equipment, customer-driven requirements and works to resolve local health and safety issues. These works are on-going throughout the AMP periods.*

To maintain a base level of performance upon which performance improvement can be achieved, we have identified minimum levels of expenditure on both infrastructure and non-infrastructure assets.

These minimum levels have been determined through a combination of analysis of historical activity and costs, deterioration modelling to establish underlying asset deterioration, and cost-benefit analysis of investment options.

We have undertaken deterioration modelling and cost-benefit analyses using the industry standard Servelec Pioneer software tool, which is founded on the principles of the UK Water Industry Research Framework for Expenditure Decision Making6.

Excluded from the base maintenance investment cases are interventions or asset-related schemes that provide performance enhancements, or are strategic capital maintenance interventions. In the context of the investment cases, the term 'strategic interventions' are defined as:

> *Interventions that are individually reviewed through the Investment Planning process for PR19, and usually include larger projects that require more sophisticated or complex solutions or procurement processes, and that will normally require engineering design and delivery.*

And enhancements schemes are defined as:

> *Interventions that are required to improve future performance above current levels, as dictated by statutory, regulatory or business requirements.*

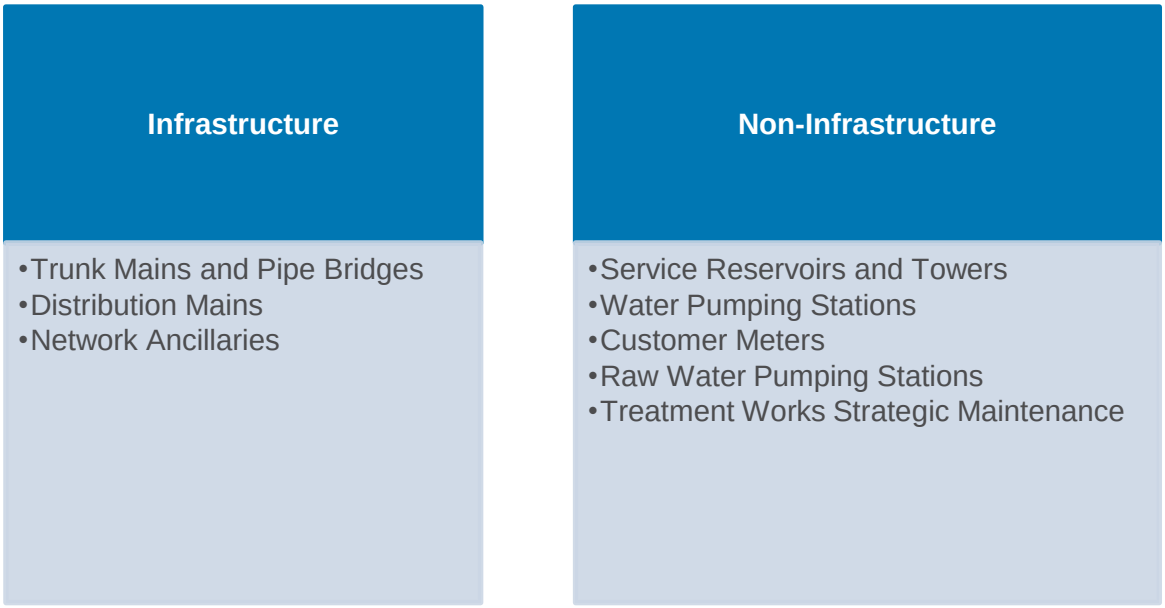
6 https://www.servelectechnologies.com/servelec-technologies/products/business-optimisation/pioneer

Also excluded from these investment cases are the base levels of operational expenditure (opex) associated with infrastructure and non-infrastructure assets. The exception to this is the Leakage investment case, which is a totex investment case.

Where the minimum levels of expenditure are not obtained through the interventions selected during the optimisation process, the approach as defined in the two base maintenance investment cases are followed to ensure this base level of performance is upheld.

Base maintenance requirements are categorised in line with the investment cases shown in Figure 13.

Figure 13: Base Maintenance Categorisation



The minimum levels of base maintenance expenditure proposed in our business plan are detailed in Table 9 and Table 10 below.

Table 9: Minimum levels of infrastructure base maintenance expenditure to be included in the Business Plan

Intervention Title	2016/17 Prices	
	Total Capex (£m)	Change in Opex (£m)
Mains Replacement (inc mains in zonal schemes)	30.0 max	0
Mains and Network Assessment	0.0	0
Network Analysis	1.0	0
Stop Tap Replacement	4.5	0
Communications Pipes (not Quality driven)	5.5	0
Mains and Communication Pipes: Other	5.0	0
Total	**46.0**	**0**

Table 10: Minimum levels of non-infrastructure base maintenance expenditure to be included in the Business Plan

Intervention Title	Description	2016/17 Prices	
		Total Capex (£m)	Change in Opex (£m)
Mechanical &Electrical	Includes all non-infrastructure Mechanical & Electrical assets in treatment works and pumping stations	25.0	0
Treatment Works Civils	Structures, Buildings and Site works in treatment works and operational buildings	5.5	0
Service Reservoir Inspections	Service reservoirs and Towers inspections and remedial work	4.2	0
Customer Meters	Age based replacement of customer meters	4.5	0
Total	**-**	**39.2**	**0**

Base maintenance and the calculation of minimum levels of expenditure is described in more detail in the Infrastructure and Non-Infrastructure Base Maintenance investment cases, which are technical annexes to section C5B of our business plan.

8 Investment Case Development

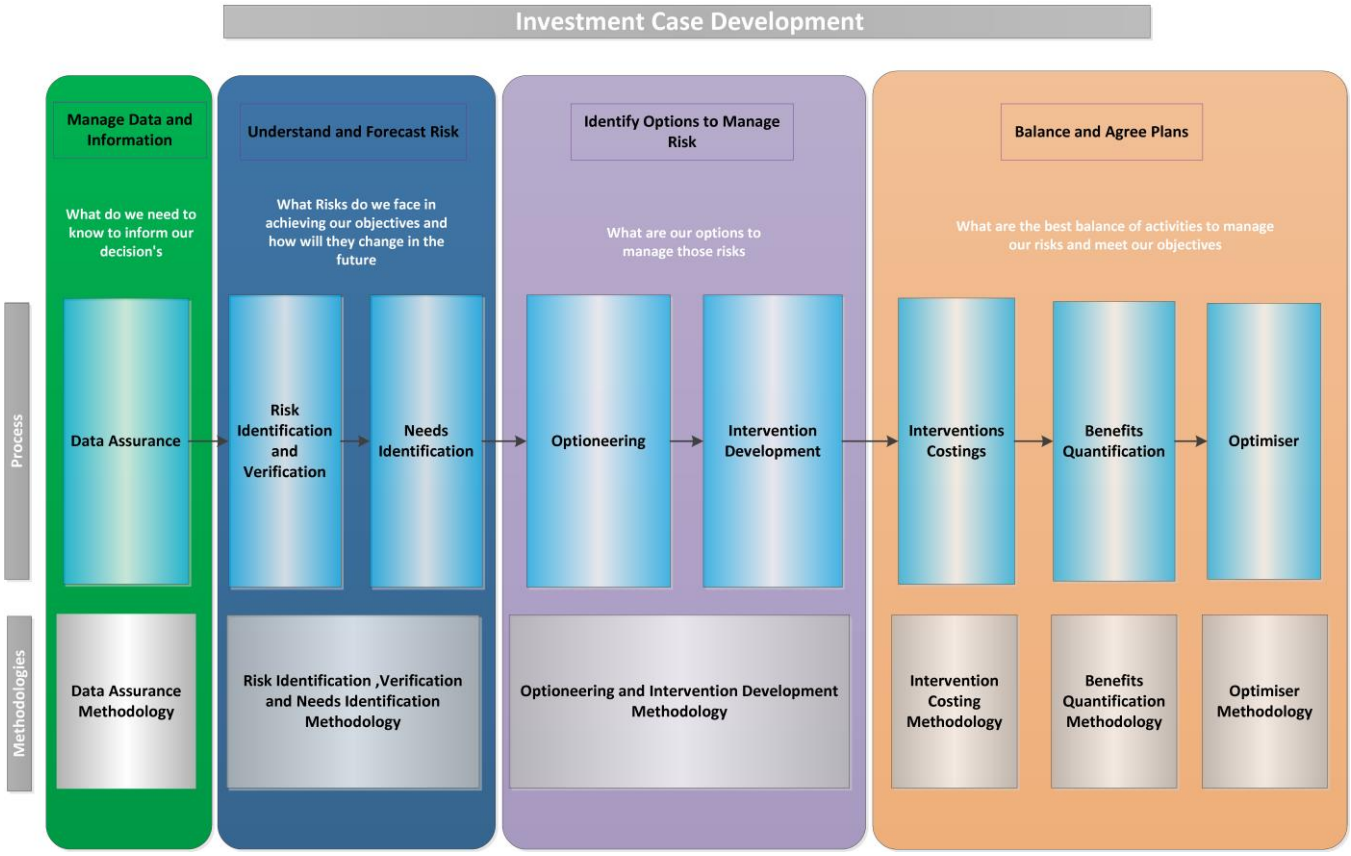
To develop our investment cases we have followed a set of five distinct processes. These were required to enable us to demonstrate that our investment:

- Delivers services that our customers value at a price they are willing to pay;
- Satisfies our business needs; and
- Delivers a high quality business plan in accordance with Ofwat's Company Monitoring Framework.

The collective application of these processes has enabled us to development investment proposals that are well evidenced through a line of sight approach, ensuring our investment plan achieves the required targets at the optimal cost.

Figure 14 illustrates, at a high level, the processes required to identify risks that require addressing in AMP7, and the subsequent development of appropriate interventions.

Figure 14: Investment Case Process Overview - Level 1 Diagram



The processes shown in above, and described in Table 11 below, have supporting methodologies that describe the interrelated activities that demonstrate the detailed development of fully costed and optimised interventions within an investment case.

In some instances, the above processes were not followed in their entirety to develop an investment case. This includes the Leakage, New Development, IT and Management and General investment cases. Where alternative methodologies have been followed, these are discussed in detail within the individual investment case documents.

Table 11: Investment Case Development Process Stages

Process	Description
Risk Identification, Verification and Needs Identification	The process of determining whether a risk is valid and requires consideration for AMP7 mitigation. Identification of the actual need(s), in terms of impact on the customer, performance commitments and cost.
Optioneering and Intervention Development	The process of developing potential options and subsequently interventions, which mitigate a risk(s). Considers the level of mitigation that an intervention provides, aligned to the customer and performance commitments.
Intervention Costing	The process of developing costs for individual interventions. Describes the interdependencies and control points relating to intervention cost development.
Benefits Quantification	The process of defining and assessing benefits attributable to individual interventions, in terms of contribution to achieving performance enhancement aligned to performance commitments.
Optimisation	The assessment and selection of interventions using constrained scenarios. Establishes the ranking of interventions in terms of improving performance/achieving pre-determined performance commitment targets at optimal cost.

8.1 Risk Identification, Verification and Needs Identification

The Methodology for Risk Identification, Verification and Needs Identification[7] explains the process by which we initially identified risks and how we verified them. It also details the assessment of whether a risk is significant. If we deemed a risk to be significant, the methodology describes how we developed the risk into a 'need'.

The deliverables from this process were a set of uniquely identified needs statements for each of the significant risks we identified.

This methodology is succeeded by the Methodology for Optioneering and Intervention Development.

The steps covered in this methodology aim to ensure that:

[7] Bristol Water, 2018. *NTPBP-MET-MET-0470 Methodology for Risk Identification, Verification and Needs Identification.docx*

- The programme of work we are proposing for AMP7 is split into numbered investment cases;
- The risks that we are currently facing are captured in a single risk register;
- We assess and verify each risk to determine details about the nature and magnitude of the risk, and whether any mitigation is planned in the current AMP period;
- We score each risk on a common basis to allow risks to be compared; and
- We identify the most significant risks and for each of these, we produce a clear and uniquely referenced statement of need (the needs statement). The needs statement defines the problem as clearly as possible, and identifies what benefit(s) or contribution to performance commitments the mitigation of the risk will achieve.

We captured the risks; risk scoring; and associated needs statements in the Strategic Risk Register[8].

The process of risk verification relies on both measurable data and our engineering judgement. The process is not linear but iterative, and relies heavily on feedback from subsequent data collection, analysis, stakeholder engagement and from applying self-checks, as every new risk is scored to ensure we applied a consistent approach across all risks.

Further, the wider process from risk identification through to investment optimisation is also iterative. Multiple iterations of optimisation were undertaken and after each iteration, the results were reviewed by all of our stakeholders. This review stage verified the output of each stage of the process leading up to optimisation and where necessary, changes were made to judgement decisions in the earlier stages. This ensured that investment optimisation results were better aligned with customer priorities and performance commitments.

A full copy of the methodology is contained in Appendix B.

8.2 Optioneering and Intervention Development

The Methodology for Optioneering and Intervention Development[9] is the process by which we developed needs into options and how, in turn, we developed these options into interventions.

The deliverables from this process were a set of named options associated with each need, and a set of named and referenced interventions selected from these options.

This methodology is preceded by the Methodology for Risk Identification, Verification and Needs Identification[10], and succeeded by the Intervention Costing[11], Benefits Quantification[12], and Optimisation[13] methodologies.

The steps covered in this methodology aim to ensure that:

[8] Bristol Water, 2018. *NTPBP-CAL-STR-0127 Strategic Risk Register (WIP).xlsx*
[9] Bristol Water, 2018. *NTPBP-MET-MET-0469 Methodology for Optioneering and Intervention Development.docx*
[10] Bristol Water, 2018. *NTPBP-MET-MET-0470 Methodology for Risk Identification, Verification and Needs Identification.docx*
[11] Bristol Water, 2018. *NTPBP-MET-MET-0475 Methodology for Intervention Costing.docx*
[12] Bristol Water, 2018. *NTPBP-MET-BEN-0168 Methodology for Benefits Quantification.docx*
[13] Bristol Water, 2018. *NTPBP-MET-OPT-0487 Methodology for Optimisation.docx*

- We consider a suite of options and compared them to each other in response to each Need identified, and
- We record these options and their associated comparison.

We included a 'Do Nothing' option for every Need and this was defined as taking no additional mitigating action, other than what is currently already being done. The number of options we investigated was broadly linked to the likely cost of the intervention(s) that may result.

At this stage the options we considered were in effect a 'long list' of options, which we typically compared qualitatively and with a high level cost estimate, to confirm their viability and relative merit. Any options which we could not separate in this way were carried forward as interventions to be compared by the optimisation process, which was effectively used to select between competing options.

A full copy of the methodology is contained in Appendix C.

8.3 Intervention Costing

The Methodology for Intervention Costing[14] explains the process by which we scoped and costed Interventions. The deliverables from this process were a capex and opex cost estimate for each intervention.

This methodology is preceded by the Methodology for Optioneering and Intervention Development[15]. The Methodology for Benefits Quantification[16] runs in parallel to this methodology, and both are succeeded by the Optimisation Methodology[17].

The steps covered in this methodology aim to ensure that:

- We track the progress of all Interventions in the Investment Planning Interventions Register[18];
- We produce a sufficient activity schedule for each intervention, supplemented where necessary by drawings or sketches, so that the intervention can be costed;
- We follow the most appropriate sub-process for costing each intervention, which includes:
    - A ChandlerKBS costing; and
    - An in-house costing by Bristol Water.

In three specific cases where an intervention could not be costed by ChandlerKBS, costings were prepared by external specialists (Minerva, Ricardo and Wipro). The reasons for this are described in detail within the methodology.

Options for leakage control were identified and costed by external specialists RPS. This is described in detail in the Leakage investment case.

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[14] Bristol Water, 2018. *NTPBP-MET-MET-0475 Methodology for Intervention Costing.docx*
[15] Bristol Water, 2018. *NTPBP-MET-MET-0469 Methodology for Optioneering and Intervention Development.docx*
[16] Bristol Water, 2018. *NTPBP-MET-BEN-0168 Methodology for Benefits Quantification.docx*
[17] Bristol Water, 2018. *NTPBP-MET-OPT-0487 Methodology for Optimisation.docx*
[18] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*

A full copy of the methodology is contained in Appendix D.

8.4 Benefits Quantification

The Methodology for Benefits Quantification[19] explains the process by which we assessed individual intervention options, in terms of the benefits that are considered to be generated that affect company performance during subsequent AMP periods.

Benefits can be assessed as either being:

- Direct - savings in reactive capex or savings in opex; or
- Indirect - improvement in performance commitments or other resultant effects on the company's performance, such as health & safety and environmental costs or fines.

Deliverables from this methodology were benefits calculations for each individual intervention option, and investment optimiser input forms for each investment case, which summarised the data for each individual intervention option.

This methodology is preceded by the Methodology for Intervention Costing[20], and succeeded by the Optimisation Methodology[21].

The steps covered in this methodology aim to ensure that:

- We identify all specific inputs to the Indirect Costs, assessing these in the most appropriate way to support the process; and
- We gather assured data to enable effective decision making in the subsequent investment optimisation stage.

A full copy of the methodology is contained in Appendix E.

8.5 Investment Optimisation

The Optimisation Methodology explains the process by which we assessed interventions in terms of costs, benefits (both performance and cost related) and constraints, to provide an optimal solution to meet designated targets. We utilised a water industry standard system (Servelec Pioneer) to optimise our AMP7 investment plan.

The investment optimiser assesses all of the available interventions and provides an optimal investment plan to meet the constraints applied and the required levels of performance improvement required in AMP7. We optimised different scenarios across five lockdowns, to provide plans for various constraint specifications.

We did not optimise all of the performance commitments listed in Table 5. There were a number of reasons for this:

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[19] Bristol Water, 2018. *NTPBP-MET-BEN-0168 Methodology for Benefits Quantification.docx*
[20] Bristol Water, 2018. *NTPBP-MET-MET-0475 Methodology for Intervention Costing.docx*
[21] Bristol Water, 2018. *NTPBP-MET-OPT-0487 Methodology for Optimisation.docx*

- We could not optimise against performance commitment measures where we did not have data to provide evidence of the links between capital investment and performance improvement; and
- Performance improvements against a number of performance commitments will not be derived directly from capital investment. These performance improvements will be derived through our operational expenditure programme, as well as educational initiatives and customer programmes.

Those performance commitments that we did optimise against were:

- Water Quality Compliance;
- Supply Interruptions;
- Leakage;
- Mains Bursts;
- Unplanned Outage;
- Customer Contacts About Water Quality - Appearance;
- Customer Contacts About Water Quality – Taste and Smell;
- Meter Penetration;
- Raw Water Quality of Sources;
- Properties at Risk of Receiving Low Pressure;
- Per Capita Consumption (PCC);
- Turbidity Performance at Water Treatment Works;
- Unplanned Maintenance - Non-Infrastructure;
- Biodiversity Index; and
- Population at Risk from Asset Failure.

This methodology is preceded by the Intervention Costing[22] and Benefits Quantification[23] methodologies.

Deliverables from this methodology were a list of chosen interventions for each scenario, capex totals, opex totals, performance changes, costs per performance measure and timescales.

A full copy of the methodology is contained in Appendix F.

[22] Bristol Water, 2018. *NTPBP-MET-MET-0475 Methodology for Intervention Costing.docx*
[23] Bristol Water, 2018. *NTPBP-MET-BEN-0168 Methodology for Benefits Quantification.docx*

9 Assurance

We have undertaken various assurance activities during the preparation of our business plan, to ensure that the data used in the preparation of our investment programme is of high quality, and if it was not, that the impact of this low quality data was understood. All of these assurance activities are covered by our Assurance Plan.

We published out Final Assurance Plan in March 2018. This set out our approach to the assurance of our business plan and associated data. The overall assurance of our business plan was provided by PwC.

Our Assurance Plan is intended to meet or exceed the expectations of Ofwat's Company Monitoring Framework and move us out of the current prescribed assurance requirements when Ofwat publishes its next Company Monitoring Framework assessment in January 2019, alongside publication of the Initial Assessment of our business plan.

We have developed an approach to provide assurance for each part of our business plan submission, as well as related submissions that feed into it. Our approach applies to the quality of the data that goes into the business plan and also the quality of our activities, processes and judgements that are associated with generating that data. This includes the development of investment cases.

This approach follows a 'three lines of defence' technique to assurance:

- First line of defence: operational assurance
    - A documented review is performed by the team responsible
- Second line of defence: internal assurance
    - A documented review is performed by a team with some independence from the first line of defence
- Third line of defence: independent assurance
    - A documented scope of work is performed on behalf of the company by a party with no prior involvement e.g. internal audit or external insurance by a specialist consultancy

For each key component of the plan we have assessed and determined the appropriate levels of assurance to be undertaken. The different levels of assurance we have undertaken and details of what this involves are shown below in Table 12.

Table 12: Descriptions of our different levels of assurance

Level of Assurance	Description
Limited assurance	• Key elements are reviewed using the first line of defence.
Moderate Assurance	• Key elements are identified and reviewed as part of a planned approach, using two or three lines of defence. • Any caveats or limitations have no material impact on the business plan and all recommendations are closed.

Level of Assurance	Description
	• Fully documented by the lead Work Package.
Substantial Assurance	• Significant elements and dependencies are identified and reviewed as part of a planned approach using three lines of defence. • Any caveats or limitations have no material impact on the business plan and all recommendations are closed. • Fully documented by the lead Work Package and reviewed by the Assurance Work Package.
Full Assurance	• Entirety (including all dependencies) reviewed as part of a planned approach using three lines of defence. • There are no caveats or limitations and all recommendations are closed. • Fully documented by the lead Work Package and reviewed by the Assurance Work Package.

This approach has provided well-founded confidence over the activity associated with generating the data for our business plan. The level assurance that has been applied to activities that have fed into the development of our investment cases is shown in Table 13 below.

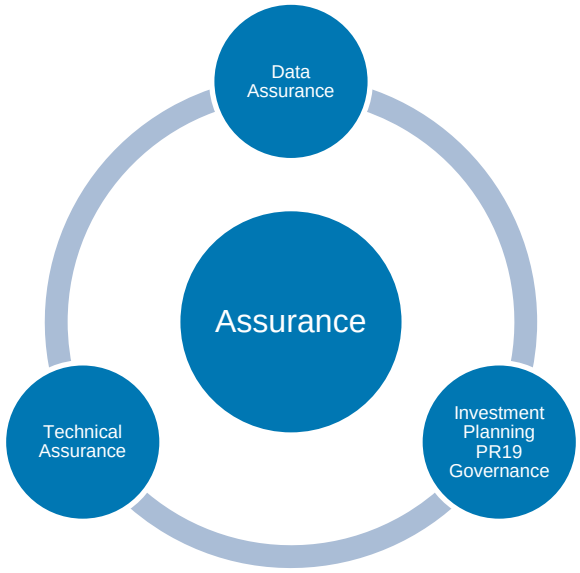
Table 13: Levels of assurance applied to the investment case building blocks

Business Plan Building Block	Risk Rating	Planned Level of Assurance
Investment Planning Data Assurance	Medium	Moderate
Investment Planning Risk Identification and Verification	High	Substantial
Investment Planning Needs Identification	Medium	Moderate
Investment Planning Optioneering and Intervention Development	High	Substantial
Investment Planning Interventions Costings	High	Moderate
Investment Planning Benefits Quantification	High	Substantial
Investment Planning Optimiser	High	Substantial

The specific assurance activities that have covered the preparation of our investment cases are shown in Figure 15 and include:

- Data assurance;
- Governance within Investment Planning; and
- Technical Assurance

Figure 15: Assurance activities covering the preparation of investment cases



9.1 Data Assurance

Throughout the development of our 21 investment cases there was a need to demonstrate, both internally and externally, that the data utilised in developing interventions was consistent, accurate and in line with our information requirements. Each investment case contributes to the overall 2020-2025 business plan, where the utilisation of specific data and its assurance has enabled us to develop and submit a high quality plan.

The master data we have used to support our investment decisions originate from single sources, across multiple systems, processes and applications. This unique reference data itself is subject to assurance activities relating to accuracy and reliability, and enhances the confidence in the quality of the data lines used for both decision making and regulatory reporting.

Our approach to assurance follows two methodologies:

1. Annual Performance Report Assurance; and
2. Data Quality Assessment.

9.1.1 Annual Performance Report Assurance

The Annual Performance Report data that we submit annually to Ofwat to demonstrate compliance with price controls, has specific data lines that have also been used to develop investment cases.

The individual data types and datasets that have provided the evidence to support the line of sight from risk identification to optimised interventions within investment cases are also a requirement for the

Annual Performance Report. These datasets undergo detailed and documented assurance that follows Ofwat's regulatory accounting guidelines, and is consistent with the overall regulatory reporting framework. The data associated with each investment case has been assessed and aligned, where applicable, to Annual Performance Report requirements.

There is a documented approach for the assessment and completion of the Annual Performance Report tables, where specific methodologies are followed for the assurance of data lines. Each data line has an assigned owner who has accountability for the completion of the annual returns following the methodology. This approach has enabled demonstration of assurance of selected data used within the development of each investment case.

Annual Performance Report assurance is documented and assessed both internally and externally. The core steps in the methodology that support demonstration of assurance are:

- The description, definition and reporting of the data line follows Ofwat reporting guideline RAG 4.07. This ensures the consistent definition of data aligned to Ofwat guidelines.
- Provision of a detailed scope and the type of assets and activities covered e.g. new mains and mains renovations.
- The description of the method of reporting and where, for example, specific processes or calculations are needed to meet regulatory requirements.
- The identification of historical data and time periods for any data requirements that support each data line.
- The source systems used to collate specific data and information requirements.
- The definition of any data that underpins the data line and how they are collected, and, where applicable, calculated.
- Documentation of how the data for the specific data lines are verified for accuracy, reliability and robustness.
- The description of the governance around each data line and how the data lines are reviewed, approved and signed off.
- The identification of any external assurance undertaken on the application of the methodology.

9.1.2 Data Quality Assessment

The data quality assessment process aims to quantify the quality of each piece of data utilised in the development of a representative sample of investment cases. This allows the business and any external stakeholders to have confidence in the outputs of key decisions made in their development.

The Data Quality Assurance Methodology[24] describes in detail the core concepts for the assessment of data quality, and this is contained in Appendix G. However, an outline of the process is included below to give context to its utilisation in the development of our investment cases.

[24] Bristol Water, 2018. *NTPBP-MET-DAT-0099 Data Quality Assurance Methodology.docx*

Data Identification

Development of each investment case is based on core processes that enable risks to be identified and mitigated through the selection of interventions that represent best value, and which meet the needs of our customers and the business. The progression from risk verification to intervention development is dependant on identifying and collating data and information created within the organisation, that enables evidence based justification of each stage. The request for supporting data is based around the specific investment case and the assets within it, and current/historical qualitative and quantitative performance of those assets. Governed activities for the identification, collation and storage of this data and information are in place for all data requests (see details of the Data Request Tracker in Table 15); to demonstrate consistency and governance of how and why it is needed, and where in the overall decision making process it is used.

Data Assessment and Preparation

The specific data and information utilised in each investment case is documented and governed through the use of a consistent data request and capture mechanism. It is through this approach that data /metadata used in key activities (for example the quantification of benefits) are identified for assessment purposes.

Once data is identified and an assessment undertaken, the outcomes are recorded. Metadata such as source location, data provider and asset type are recorded, allowing further analysis of the overall level of data quality once the assessment has been completed. Data quality levels are assessed and recorded using an approach that determines the completeness, accuracy and reliability of each dataset. Completeness is a taken as a percentage of cell completion, whereas accuracy and reliability undergo further validation and checks to define an appropriate score.

Accuracy and Reliability Verification

Verification of the quality scores for both accuracy and reliability are undertaken using the following criteria: how data is recorded; identification of validation points; frequency of update; location of the data within the company; and whether there are any issues with the data which can be taken into account when giving a score for accuracy and reliability. This scoring is undertaken through interview with the data owner/expert, to give confidence in ensuring a full understanding of the strengths and weaknesses of each dataset.

Additionally, further analysis of each data type is conducted if appropriate. One such example is when a known error code is found in a data type, for example 01/01/0001 for an unknown date. In these cases, proportional analysis of how many are found in a data type is conducted to provide the data owner with additional information for a robust scoring.

9.2 Investment Planning PR19 Governance

Internal governance within the Investment Planning engineering team is detailed in our Investment Planning Deliverable Approval Procedures[25] and fits within the PR19 governance framework as one of

[25] Bristol Water, 2018. *NTPBP-MET-INV-506 Investment Planning Engineering Team Deliverable Approval Procedures Methodology.docx*

the ten workstreams. These procedures outline the methods and procedures that were followed to take a deliverable from first draft through to approved status; providing guidance and definitions on what constitutes a check, review and approval; and determines how deliverables should be checked, reviewed and approved.

Different types of deliverables were produced by the Investment Planning engineering team and each required a different level of approval. Details of the applicable check/review/approval procedures for each deliverable are detailed below in Table 14.

Table 14: Deliverables of the Investment Planning engineering team and levels of approval

Deliverable	Investment Planning Engineering Team Check	Investment Planning Engineering Team Review	Bristol Water Review	Approval
General Calculations*	Y	Y	N	N
Benefits Calculations	Y	Y	Y	N
Engineering Methodologies	Y	Y	N	Y[1]
Business Process Methodologies	Y	N	Y	Y[2]
Investment Case Documents	Y	N	Y	Y[2]
Minutes	N	N	N	N
Presentations	N	N	N	N

1 = Investment Planning Engineering Team 2 = Senior Bristol Water Staff * includes schedules & scopes

Other documents and procedures relevant to the preparation and governance of calculations and documentation prepared within the Investment Planning engineering team are detailed in Table 15.

Table 15: Documents/procedures relevant to the preparation and governance of calculations and documentation prepared within the Investment Planning engineering team

Name of Document/Procedure	Type	Description
Document Control Guidelines[26]	Document	Provides guidance for those working in the Investment Planning team on the management, organisation and referencing of all electronic records.
Data Request Tracker[27]	Spreadsheet tracker	Records all data requested from the business. Ensures there is a flow of information that can be easily accessed and referenced by members of the team and external auditors.

[26] Bristol Water, 2017. *NTPBP-PRO-DOC-0071 Document control guidelines.docx*
[27] Bristol Water, 2018. *Data request tracker.xlsx*

Name of Document/Procedure	Type	Description
Document Register[28]	Spreadsheet tracker	Records all documents incoming to, and all documents generated by, the Investment Planning engineering team. Ensures there is a flow of information that can be easily accessed and referenced.
Calculation Control Sheets	Cover Sheets	Is placed at the front of any calculation to record the following: • The revision history and governance of a calculation. • A description of the calculation including purpose, methods used, datasets and source documents used, assumptions and conclusions.
Investment Case Interventions Registers[29]	Spreadsheet Registers	Registers that record the risks for each investment case, through to the development of interventions. Links are included to relevant data, evidence and calculations. The following is included on each register: • A record of the origin of all risks. • Verification of each risk. • The Needs Statement associated with each risk. • Details of all options considered for the mitigation of each risk. • Proposed interventions.
Investment Planning Interventions Registers[30]	Spreadsheet Register	Register that tracks the development and progress of all interventions including: • Intervention costings (scopes through to developed costs). • Breakdown of change in opex for interventions. • Allocation of financial codings and categorisations. • Details of investment optimiser outputs.
Asset Investment Database[31]	Access Database	An access database that stores the following: • Data generated in the preparation of investment cases. • Input data to the investment optimisation process.

[28] Bristol Water, 2018. *Document Register.xlsx*
[29] One Investment Case Interventions Register was produced for each investment case. These can be found in the '03-Output' folder of each investment on Sharepoint
[30] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*
[31] Bristol Water, 2017. *NTPBP-INT-ASS-0417 AssetInvestmentDatabase_Specification_P1.docx*

Name of Document/Procedure	Type	Description
		• Output data from the investment optimisation process. • Data issued form the Investment Planning team to the Finance team for financial modelling. Can be used to query/analyse data, produce reports and produce visual representations of the data.

9.3 Technical Assurance

We have completed a number of technical assurance activities. These have included two external audits conducted by Atkins Ltd and one Red Team Review conducted by independent consultants David Port and Ian Kirkaldy.

9.3.1 External Technical Audit February 2018

Our external technical audit in February 2018, conducted by Atkins, covered the review of four of the methodologies described in section 8 (Risk Identification, Verification and Needs Identification; Optioneering and Intervention Development; Intervention Costing and Benefits Quantification), and their application that has supported the development of investment cases.

Atkins carried out a focused and structured series of audits across four days (12-15 February 2018) and considered two of the investment cases we have developed to support our business plan. This included:

- Production Treatment Works Strategic Maintenance; and
- Distribution Mains.

9.3.2 External Technical Audit June 2018

Our external technical audit in June 2018, conducted by Atkins, covered the review of six methodologies and their application that has supported the development of investment cases. This included the five methodologies described in section 8 and the Data Assurance Methodology described in section 9.1.

Atkins carried out a focused and structured series of audits across four days (4-7 June 2018) and considered six of the investment cases we have developed to support our business plan. This included:

- Resilience;
- Leakage;
- Customer Meters;
- IT;

- Production Treatment Works Strategic Maintenance; and
- Distribution Mains.

The key findings of this audit are summarised below:

- The technical substance appears well understood by the teams, as well as the rational behind interventions selected;
- Methodologies are appropriate and implemented as intended to produce defensible outputs;
- There is a requirement for the investment cases to be more customer focussed, through clear lines of sight from risk through to optimised interventions; and
- The demonstration of data assurance should be improved.

9.3.3 External Red Team Reviews May 2018

The Red Team Review assessed four investment cases and one intervention from the Treatment Works Strategic Maintenance investment case. These were:

- The Resilience investment case;
- The Distribution Mains investment case;
- The Purton High Lift Scheme;
- The Leakage investment case; and
- Meter Penetration[32].

The purpose of the review was to review significant projects within the programme to ensure they were sufficient to meet the performance commitments as stated, and to test the options and decisions made during the development of interventions and investment cases.

The Red Team Review consisted of a 3 day series of high level workshops between 23rd to 25th April 2018, where the reviewers met with our project teams and discussed the purpose and scope of the investment case/scheme in question. This was followed by a site visit to Purton Water Treatment Works and a further meeting with us on 20th June 2018 to view further information made available and to discuss clarifications following the issue of the draft report.

The key findings of these reviews are summarised below and shown visually in Table 16:

- The approach for resilience investment appears to be reasonable;
- Metering to achieve 75% penetration is a challenging target, but we acknowledge that there is a plan in place that should make this achievable;

[32] Note that the Red Team Review report refers to 'Meter Penetration' but it was the Customer Meters investment case that was reviewed.

- In the context of PR19 investment planning, our overall observation from the reviews is positive; and
- Our only residual concern is the future delivery model and the need for a step change in performance by both Bristol Water and their supply chain. However, this appears to be well understood by Bristol Water and is reportedly being addressed.

Table 16: Overview of Red Team Review outputs

Overview of Outputs	Projects				
	Resilience	Distribution Mains	Purton High Lift Scheme	Leakage	Meter Penetration
Is the scope sufficient to meet the performance commitments					
Review robustness of capex estimates and change to base opex costs					
Testing the options and decisions made					
Test need, completeness and assess if all options have been considered					
Impact of Do Nothing options					
Risk and benefits of project delivery					

Criteria of the RAG status:

Minimal impact on quality – not material to final outcome.

Medium impact on quality – to be defined and agreed as part of prior scope document. Shortfall clearly defined (within process and/or documentation). Will need to be resolved to ensure quality outcome.

Major impact on quality - to be defined and agreed as part of prior scope document. Major failure of process, data, documentation, which if not resolved will cause a non-compliance failure – details must be clearly defined.

10 Efficiency

We have carried out both bottom-up and top-down efficiency assessments in order to determine the level of efficiency challenge to apply in our plan. Full details of our approach to calculating and setting efficiency targets are provided in section C5 of our business plan.

Top-down assessments were made based on econometric modelling carried out for us by a leading consultancy, NERA, which considered the potential outcome of relative efficiency models based on their own view of the most appropriate approach, and those suggested by Ofwat in its consultation on cost modelling. We considered the different efficiency gaps shown from use of different model specifications, different time periods and the impact on separated and combined wholesale price controls.

Our triangulated view of catch-up efficiency is presented in Table 17 and is largely based on the candidate PR19 models developed for us by NERA.

Table 17 - Our Triangulated View of our Efficiency Gap to the Upper Quartile (%)

	Time Series Informing Models	Assessed Period Informing Efficiency Gap	Implied Efficiency Gap to Upper Quartile (%)[33]		
			Water Resources	Network Plus	Wholesale Water
Triangulated View	2011/12 to 2016/17	2014/15 to 2016/17	45%	12%	13%
	2011/12 to 2016/17	2016/17	20%	-2%	1%

Source: Bristol Water Triangulation of Models developed by Ofwat, CMA, Oxera and NERA

We have taken the efficiency challenge implied by the modelling results set out in Table 17 into account in the development of our business plan, by using 2016/17 as our 'base' year for botex, and by assuming that the operating cost efficiency we have achieved in 2016/17 can be, at minimum, maintained at this level for the period 2020/21 to 2024/25. We have based our assumptions primarily on the efficiency challenge implied at a wholesale water level, and this reflects our view that modelling in aggregate better captures the cost relationships, synergies and efficiencies between and across price controls, which would be overlooked in more disaggregate modelling.

Therefore we believe overall that an efficiency estimate of 1% for 2016-17 operating cost and circa 5 – 13% (with a central estimate of 8%) for capital costs (which are more likely to include an element of average expenditure) is appropriate as a top down assumption. We tested this further against our bottom up estimates of efficiency.

[33] A negative (positive) gap indicates performance better (worse) than the Upper Quartile.

The optimised investment cases have an 8% (£15.8m) efficiency challenge applied based on upper quartile and programme level optimisation (see Table 1).

On capital frontier efficiencies, we have effectively absorbed the 0.9% above Consumer Prices Index Housing capex input price inflation identified by NERA with the 0.6% capex frontier shift assumption, plus an additional 0.3% frontier shift efficiency challenge in order to maintain upper quartile efficiency. Effectively, after the 8% efficiency adjustment, we assume that wholesale costs are in line with Consumer Prices Index Housing inflation.

11 Risk

There are three main risks associated with our investment plan:

- The Strategic Risk Register;
- Risks associated with the process; and
- Delivery risks

11.1 The Strategic Risk Register

As described in section 8.1, we captured all of our risks in the Strategic Risk Register and scored each risk on a common basis to allow the risks to be compared. This allowed us to identify the most significant risks and take these forward for further consideration, and in many cases, to develop interventions that would mitigate the risk. There remains a risk that the level at which we have set our risk appetite may differ from the rest of the industry, in either direction.

11.2 Risks Associated with the Process

All of our processes and methodologies described in section 8 have decisions and assumptions built into them. If we applied different assumptions throughout the process, there is a risk that our resulting investment plan would be different.

11.3 Delivery Risks

The most significant risks in relation to the development of these investment cases are the intervention costings. As this is an investment plan not an implementation/delivery plan, costs have been based on high level, outline designs, not detailed designs. This means that there may be some variation in costs when interventions are delivered.

In developing our intervention costs, we have worked with industry experts, ChandlerKBS. Where available, ChandlerKBS used known unit costs based on our own historical cost data. However, when this was not available, they used industry average unit cost data. There is a risk that some of our costs are not representative of how much it will actually costs us to deliver this work. This risk relates to less than 10% of our investment plan.

A benchmarking exercise undertaken by ChandlerKBS identified that our costs are higher than benchmark comparators where there is comparative data available (for example distribution mains). Approximately 81% of our investment plan is based on our own cost data. We have decided to apply 8% efficiency to our investment plan but there remains a risk that we will not be able to deliver our plan at this cost unless we make changes to our delivery model.

12 Assumptions

There are a number of general assumptions that have been made in the development of our investment cases. These are discussed in detail below. Assumptions specific to each investment case are discussed in detail within the individual investment case documents.

When quantifying the benefits/performance enhancement associated with each intervention, we have assumed that the forecast 2019/20 performance commitment target will be met, as shown in Table 7 in section 3.6.

No detailed or outline design was undertaken during intervention scoping for costing purposes and without detailed site investigations and minimal risk assessments. Accordingly, costing was carried out on the same basis. It is therefore assumed that project risks are accounted for in the unit cost models and shared across all schemes, rather than individual risks for the interventions.

Some of the intervention cost estimates provided by ChandlerKBS are based on industry unit rates and therefore include average risk. However, the risk of any particular intervention may prove to be higher than average and therefore the cost benefit ratio will be undermined.

As no detailed design was undertaken when developing interventions, there remains a risk that the intervention costings could be inaccurate. If this is the case, the cost-benefit of an intervention could change, which could impact the interventions selected during the investment optimisation process.

13 Innovation

We see innovation as integral to our everyday working at Bristol Water. We have deliberately embedded it within the business-as-usual processes of our asset management teams, by embracing the full flexibility that totex and outcomes enables.

Innovation is supported by our Innovation Framework, which ensures we put the right building blocks in place to steer and monitor innovation, and foster corporate culture from the ground up. This is discussed in more detail below. Innovation specific to each investment case is discussed in detail within the individual investment case documents.

We prioritise our asset risks according to their impact on our outcomes, which ensures alignment with what our customers have said they value. We bring forward meaningful innovations into this process by ensuring that those who are responsible for intervention development have access to cutting edge options through a suit of activities:

- **Open Innovation:** We have defined our strategic innovation challenges and run events such as our 'Innovation Exchange' that invite suppliers to present their innovative solutions to predefined challenges that we set.
- **Market Scanning:** We conduct market scanning for cutting edge technology against our strategic innovation challenges, and feed this into our optioneering process. In particular we subscribe to the Technology Approval Group which regularly scans and meets with water companies to unearth the most promising innovations for the sector
- **Partnering:** we undertake leading research into areas that we provide effective solutions for the future. Where this is the case, it is discussed in more detail within the relevant investment case document.

We will specifically look for innovations that mean we can contribute to our 8% efficiency challenge and keep our customers' bills low into the future.

14 AMP8

There are a number of risk items that have been developed into interventions which have not been selected for inclusion in the AMP7 business plan. These will be reappraised for investment in AMP8.

Appendix F within each investment case contains details of those interventions not selected for inclusion in our investment plan.

15 Appendices

Appendix A: Performance Commitment Definitions

Appendix B: Risk Identification, Verification and Needs Identification Methodology

Appendix C: Optioneering and Intervention Development Methodology

Appendix D: Costing Methodology

Appendix E: Benefits Quantification Methodology

Appendix F: Optimisation Methodology

Appendix G: Data Quality Assurance Methodology

15.1 Appendix A: Performance Commitment Definitions

Customer Measure of Experience (C-MeX)

The customer measure of experience (C-MeX) is a mechanism to incentivise water companies to provide an excellent customer experience for residential customers, across both the retail and wholesale parts of the value chain.

Developer Services Measure of Experience (D-MeX)

The developer services measure of experience (D-MeX) is a mechanism to incentivise water companies to provide an excellent customer experience for developer services (new connections) customers. These customers include small and large property developers, self-lay providers (SLPs), and those with new appointments and variations (NAVs).

Percentage of Customers in Water Poverty

The percentage of customers within our supply area for whom their water bill represents more than 2% of their disposable income, defined as gross income less income tax.

Value for Money Survey

The percentage of customers responding to the company's annual household customer tracking survey, who consider that we provide good value-for-money, by either responding very good or good after being asked the question.

Vulnerability Assistance

The percentage of customers within our supply area receiving vulnerability assistance who are satisfied with the assistance given.

Void Properties

The average total number of household properties within the supply area, which are connected to our water supply but do not receive a charge as there are no occupants, as a percentage of the total number of connected households.

Water Quality Compliance (CRI)

The Compliance Risk Index (CRI) is a measure designed to illustrate the risk arising from treated water compliance failures, and it aligns with the current risk based approach to regulation of water supplies used by the Drinking Water Inspectorate. All compliance failures are assessed by the Drinking Water Inspectorate using the provisions of the Water Industry Act 1991. In doing so, the Drinking Water Inspectorate has regard to its published Enforcement Policy, and it also follows the principles of 'better regulation' to scrutinise company performance on the basis of their risk of failing to meet the requirements of the Regulations.

Supply Interruptions

Average supply interruption greater than three hours (minutes per property).

Mains Bursts

Number of mains bursts per thousand kilometres of total length of mains. Mains bursts include all physical repair work to mains from which water is lost.

Unplanned Outage

The annualised unavailable flow, based on the peak week production capacity for each company. This measure is proportionate to the frequency of asset failure, as well as the criticality and scale of the assets that are causing an outage.

Risk of Severe Restrictions in Drought

Percentage of the population the company serves that would experience severe supply restrictions (for example, standpipes or rota cuts) in a 1 in 200 year drought.

Customer Contacts About Water Quality – Appearance

The number of times Bristol Water was contacted by customers about the appearance of their tap water (per 1,000 people supplied) in the calendar year.

Customer Contacts About Water Quality – Taste and Smell

The number of times Bristol Water was contacted by customers about their water's taste/ smell (per 1,000 people supplied) in the calendar year.

Properties at Risk of Low Pressure

The total number of properties in our area of water supply which, at the end of the year, have received, and are likely to continue to receive, a pressure or flow below the reference level.

Turbidity Performance at Water Treatment Works

The number of operational potable water treatment works whose turbidity 95th percentile equals or exceeds a 0.5 NTU (Nephelometric Turbidity Units) threshold.

Unplanned Maintenance - Non-Infrastructure

The total unplanned non-infrastructure maintenance jobs required as a result of equipment failure or reduced asset performance, as a proportion of all non-infrastructure assets.

Population at Risk From Asset Failure

The total number of customers in areas of population greater than 10,000 people who are at risk of interruption to their water supply in the event of failure of a critical asset that supplies them.

Leakage

Leakage expressed in mega litres per day (Ml/d), three-year average, defined as the sum of distribution system leakage, including service reservoir losses and trunk main leakage, plus customer supply pipe leakage.

Per Capita Consumption (PCC)

The average amount of water used by each person that lives in a household property (litres per head per day), defined as the sum of measured household consumption and unmeasured household consumption divided by the total household population.

Meter Penetration

The proportion of total household properties of billed customers that are charged for water on a measured basis.

Raw Water Quality of Sources

An assessment of the company's progress in implementing catchment management of nutrients across its catchments. The measure relates to the level of nutrient loss reduction, modelled as kg of phosphorus, not lost to the environment as a result of the measures taken up by farmers across source catchments.

Biodiversity Index

An assessment of the company's delivery of enhancements and provision of ecological habitats and environmental features. This assessment also considers whether management of habitats has been delivered to maintain a high condition status of a specified habitat. The measure relates to the quantity of habitats and the quality of these habitats on Bristol Water landholdings.

Waste Disposal Compliance

The percentage compliance, as per the number of Bristol Water samples taken, of discharged trade effluent from designated Company sample points that meet the consent requirements in the Environment Agency permits.

WINEP Compliance

The metric will measure compliance with requirements of the Water Industry National Environment Programme (WINEP) around delivery of a set of eight abstraction sustainability investigations and two projects to undertake works to benefit the Rivers Chew and Yeo downstream of Chew Valley and Blagdon Reservoirs.

Abstraction Incentive Mechanism (AIM)

Reducing abstraction at Shipton Moyne (an abstraction linked to environmentally-sensitive sites) at times where there is a risk of low river flows due to low local groundwater levels. Performance is measured as the Ml reduction in abstraction during times of low groundwater level.

Local Community Satisfaction

The percentage of stakeholders within our supply area who are satisfied with the contribution we have made against our agreed commitments to the communities that we serve.

15.2 Appendix B: Risk Identification, Verification and Needs Identification Methodology

C5 B

Cost and Efficiency

Appendix
Methodology for Risk Identification, Verification and Needs Identification

BRISTOL WATER

NTPBP-MET-MET-0470

Contents

Tables

1 Overview

This methodology is one of six that describe the interrelated activities that demonstrate the detailed development of fully costed and optimised interventions within an investment case.

This methodology forms part of a wider process and should be read in conjunction with the following associated methodologies:

- Methodology for Optioneering and Intervention Development;
- Methodology for Intervention Costing;
- Methodology for Benefits Quantification;
- Optimisation Methodology; and
- Data Assurance Methodology.

2 Purpose Of This Document

The purpose of this methodology is to explain the process by which we identify risks and how we verify them. It also details the assessment of whether a risk is significant. If we deem a risk to be significant, the methodology describes how we develop the risk into a 'need'.

The deliverables from the process described in this methodology are a set of uniquely identified statements of need associated with each identified significant risk.

3 Principles Of The Methodology

The steps covered in this methodology aim to ensure that:

- Investment cases are created based on designated asset classes, performance classes or business areas;
- The risks that we are currently facing are captured in a single risk register;
- Each risk is aligned to one of our investment cases;
- Each risk is assessed and verified using data and information collated from across the business, to determine details about the nature and magnitude of the risk and whether any mitigation is currently planned in this AMP period;
- Each risk is scored on a common basis to allow risks to be compared and is challenged through a peer review process; and
- The most significant risks are identified and that for each a clear and uniquely referenced statement of need is produced to define the problem as clearly as possible, and to identify what benefits or performance improvements mitigation of the risk will achieve.

It should be noted that the process of risk verification relies on both measurable data and engineering judgement. The process is not linear but iterative, and relies heavily on feedback from subsequent data collection, analysis, and stakeholder engagement, and from applying self-checks when every new risk is scored to ensure a consistent approach across all risks.

Further, the wider process from risk identification through to investment optimisation is also iterative. Multiple iterations of the investment optimiser will be undertaken, and after each iteration the results will be reviewed by all internal stakeholders and the investment planning team. These reviews will verify the output of each stage of the process leading up to investment optimisation, and where appropriate, changes may be made to assumptions made in the processes preceding investment optimisation, so that our investment plan is better aligned to customer priorities and performance commitments.

4 Application

Verified risks and needs determined by this process are aligned to each investment case and recorded in the relevant investment case interventions registers (see Appendix C)[1].

The steps required to achieve this process are described in more detail below and illustrated in the flow chart in Appendix F.

4.1 Create Investment Case Summaries

Investment cases are to be created based on designated asset classes, performance classes or business areas. This will allow risks and subsequent interventions to be aligned to the most relevant investment case.

The steps below describe how an investment case will be defined.

1. The investment planning team will determine broad split of investment cases based on asset type.
2. Internal stakeholders will be identified and then a programme of engagement will be undertaken with them to agree further details relating to each investment case.
3. The investment planning team will write Investment Case Summaries that will describe which assets are to be included/excluded from an investment case.
4. An investment case number will be assigned.
5. A internal stakeholder review of investment cases will be completed.

4.2 Risk Identification

The steps below describe how a risk will be identified.

1. All risk registers that identify current operational and performance related risks within the business will be located.
2. The risk registers identified in step 1 will be filtered to remove those risks that are being addressed in the current AMP period.

   Snapshots of the following supporting risk registers will be taken at the start of this process and each filtered in the way described in Appendix A:

   - Operational Risk Register (which includes risks from the Drinking Water Safety Plan);
   - Pumping Station Risk Collection Table; and
   - Network Risk Register.

   These supporting risk registers are described in more detail in Appendix A and links to all the above documents are included in Appendix B.

[1] These registers are saved into the 'Output' folder for each investment case on SharePoint.

It should be noted that the Corporate Risk Register is also a potential source of risks. However the risks within the Corporate Risk Register are high level non-specific risks associated with the wider business and cannot readily be further analysed in the specific way required by this methodology.

3. The Strategic Risk Register[2] will be created by combining risks extracted from the risk registers listed in step 2 above. All risks entered into the Strategic Risk Register will:
    - Be assigned a unique identifier in the form SRRXXX where XXX represent a three-digit number. This will be referred to as the risk ID;
    - Be aligned to an investment case (note that this alignment may be modified based on the evidence collected during the risk verification step described in section 4.3);
    - Be assigned to one of the risks in the Corporate Risk Register;
    - Identify which of the supporting risk registers, listed in step 2 above, they originate from;
    - Identify the original risk reference from the supporting risk register they have been taken from; and
    - Identify the original risk owner, as identified in the supporting risk register from which the risk has been taken.

    Note that the next step of Risk Verification (described in section 4.3) includes stakeholder consultation, data collection and analysis. These activities may identify additional risks which should be added to the Strategic Risk Register, supplementing the initial list of risks taken from the snapshots described in section 4.2.

4.3 Risk Verification

Risk verification will be achieved through:

1. Data collection, to provide evidence that supports inclusion of the risk on the Strategic Risk Register (data will be requested through the data request tracker[3]).
2. Data analysis using a variety of techniques dependent on the risk and investment case in question, the results of which will be recorded in individual peer reviewed calculations.
3. Internal stakeholder engagement, which may also identify additional data sources or additional risks. This step will specifically identify any risks that have been added to the operational risk register after the initial snapshot is taken (as described in section 4.2).
4. Qualitative and quantitative data and information specific to the nature of the risk and the investment they influence will be collected from a range of sources, including, but not limited to:
    - Our Geographical Information System data;
    - Our company financial, operational and asset systems;
    - Aprotec[4];

[2] Bristol Water, 2018. *NTPBP-CAL-STR-0127 Strategic Risk Register (WIP).xlsx*
[3] Bristol Water, 2018. *Data request tracker.xlsx*
[4] This is one of our internal document storage systems that holds final/approved asset documentation.

- Our telemetry systems;
- Production data records;
- Survey reports;
- Manufacturers' data and proposals;
- Previous studies undertaken on our behalf;
- Previous studies we have completed internally; and
- Our document records;

Analysis of this data will be undertaken where necessary, to help inform the scoring of the risks on the Strategic Risk Register[5] (see section 4.4).

This step of the process will also highlight if there are any additional risks which should be added to the Strategic Risk Register, supplementing the initial list of risks taken from the snapshots described in section 4.2.

4.4 Risk Scoring

The steps below describe how a risk will be scored.

A standard 5 x 5 matrix based on the likelihood and impact of a risk occurring will be used to score each risk. This method mirrors the method that we use in the assessment of our Drinking Water Safety Plan, which is described in detail in the methodology for that assessment[6].

1. Determine Likelihood Score.

   Likelihood will be scored by the investment planning team, or other originating team, using the definitions shown in Appendix D, Table 2: Likelihood of Risk Occurring. These definitions were taken initially from the definitions used in the Corporate Risk Register but were subsequently modified to provide a more meaningful analysis when used in the Strategic Risk Register. The modified definitions have been peer reviewed within the investment planning team and agreed with the Head of Investment Planning.

   For the risks originating from the Operational Risk Register and Pumping Station Risk Collection Table, the score will be assigned directly by the investment planning team, or other originating team, based on the description of the risk and their experience.

   Risks from the Network Risk Register already have an asset failure probability assigned to them by our network risk team. This was assigned as a percentage of failure in the next year and is located in column AD of the Network Risk Register. This likelihood will be converted into the terms of the definition in Appendix D Table 2, based on the calculation in the worksheet 'Network Likelihood Score', and using a formula in the 'Likelihood' column of the Strategic Risk Register. This calculation will be reviewed by the Asset Modelling team[7]. The resulting likelihood score will be

[5] Bristol Water, 2018. *NTPBP-CAL-STR-0127 Strategic Risk Register (WIP).xlsx*
[6] Bristol Water, 2017. *WSP030 Drinking Water Safety Plan Methodology*, version 2.40.
[7] The calculation was checked by the Asset Modelling Team as the check was a pure mathematical check. The calculation was a manipulation of statistical likelihoods and the Asset Modelling team are well versed in statistical mathematics.

reviewed by the investment planning team, or other originating team, based on the description of the risk and their experience.

2. Determine Impact Scores.

   The definitions used for the impact score are shown in Appendix D, Table 3: Impact of Risk Occurring. Values are to be assigned against each of the impact criteria by the investment planning team, or other originating team, based on the description of the risk and their experience.

3. Calculate the Risk Score.

   The product of the likelihood and impact scores will be used to determine a total risk score for each risk. The highest scoring impact category will be used to produce the risk score. Using an average was considered to give a disproportionately low score and so was rejected. The scoring will then be peer reviewed by another member of the investment planning team, or other originating team, and the initials of the reviewer will be entered into the Strategic Risk Register[8] against the risk in question to record the review.

4.5 Selection of the Most Significant Risks.

The risk score evaluation matrix is shown in Appendix D, Table 4: Consequence Score. A risk with a score of 1-4 is considered to be a low level risk, and is shown to be green. Risks with a risk score of 5-12 are considered to be medium level risks and are shown to be amber. Risks with a risk score of 15-25 are considered to be high level risks and are shown to be red. These bandings have been reviewed and agreed by the Head of Investment Planning.

Based on the risk score, a decision will be made as to whether the risk needs to be evaluated further for possible mitigation in AMP7, or whether the risk is classified as base maintenance and would be dealt with using money allocated to the base maintenance investment cases should the risk arise in AMP.

The selection of the most significant risks is described further below.

1. Low Level Risks

   Low level risks have likelihood and impact scores of either 1 or 2. These are considered to be risks which will not prevent us achieving our performance commitment targets, and the mitigation of any risks which do arise in AMP, will be dealt with using money allocated to the base maintenance investment cases. These risks will not be considered further as part of the PR19 investment planning process.

2. Medium Level and Borderline Risks

   Medium level risks have likelihood and impact scores of 1-5. Generally, one of the criteria will have a score of 4 or 5, with the remaining criteria scoring lower, creating medium level risk.

3. Determine If The Risk Score Is Below 10

   Risks with a score below 10 will either be infrequent events (likelihood score 1, 2 or 3) or have a low impact (impact score 1, 2 or 3). They will not normally prevent us achieving our performance

[8] Bristol Water, 2018. *NTPBP-CAL-STR-0127 Strategic Risk Register (WIP).xlsx*

commitments targets. These risks will not be considered further as part of the PR19 investment planning process.

4. Determine If The Risk Is To Be Developed Into A Needs Statement

   Medium risks with a score of 10 or more are considered to be borderline risks, because they border the red zone within the risk matrix (see Table 4). In some cases, these risks may prevent us achieving our performance commitment targets, and therefore each of these borderline risks (scoring 10-12) will be reviewed further. Where it is considered that mitigation of the risk will enhance our ability to achieve our performance commitment targets, the risk will be developed into a 'needs' statement as described in section 4.7 below. This decision will be peer reviewed and discussed with internal stakeholders.

5. High Level Risks

   High level risks have likelihood and impact scores of 3-5 and are considered to be serious risks to business, and will impact our ability to achieve our performance commitment targets. Each of these risks will be developed into a 'needs' statement as described below in section 4.7.

4.6 Map Benefits and Impacts to Investment Cases

The performance commitments themselves provide a useful means of assessing the impacts of risks. An exercise to map the performance commitments to the investment cases has been undertaken and is presented in the Investment Case vs Performance Commitment Schedule calculation[9]. This defines links between investment cases and performance commitments in four levels:

- Primary - direct link to performance commitment;
- Secondary - indirect link to performance commitment;
- Tertiary - subjunctive link to performance commitment; and
- Blank - no obvious link to performance commitment.

For the purposes of the benefits quantification exercise, tertiary links may be ignored as these are only considered to contribute negligible performance improvements, and the level of detail explored prohibits meaningful assessment (unless it is possible to assess broad benefits contributed by an asset class, reduced to individual asset level). Secondary links are only to be considered where there is demonstrable performance improvement accrued, and is often assessed using engineering judgement.

This information is used as an initial direction for exploring the possible benefits that may be attributable to an intervention, by understanding the performance data available and the investment case in which it is aligned.

The steps are:

- Identify the performance commitments to be used in impact and benefits assessments;
- Map the benefits and Impacts to performance commitments (as described above); and
- Align the benefits to investment cases (as described above).

[9] Bristol Water, 2018. *NTPBP-STR-INV-0084 IC to PC mapping v0_1.xlsx*

4.7 Production of Needs Statement

For each of the significant risks identified in section 4.5 above, a 'needs' statement will be produced and recorded in the Strategic Risk Register[10]. The steps below describe how a 'needs' statement will be developed.

1. Assign a needs identification number to the 'needs' statement. This number will take the form SRRNXXX, where XXX represents a three-digit number.
2. Align the 'needs' statement with the risk ID of the relevant risk (the risk ID is described in section 4.2).
3. Produce the 'needs' statement. The 'needs' statement will define the problem as clearly as possible and will identify what impact mitigation of the risk will have in relation to business objectives and performance commitment targets. The impacts and benefits will be informed by any performance data identified that is associated with the risk.

[10] Bristol Water, 2018. *NTPBP-CAL-STR-0127 Strategic Risk Register (WIP).xlsx*

5 Interdependencies

This methodology has a key interdependency with the Methodology for Optioneering and Intervention Development and the Methodology for Benefits Quantification, as described below.

The outputs from this methodology are captured in the Strategic Risk Register[11]. This register includes a list of verified and scored risks in the worksheet titled 'Strategic Risk Register' and a list of 'needs' statements in the worksheet titled 'Strategic Risk Register Needs'.

The process of mapping benefits and impacts to investment cases is the starting point for the benefits quantification assessment.

The Strategic Risk Register is a key input to the optioneering and intervention development process.

The 'line of sight' for each investment case, of risk identification, verification and needs identification, is recorded in the respective investment case interventions register. A full list of these registers is provided in Appendix A.

[11] Bristol Water, 2018. *NTPBP-CAL-STR-0127 Strategic Risk Register (WIP).xlsx*

6 Data Assurance

Data used within the investment planning process as a whole, including the costing process, has been recorded within the Data Request Tracker[12].

Data is assured using the Data Assurance Methodology[13].

[12] Bristol Water, 2018. *Data request tracker.xlsx*
[13] Bristol Water, 2018. *NTPBP-MET-DAT-0099 Data Quality Assurance Methodology.docx*

7 Control Points

The control points shown in Table 1 have been identified. Against each control point, the means of checking is listed, together with any feed back loop which provides further verification of that control point. In all cases, the output from the control point is recorded in the investment case interventions registers, as listed in Appendix A.

It should be noted that these control points are not identified on the flow chart in Appendix F. However, the control point names correspond to process steps that are identified.

Table 1: Control Points in the Methodology for Risk Identification, Verification and Needs Identification

Control Point	Means of Checking	Feedback
Identification of risks in the Strategic Risk Register	Peer review within the investment planning team or other originating team , and with internal stakeholders.	Stakeholder meetings in subsequent steps will verify the selection and may highlight additional risks to be added to the Strategic Risk Register. Data collection and analysis in subsequent steps will verify the selection and may highlight additional risks to be added to the Strategic Risk Register.
Verification of Risks	Peer review within the investment planning team or other originating team , and with internal stakeholders.	Engagement with stakeholders will continue through the investment planning process and this engagement will provide feedback on verification of risks. Formal feedback will take place in the buddy meetings, which will take place after the initial investment optimiser runs.
Risk Scoring	Peer review within the investment planning team or other originating team , and with internal stakeholders.	Feedback into the risk scoring will be gained through continued stakeholder engagement and through continued collection and analysis of data. Feedback is also gained as more and more risks are scored and consistent values are applied across all risks.
Selection of Most Significant Risks	Peer Review within the investment planning team or other originating team , and with internal stakeholders.	Feedback into the selection of the most significant risks (and in particular those scoring 10-12 where judgement is applied to select the most significant) will be gained through continued stakeholder engagement and through continued collection and analysis of data.
Production of Needs Statement	Peer review within the investment planning team or other originating team , and with internal stakeholders.	-

8 Appendices

Appendix A: Supporting Risk Registers

Appendix B: Existing Bristol Water Registers

Appendix C: Investment Case Interventions Registers List

Appendix D: Risk Scoring Tables

Appendix E: Corporate Register – Risk Basket

Appendix F: Flow Chart

8.1 Appendix A: Supporting Risk Registers

Corporate Risk Register

The Corporate Risk Register is the high level business risk register and covers a wide range of risks.

Many of the risks are commercial and not directly related to the business of supplying water to customers. Where risks are related to supplying water to customers, they are for the most part generic and are not useful in preparing bottom up assessments for the development of the investment cases. For this reason, the risks on the Corporate Risk Register have not been transferred to the Strategic Risk Register. However, a cross reference is provided during the risk verification step (section 4.3) that relates the risks in the Strategic Risk Register to the Corporate Risk Register risks.

Drinking Water Safety Plan

A Drinking Water Safety Plan has been prepared to comply with Regulation 27 and 28 of the Water Supply (Water Quality) Regulations 2000 and the Regulation 28 reporting requirements.

This methodology for preparing the associated Drinking Water Safety Plan and associated risk assessments is detailed in the Drinking Water Safety Plan Methodology, Version 2.4, dated February 2017[14]. A Drinking Water Safety Plan is produced for each component or asset of the supply system including catchments, abstraction points, treatment works, supply points, service reservoirs and water supply zones.

A snapshot of the Drinking Water Safety Plan for Medium and Unacceptable risk summary was taken at the start of the investment planning process in May 2017[15] [16].

A crosscheck shows that the Drinking Water Safety Plan risks are identified and included on the Operational Risk Register. No further action was taken on the risks within these registers.

Operational Risk Register

The Operational Risk Register is made up of risks identified by operation and maintenance staff and added to the risk register by the area managers or their delegates. A snap shot of the Operational Risk Register taken in June 2017[17] identified 709 risks on the register.

Operational risks are reviewed regularly and where considered necessary are passed for resolution either as a specific project or through a rolling investment programme. Where the risk has been addressed in this manner it is indicated in the filter of column CT (‘Stat1’) of the Operational Risk Register as either:

- Fully Mitigated the Risk;
- With Customer Services;
- With Projects;
- With Solutions;
- With Solutions (Networks);
- With Solutions (Production); or

[14] Bristol Water, 2017. *Drinking Water Safety Plan Methodology Version 2.4.pdf*
[15] Bristol Water, 2017. *DWSP Medium Risks Summary 05-17.xlsx*
[16] Bristol Water, 2017. *DWSP Unacceptable Residual Risk Summary 05-17.xlsx*
[17] Bristol Water, 2017. *Operational Risk Register 20170612.xlsx*

- With Solutions (O&M).

When these risks are removed (filtered out) 285 risks remain. The remaining 285 risks from the Operational Risk Register were transferred to the Strategic Risk Register.

Pumping Station Risk Collection Table

The Pumping Station Risk Collection Table contains 85 risks, identified following an assessment of 45 key pumping stations carried out in May June 2017.

The 85 risks have been added to the Strategic Risk Register.

Network Risk Register

The Network Risk Register[18] has been derived from the risks in the Operational Risk Register and comprises the risks indicated in the filter of column G, 'Dire' of the Operational Risk Register as:

- Network.

A snapshot of the Network Risk Register taken in July 2017 identified 408 risks on the register.

Column, H ('Status') of the Network Risk Register is filtered to show only the following:

- With Solutions O&M; and
- With Solutions (Network).

Column A ('Risk Ref/Number') is filtered to remove any risk indicated as either Closed or Transferred. This filtering results in 318 risks.

Where risks are removed that are either 'Yes/Blank/?' in column I ('In Process') of the Network Risk Register, the number of risks is reduced to 227.

The remaining 227 risks from the Network Risk Register were transferred to the Strategic Risk Register.

Remaining 'Base' Risks

A total of 597 risks have been carried from the Operational Risk Register, Pumping Station Risk Collection Table and Network Risk Register registers to the Strategic Risk Register. These 597 risks form the base of the Strategic Risk Register and are flagged in column K of the Strategic Risk Register ('Base Risk?'). The base risks are supplemented by additional risks identified during stakeholder consultation, data collection and analysis. Additional risks will include those added to the source risk registers since the snapshots were taken.

[18] Bristol Water, 2017. *Network Risk Register 14-07-17.xlsx*

8.2 Appendix B: Existing Bristol Water Registers

Ref	Name	SharePoint Link
A	Strategic Risk Register	Strategic Risk Register (WIP).xlsx
B	Corporate Risk Register – Risk File April 2017	Corporate Risk Register Risk File April 2017.xlsm
C	Drinking Water Safety Plan Medium Risk Summary 05-17	DWSP Medium Risks Summary 05-17.xlsx
D	Drinking Water Safety Plan Unacceptable Residual Risk Summary 05-17	DWSP Unacceptable Residual Risk Summary 05-17.xlsx
E	Operational Risk Register 2017-06-12	Operational Risk Register 20170612.xlsx
F	Network Risk Register 14-07-017	Network Risk Register 14-07-17.xlsx
G	Pumping Station Risk Collection Table	Pumping Station Risk Collection Table 07-17.xlsx
H	Reservoir Structures Action List	Reservoir Structures Action List.xlsx
I	Drinking Water Safety Plan Methodology	Drinking Water Safety Plan Methodology Version 2.4.pdf

8.3 Appendix C: Investment Case Interventions Registers List

Document ID	Document Type	Document Name
NTPBP-CAL-TRU-0137	Calculation Sheet	Trunk Mains and Pipe Bridges Investment Case Intervention Register
NTPBP-CAL-DIS-0138	Calculation Sheet	Distribution Mains Investment Case Intervention Register
NTPBP-CAL-SER-0139	Calculation Sheet	Service Reservoirs and Towers Investment Case Intervention Register
NTPBP-CAL-WAT-0140	Calculation Sheet	Water Pumping Stations Investment Case Intervention Register
NTPBP-CAL-BUL-0142	Calculation Sheet	Bulk Meters and Pressure Control Valves Investment Case Intervention Register
NTPBP-CAL-CUS-0143	Calculation Sheet	Customer Meters Investment Case Intervention Register
NTPBP-CAL-NET-0144	Calculation Sheet	Network Ancillaries Investment Case Intervention Register
NTPBP-CAL-NET-0145	Calculation Sheet	Network Monitoring Investment Case Intervention Register
NTPBP-CAL-LEA-0146	Calculation Sheet	Leakage Investment Case Intervention Register
NTPBP-CAL-NEW-0147	Calculation Sheet	New Development Investment Case Intervention Register
NTPBP-CAL-WAT-0149	Calculation Sheet	Water Resources Investment Case Intervention Register
NTPBP-CAL-RAW-0150	Calculation Sheet	Raw Water Distribution Investment Case Intervention Register
NTPBP-CAL-RAW-0151	Calculation Sheet	Raw Water Pumping Stations Investment Case Intervention Register
NTPBP-CAL-TW -0153	Calculation Sheet	Treatment Works Strategic Maintenance Investment Case Intervention Register
NTPBP-CAL-ICA-0154	Calculation Sheet	ICA and Telemetry Investment Case Intervention Register
NTPBP-CAL-RES-0157	Calculation Sheet	Resilience Investment Case Intervention Register
NTPBP-CAL-IT -0158	Calculation Sheet	IT Investment Case Intervention Register
NTPBP-CAL-M&G-0159	Calculation Sheet	Management and General Investment Case Intervention Register
NTPBP-CAL-ENV-0160	Calculation Sheet	Environment Investment Case Intervention Register

8.4 Appendix D: Risk Scoring Tables

Table 2: Likelihood of Risk Occurring

LIKELIHOOD				
Score	**Description**	**Probability**	**Frequency**	**Comment on Significance**
1	Unlikely	< 5%	> 20yrs	Event not likely to occur within planning horizon
2	Possible	5% - 12%	8 to 20yrs	Event likely in AMP 8/9 period
3	Likely	12% - 33%	3 to 8yrs	Event likely in AMP 7 period
4	Probable	33 - 99%	12 to 36 month	Event likely in AMP6 period
5	Almost Certain	> 99 %	< 12 months	Event likely in next 12 months

Table 3: Impact of Risk Occurring

IMPACT						
Score		**Human Health / Environment**	**Ease to Resolve**	**Publicity & Reputation**	**Regulatory Impacts**	**Customers Impacted**
1	Low	No impact on human health or environment	Situation usually reversible in 48 hrs	Local or low media coverage	Risk is not materially critical to any Regulatory or Statutory compliance, company or operational drivers or customer expectations	<100
2	Moderate	Temporary impact on human health (less than 3 days off work) and/or contained pollution incident	Situation reversible in less than 4 weeks	Media coverage possible at the regional level	Failure to meet BW internal operational drivers	100 to 1000
3	Significant	Impact on human health (serious injury, long-lasting 3 days to 6 months off work) and/or minor impact on the environment	Situation reversible in between 1 - 6 months	Regional or national media coverage	Failure to meet BW KPIs	1000 to 10000
4	Severe	Harmful situation with a strong impact on health and human life threatening and/or localised pollution incident	Situation reversible within AMP 7 period	Major media coverage	Failure to meet customer expectations	10000 to 25000
5	Catastrophic	Strong impact on health and human life (multiple deaths) and/or major pollution incident	Situation reversible in AMP 8/9	Major and sustained media coverage against the company	Regulatory and / or Statutory compliance would be compromised by issues relating to this risk	25000+

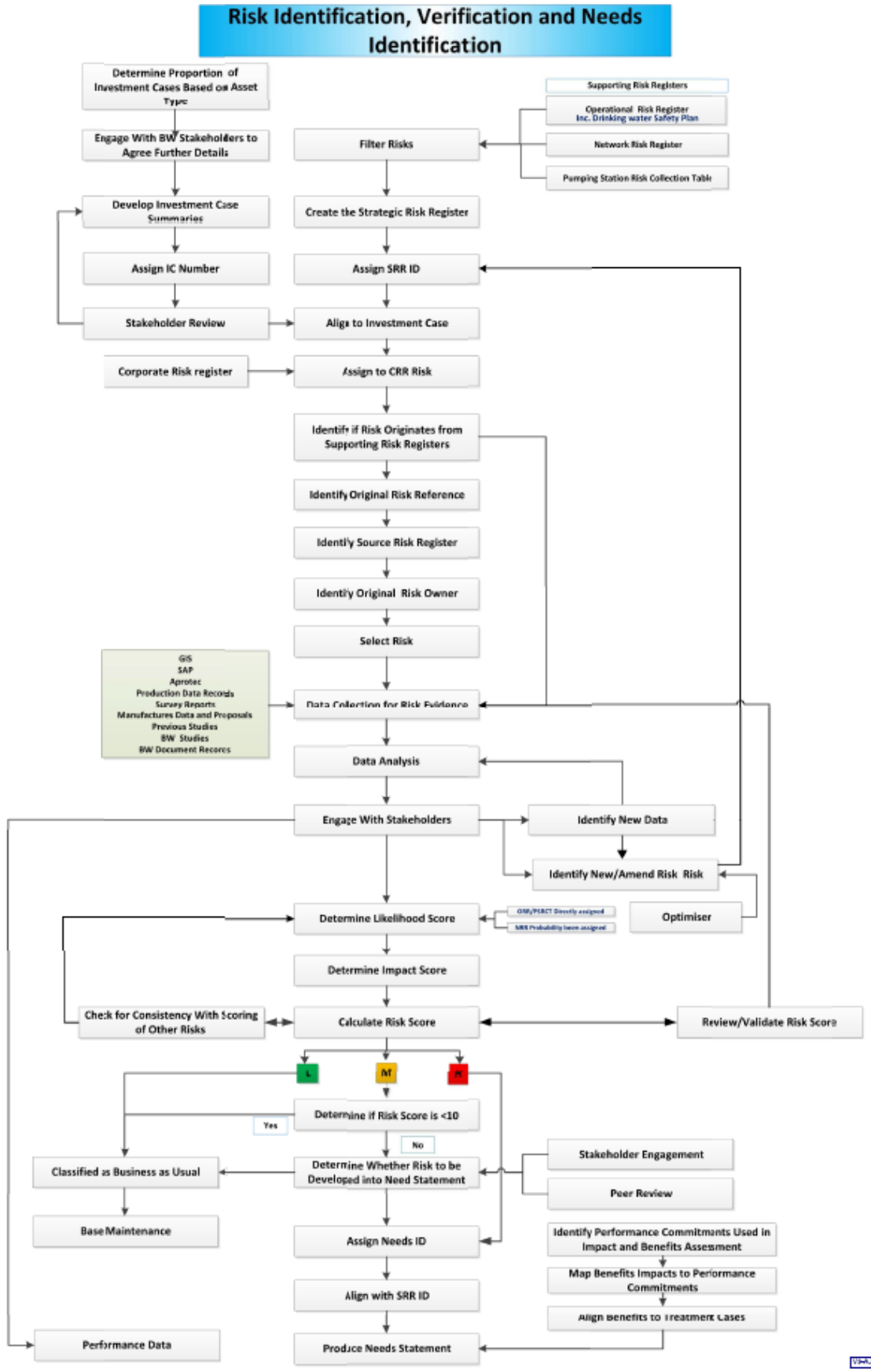
Table 4: Consequence Score

LIKELIHOOD \ IMPACT	1	2	3	4	5
1	1	2	3	4	5
2	2	4	6	8	10
3	3	6	9	12	15
4	4	8	12	16	20
5	5	10	15	20	25

8.5 Appendix E: Corporate Register – Risk Basket

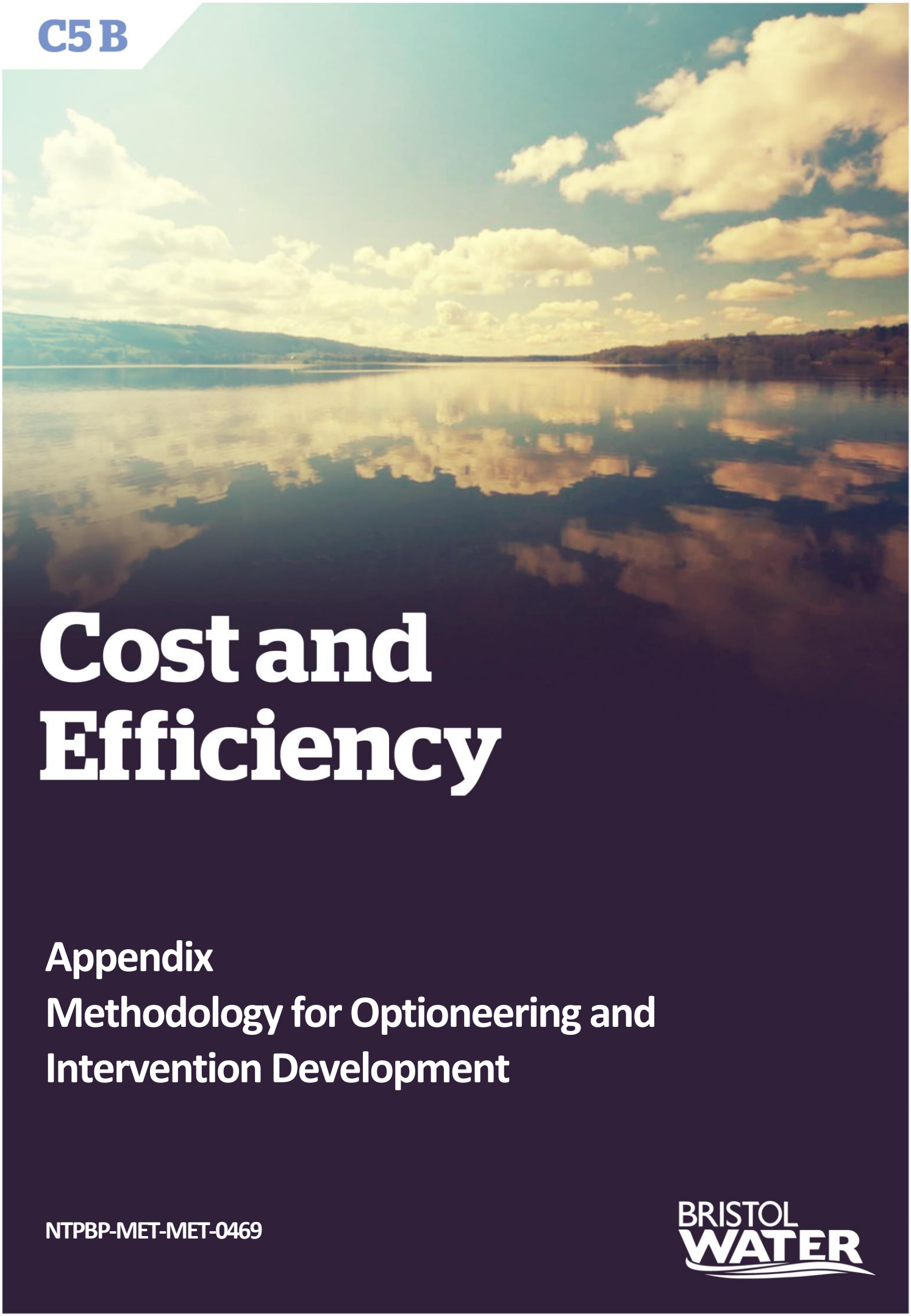
CR01	Risk of not maintaining good Customer Management practices and incurring financial penalties as a result
CR02	Failure, or unable, to develop appropriate strategy to deal with water resource risks, including climate change, extremes of weather and the subsequent impact on operations, costs and legislation.
CR03	Risk of Bristol Water causing major contamination or environmental incident and not meeting environmental legislation.
CR04	Risk of Bristol Water not being able to raise sufficient finance to fund its operations
CR05	Risk of Bristol Water suffering excessive costs, whether due to pension scheme obligations, bad debts provisions, inflation, interest rates, commodity prices, other operational areas or fraud
CR06	Risk of Bristol Water not being able to recruit, maintain and train the right people, at the right numbers in the right roles
CR07	Risk of Bristol Water not being able maintain supplies of key materials or services
CR08	Risk the Incident occurs relating to failure of the company's health & safety arrangements which cause serious harm and potentially death to people, internally or externally.
CR09	Risk associated with the failure, or loss of use, of a key operational asset or location. The occurrence of an incident, which may involve operational activities, criminal acts etc. that could overwhelm BW's resilience planning
CR10	Risk of Water Quality breaches occurring giving rise to harm to customers and statutory DWI failures.
CR11	Risk of the company fraudulently or accidentally reporting incorrect data or misinterpreting the Ofwat Regulatory requirements
CR12	Risk of the company failing to maintain its assets to the standards expected by the financial regulator (Ofwat) and incurring financial penalties.
CR13	Risk of failing to complete delivery of the capital programme within the appropriate AMP period.
CR14	Risk of changes in the Regulatory Regime, including the introduction of competition, adversely affecting the Company

8.6 Appendix F: Flow Chart


Risk Identification, Verification and Needs Identification
Determine Proportion of Investment Cases Based on Asset Type
Engage With BW Stakeholders to Agree Further Details
Develop Investment Case Summaries
Assign IC Number
Stakeholder Review
Corporate Risk register
Supporting Risk Registers
Operational Risk Register Inc. Drinking water Safety Plan
Network Risk Register
Pumping Station Risk Collection Table
Filter Risks
Create the Strategic Risk Register
Assign SRR ID
Align to Investment Case
Assign to CRR Risk
Identify if Risk Originates from Supporting Risk Registers
Identify Original Risk Reference
Identify Source Risk Register
Identify Original Risk Owner
Select Risk
GIS
SAP
Aprotec
Production Data Records
Survey Reports
Manufactures Data and Proposals
Previous Studies
BW Studies
BW Document Recores
Data Collection for Risk Evidence
Data Analysis
Engage With Stakeholders
Identify New Data
Identify New/Amend Risk Risk
Optimiser
Determine Likelihood Score
Determine Impact Score
Check for Consistency With Scoring of Other Risks
Calculate Risk Score
Review/Validate Risk Score
L
M
H
Determine if Risk Score is <10
Yes
No
Classified as Business as Usual
Base Maintenance
Determine Whether Risk to be Developed into Need Statement
Stakeholder Engagement
Peer Review
Assign Needs ID
Identify Performance Commitments Used in Impact and Benefits Assesment
Map Benefits Impacts to Performance Commitments
Align Benefits to Treatment Cases
Align with SRR ID
Performance Data
Produce Needs Statement

15.3 Appendix C: Optioneering and Intervention Development Methodology

C5 B



Cost and Efficiency

Appendix
Methodology for Optioneering and Intervention Development

NTPBP-MET-MET-0469

BRISTOL WATER

Contents

Tables

1 Overview

This methodology is one of six that describe the interrelated activities that demonstrate the detailed development of fully costed and optimised interventions within an investment case.

This methodology forms part of this wider process and should be read in conjunction with the following associated methodologies:

- Methodology for Risk Identification, Verification and Needs Identification;
- Methodology for Intervention Costing;
- Methodology for Benefits Quantification;
- Optimisation Methodology; and
- Data Assurance Methodology.

2 Purpose Of This Document

The purpose of this methodology is to identify the activities required to evaluate and select all options and interventions aligned to the risks and associated ‘needs’ of an investment case, identified in the risk identification, verification and needs identification process.

The deliverables from the process described in this methodology are a set of named options associated with each ‘need’ and a set of named and referenced interventions selected from these options.

3 Principles Of The Methodology

The steps covered in this methodology aim to ensure that:

- A suite of options are developed, considered and compared in response to each ‘need’ identified for each risk;
- The viability of each option is assessed and verified using data and information collated from across the business;
- The options for mitigating each risk are recorded in the individual investment case interventions registers; and
- The interventions developed are recorded in the individual investment case interventions registers and assigned a unique ID for use in the costing, benefits quantification and investment optimisation processes.

The options are to include the ‘Do Nothing’ option and this is defined as taking no additional action other than what is currently being done in AMP to mitigate the risk (if anything).

At this stage, the ‘long list’ of options will typically be compared qualitatively on a case by case basis and with a high level cost estimate, to confirm their viability and relative merit. Any options identified as viable will be taken forward as interventions to be compared by the investment optimisation process. The investment optimiser can be used to select between competing, mutually exclusive interventions that are seeking to mitigate the same risk.

4 Application

Options and interventions developed by this process are aligned to each investment case and recorded in the relevant investment case interventions registers (see Appendix A)[1].

The steps required to achieve this are described in more detail below and illustrated in the flow chart in Appendix B.

4.1 Optioneering

1. The outputs from the risk identification, verification and needs identification stage (a list of verified risks and associated 'needs' statements) should be identified for each investment case. These will have been recorded in the Strategic Risk Register[2].
2. For each identified 'need', a list of options should be developed. Options will be developed by utilising data and information from a range of sources including, but not limited to:
    - Engagement with internal stakeholders;
    - Engagement with suppliers and our supply chain;
    - Engineering experience and judgement of the investment planning team or other originating team;
    - A review of available data held internally;
    - A review of literature and media reports regarding solutions adopted within the water industry; and
    - A review of best/good practice within the water industry.

    It should be noted that the process of identifying options is iterative and will depend on the data collected. New data may reveal new options, so there is a feedback loop from steps 4 and 8 back to this step.
3. Each option should be given a unique name and recorded in the relevant investment case interventions register.
4. Available data should be identified to assess the viability of each option.
5. Collect data pertaining to each option to allow the viability of the option to be assessed and record this data request in the Data Request Tracker[3]. Data will include performance data and asset data and will be gathered from a range of sources, for example:
    - Our Geographical Information System data;
    - Our company financial, operational and asset systems;
    - Aprotec[4];

[1] These registers are saved into the 'Output' folder for each investment case on SharePoint.
[2] Bristol Water, 2018. *NTPBP-CAL-STR-0127 Strategic Risk Register (WIP).xlsx*
[3] Bristol Water, 2018. *Data request tracker.xlsx*

- PRISM
- Production data records;
- Survey reports;
- Manufacturers' data and proposals;
- Previous studies undertaken on our behalf;
- Previous studies we have completed internally;
- Our document records; and
- Our operations and maintenance manuals.

6. Assess/analyse the data collected in step 5 for its relevance in assessing the viability of an option. The analysis of the data will allow the investment planning team or other originating team to review whether any additional options are required at this stage. The type of data analysis required will be dependent on the option being considered and will not be consistent between options.
7. A high level assessment of the capital cost of each intervention will be made and recorded in the relevant investment case interventions registers. This will consist of a high/medium/low rating, not a monetary value. This estimate will allow the options to be compared qualitatively, as described in step 8 below. This high level cost estimate also provides a secondary means, along with intervention scoping documents and activity schedules, to communicate to the party undertaking the intervention costing the potential scale of the costing exercise. This is described in detail in the Methodology for Intervention Costing[5].
8. Using the data collected in step 5 and assessed/analysed in step 6, options should be compared qualitatively. The qualitative assessment will assess:
    - The extent to which each option mitigates a given risk and meets its 'need'. This will include a broad comparison of how successful the option is likely to be in achieving the expected level of mitigation. The actual expected level of mitigation will not be assessed until the benefits quantification stage, but based on experience and engineering judgement, consideration of the expected benefit/impact can be undertaken at this stage.
    - The comparative cost of a given option compared to other options that will mitigate the same risk (based on the high/medium/low rating applied in step 7). This will consider broadly whether the option is more, less or about the same cost as these other options. At this stage, this assessment is based on engineering judgement rather than a comparison of detailed cost estimates, as these detailed cost estimates are not prepared until the next stage of the process (the intervention costing stage).
    - The comparative health, safety and environmental risks associated with each option.
    - The comparative operational expenditure associated with a given option compared to other options that will mitigate the same risk. This will consider broadly whether the operational

[4] This is one of our internal document storage systems that holds final/approved asset documentation.
[5] Bristol Water, 2018. *NTPBP-MET-MET-0475 Intervention Costing Methodology.docx*

expenditure is more, less or about the same as these other options. At this stage, this assessment is based on engineering judgement rather than a comparison of detailed operational expenditure estimates, as these are not prepared until the next stage of the process (the intervention costing stage).

- The comparative third party impacts of each option on external stakeholders, such as businesses and members of the public.
- All other benefits associated with an option, beyond those that mitigate the primary 'need'.

The results of the qualitative assessment described above are recorded in the relevant investment case interventions register.

9. At this stage a high level comparison of options will be undertaken based on the assessment completed in step 8, and the worst performing options will be rejected. The reasons for this decision will be recorded in the relevant investment case interventions registers and reviewed in the options viability stage below (see step 11).

10. Based on the assessments, analysis and comparisons detailed in section 4.1, the viability of the option should be confirmed. This confirmation will also be informed by internal stakeholder engagement. The confirmation of an option will result in an option being developed into an intervention. Options that are not confirmed will not be taken any further forward in the PR19 investment planning process, subject to the peer review described in step 11 below.

    If no clear distinction can be made between different options that mitigate the same risk, all options will be developed into interventions.

    The outputs from later processes (namely the costing and benefits quantification processes, described in detail in the Methodology for Intervention Costing and Methodology for Benefits Quantification respectively) will feed back into this step, to help confirm option viability. For example, if an option does not provide the expected benefits after a quantitative assessment is completed, or the cost is much higher than expected after a detailed costing is prepared, the option may become unviable.

11. Confirmation of an option's viability is recorded in the relevant investment case interventions register. This viability decision will be peer reviewed by an investment planning engineer. In some cases this peer review will identify further viable options that should be assessed, or it may make recommendations for revising the option viability assessment. If this is the case, return to step 3 in section 4.1. If the peer review concludes that an option should be rejected when it has initially been identified as being viable, the investment planning engineer reviewer will discuss this with the individual who developed the option, and both parties will come to an agreed decision on viability. This decision will be recorded in the relevant investment case interventions register.

12. All options identified as viable will be developed into interventions, as described in section 4.2 below.

4.2 Intervention Development

1. Each viable option that has been identified for development into an intervention will be allocated a unique intervention ID. The ID will take the form, AA.BBB.CC, where:
    - AA represents the two-digit investment case number;
    - BBB represents the three-digit reference of the investment case sub-category; and
    - CC represents the two-digit reference for the intervention.
2. Each intervention that has been identified will be allocated a unique intervention title. Typically, this will be the same as the option name.
3. A description will be formulated for each intervention that has been identified. The description will describe the key components of the intervention, together with key metrics associated with each component. The description will be sufficient to provide a good appreciation of the extent and scale of the intervention for cost estimating purposes and benefits quantification. The description will be informed by internal stakeholder engagement and will be peer reviewed by the investment planning team or other originating team.
4. Confirmation should be provided as to whether an intervention should be included in the investment optimisation process. This is recorded in the relevant investment case interventions register.
5. Once an intervention is confirmed, it should be logged on the Investment Planning Interventions Register[6], for use in the costing and benefits quantification stages.

[6] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*

5 Interdependencies

This methodology has a key interdependency with the Methodology for Risk Identification, Verification and Needs Identification, in order to have verified risks and 'needs' as an input.

The Strategic Risk Register and the 'needs' statements within it form a key input to the optioneering and intervention development process.

The outputs from implementing this methodology are captured in the relevant investment case interventions register.

The developed interventions, as described in this methodology, are the starting point for the costing process and benefits quantification assessment, which are described in the Methodology for Intervention Costing and Methodology for Benefits Quantification respectively. The developed interventions also form the inputs to the investment optimisation process, as described in the Optimisation Methodology.

The 'line of sight' for each investment case, of risk identification, risk verification, needs identification optioneering, and intervention development, is recorded in the respective investment case interventions register. A full list of these registers is provided in Appendix A.

6 Data Assurance

Data used within the investment planning process as a whole, including the costing process, has been recorded within the Data Request Tracker[7].

Data is assured using the Data Assurance Methodology[8].

[7] Bristol Water, 2018. *Data request tracker.xlsx*
[8] Bristol Water, 2018. *NTPBP-MET-DAT-0099 Data Quality Assurance Methodology.docx*

7 Control Points

The control points shown in Table 1 have been identified. Against each control point, the means of checking is listed, together with any feed back loop which provides further verification of that control point. In all cases, the output from the control point is recorded in the relevant investment case interventions register as listed in Appendix A.

It should be noted that these control points are not identified on the flow chart in Appendix B. However, the control point names correspond to process steps that are identified.

Table 1: Control Points in the Methodology for Optioneering and Intervention Development

Control Point	Means of Checking	Feedback
Identification of Options	Peer review within the Investment Planning Team or other originating team, and with internal stakeholders.	Subsequent data collection steps may reveal new options which will feedback into this step. Subsequent benefits quantification, costing calculations or stakeholder meetings may reveal that the benefits can be enhanced or costs reduced by introducing a new option into the process.
Assess/analyse data for relevance and justification of the option	Peer Review within the Investment Planning Team or other originating team, and with internal stakeholders.	Additional options may need to be identified
Viability of Options	Peer Review within the Investment Planning Team or other originating team, and with internal stakeholders.	The viability decision may be informed by subsequent benefits quantification or costing calculations. Stakeholder meetings may inform the viability decision. The review may require revision to the assessment of the extent that the option mitigates risks and meets needs or it may require additional options to be identified.
Scope of Interventions	Peer Review within the Investment Planning Team or other originating team, and with internal stakeholders.	Stakeholder meetings in subsequent steps may inform the scope of the intervention.

8 Appendices

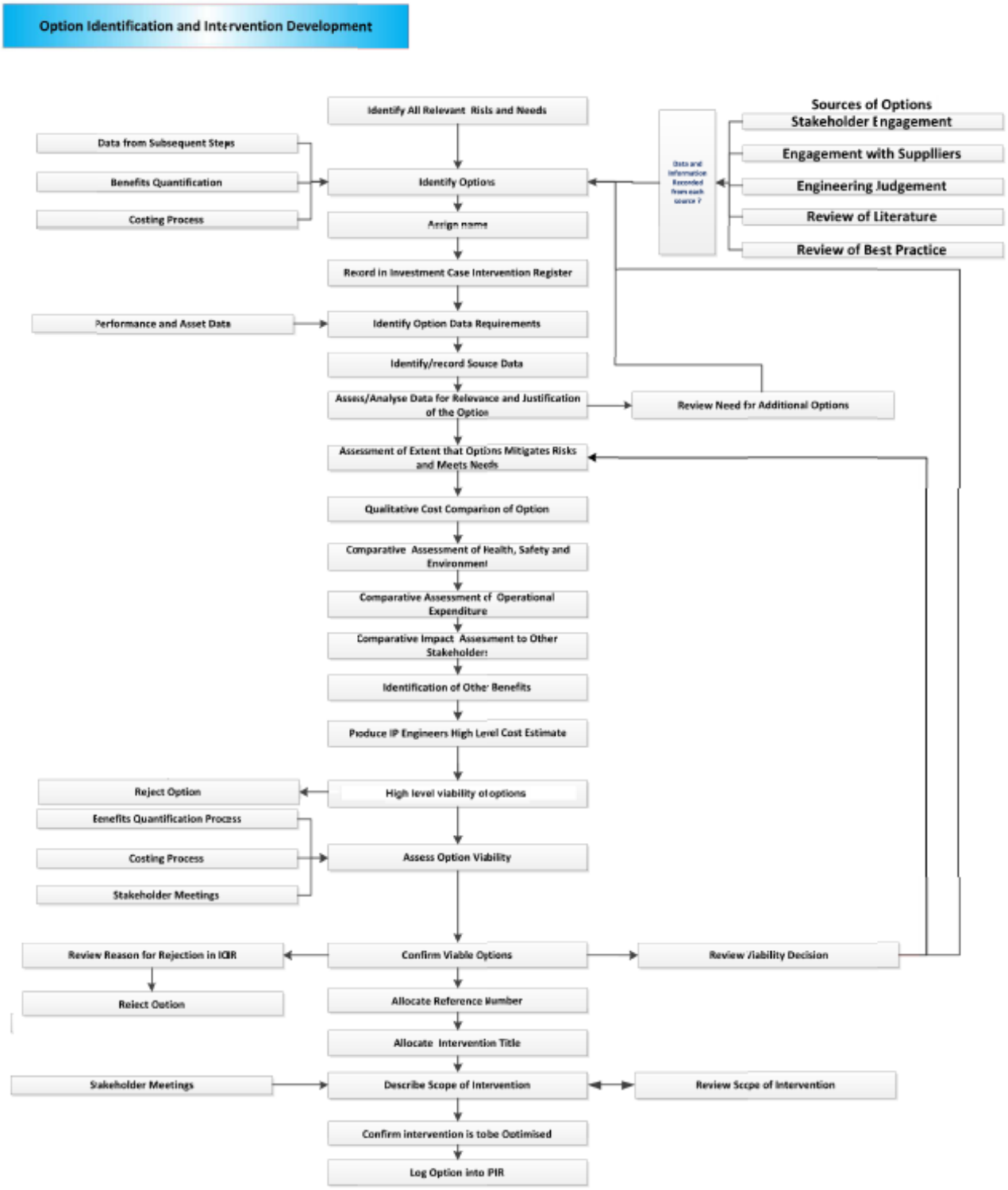
Appendix A: Investment Case Interventions Registers List

Appendix B: Appendix B: Flow Chart

8.1 Appendix A: Investment Case Interventions Registers List

Document ID	Document Type	Document Name
NTPBP-CAL-TRU-0137	Calculation Sheet	Trunk Mains and Pipe Bridges Investment Case Intervention Register
NTPBP-CAL-DIS-0138	Calculation Sheet	Distribution Mains Investment Case Intervention Register
NTPBP-CAL-SER-0139	Calculation Sheet	Service Reservoirs and Towers Investment Case Intervention Register
NTPBP-CAL-WAT-0140	Calculation Sheet	Water Pumping Stations Investment Case Intervention Register
NTPBP-CAL-BUL-0142	Calculation Sheet	Bulk Meters and Pressure Control Valves Investment Case Intervention Register
NTPBP-CAL-CUS-0143	Calculation Sheet	Customer Meters Investment Case Intervention Register
NTPBP-CAL-NET-0144	Calculation Sheet	Network Ancillaries Investment Case Intervention Register
NTPBP-CAL-NET-0145	Calculation Sheet	Network Monitoring Investment Case Intervention Register
NTPBP-CAL-LEA-0146	Calculation Sheet	Leakage Investment Case Intervention Register
NTPBP-CAL-NEW-0147	Calculation Sheet	New Development Investment Case Intervention Register
NTPBP-CAL-WAT-0149	Calculation Sheet	Water Resources Investment Case Intervention Register
NTPBP-CAL-RAW-0150	Calculation Sheet	Raw Water Distribution Investment Case Intervention Register
NTPBP-CAL-RAW-0151	Calculation Sheet	Raw Water Pumping Stations Investment Case Intervention Register
NTPBP-CAL-TW -0153	Calculation Sheet	Treatment Works Strategic Maintenance Investment Case Intervention Register
NTPBP-CAL-ICA-0154	Calculation Sheet	ICA and Telemetry Investment Case Intervention Register
NTPBP-CAL-RES-0157	Calculation Sheet	Resilience Investment Case Intervention Register
NTPBP-CAL-IT -0158	Calculation Sheet	IT Investment Case Intervention Register
NTPBP-CAL-M&G-0159	Calculation Sheet	Management and General Investment Case Intervention Register
NTPBP-CAL-ENV-0160	Calculation Sheet	Environment Investment Case Intervention Register

8.2 Appendix B: Flow Chart


Option Identification and Intervention Development
Identify All Relevant Risks and Needs
Sources of Options
Stakeholder Engagement
Engagement with Suppliers
Engineering Judgement
Review of Literature
Review of Best Practice
Data from Subsequent Steps
Benefits Quantification
Costing Process
Identify Options
Assign name
Record in Investment Case Intervention Register
Performance and Asset Data
Identify Option Data Requirements
Identify/record Souce Data
Assess/Analyse Data for Relevance and Justification of the Option
Review Need for Additional Options
Assessment of Extent that Options Mitigates Risks and Meets Needs
Qualitative Cost Comparison of Option
Comparative Assessment of Health, Safety and Environment
Comparative Assessment of Operational Expenditure
Comparative Impact Assesment to Other Stakeholder
Identification of Other Benefits
Produce IP Engineers High Level Cost Estimate
Reject Option
High level viability of options
Benefits Quantification Process
Costing Process
Stakeholder Meetings
Assess Option Viability
Review Reason for Rejection in ICIR
Confirm Viable Options
Review Viability Decision
Reject Option
Allocate Reference Number
Allocate Intervention Title
Stakeholder Meetings
Describe Scope of Intervention
Review Scope of Intervention
Confirm intervention is tobe Optimised
Log Option into PIR

15.4 Appendix D: Costing Methodology

C5 B

Cost and Efficiency

Appendix
Methodology for Intervention Costing

NTPBP-MET-MET-0475

BRISTOL WATER

Contents

Tables

1 Overview

This methodology is one of six that describe the interrelated activities that demonstrate the detailed development of fully costed and optimised interventions within an investment case.

This methodology forms part of a wider process and should be read in conjunction with the following associated methodologies:

- Methodology for Risk Identification, Verification and Needs Identification
- Methodology for Optioneering and Intervention Development;
- Methodology for Benefits Quantification;
- Optimisation Methodology; and
- Data Assurance Methodology.

2 Purpose Of This Document

The purpose of this methodology is to explain the process by which the interventions identified in the previous stage (optioneering and intervention development) are scoped and costed.

The deliverables from the process described in this methodology are capital cost estimates and operational expenditure estimates for each intervention, which will be used as part of the benefits quantification and investment optimisation processes.

3 Principles Of The Methodology

The steps covered in this methodology aim to ensure that:

- The progress of costing an intervention is tracked in the Investment Planning Interventions Register[1] through the remaining stages of the investment planning process;
- An activity schedule is produced for each intervention that is sufficient to allow the intervention to be costed. Where necessary, this will be supplemented with drawings or sketches;
- The most appropriate sub-process is followed for the costing of individual interventions;
- Each intervention is costed using the appropriate methodology for the selected sub-process; and
- Any costs completed by external providers are checked by the investment planning team and if necessary, updated through consultation with the investment planning team and external provider.

[1] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*

4 Application

Costs developed in this process are aligned to individual interventions and recorded in the Investment Planning Interventions Register[2].

The steps required to achieve this are described in more detail below and illustrated in the flow chart in Appendix B.

1. An activity schedule should be prepared for each intervention. In some cases an activity schedule will already exist for an Intervention[3] and in such cases, this will be used.

   To produce the activity schedule, data will be gathered from a range of sources including, but not limited to:

   - Our Geographical Information System data;
   - Our company financial, operational and asset systems;
   - Aprotec[4];
   - Production data records;
   - Survey reports;
   - Manufacturers' data and proposals;
   - Previous studies undertaken on our behalf;
   - Previous studies we have completed internally; and
   - Our document records.

2. For costings being prepared by our costing partner ChandlerKBS, the activity schedule developed in step 1 should be emailed to ChandlerKBS. There is an interdependency between this step and step 2(i) of ChandlerKBS' methodology. The e-mail should contain:

   - The intervention title;
   - The intervention ID;
   - A hyperlink to the location of the activity schedule and supporting documents on our SharePoint site; and
   - Any notes or special costing requirements related to the intervention not detailed on the activity schedule for that intervention.

[2] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*
[3] An activity schedule may already exist if an intervention has been considered previously by the business, but was not pursued for implementation.
[4] This is one of our internal document storage systems that holds final/approved asset documentation.

3. The most appropriate costing sub-process should be selected. These sub-processes are:
    - A ChandlerKBS costing; or
    - An in-house costing to be prepared internally (see Appendix A).

    The default position is to select ChandlerKBS to prepare the costing for an intervention. However, costings are to be prepared in-house where the interventions are:

    - Studies;
    - Changes to operational procedure;
    - Expenditure or contributions from New Development;
    - Catchment management;
    - Base maintenance;
    - In the Instrument Control and Automation & Telemetry investment case;
    - Distribution mains - zonal replacement;
    - MCERT meters;
    - Customer meters;
    - Communication pipe replacement;
    - The Water Resources: Appointed Lakeside Recreations Works interventions;
    - The Water Resources: Large Raised Reservoirs Proactive and Statutory Maintenance interventions; and
    - In the Management & General investment case.

    However, for four specific investment cases, the intervention costings are to be prepared by other external parties as described below:

    - Trunk Mains and Pipe Bridges Investment Case, intervention sub-category 002. Interventions within this sub-category are to be costed by Minerva. The process from risk identification through to costing and benefits quantification is being completed as a single package of work by external consultants Minerva.
    - Water Resources Investment Case, intervention 20.001.01 (Water Resource Management Investigations). These studies and surveys will be costed by external consultants Ricardo as they have produced similar cost estimates for our Water Resources Management Plan.
    - IT Investment Case. All interventions in this investment case are to be costed by Wipro, our IT support partner.
    - Environment Investment Case. Eight interventions in this investment case are to be costed by Ricardo, due to their expertise in this area of work.
4. Each intervention is to be costed following the appropriate sub-process and methdology.

For interventions that are to be costed in-house, go to step 9.

5. For costings being prepared by ChandlerKBS, respond to any queries from them requesting any additional cost data.
6. The investment case lead engineer should respond to any queries and requests send to them via e-mail during the cost estimation process. Such queries could include:
    - Queries on details of the scope included in an activity schedule. It is anticipated that clarification on scope details will need resolving to allow ChandlerKBS' estimators to complete their estimates. A dialogue will be started by the ChandlerKBS Lead Estimator via email, with the investment case engineer responsible for the intervention, resolving the query.
    - Resolutions to queries from the investment planning team should be contained in emails to the ChandlerKBS Lead Estimator for actioning.
    - Queries that are raised will be brought up in the weekly estimating progress call with the ChandlerKBS Project Manager.
7. The investment case engineer responsible for the intervention should respond to any requests for additional Bristol Water cost data for gap filling (where ChandlerKBS do not have the data within their own cost models). Where this is required, the ChandlerKBS Lead Estimator will send an email request to the investment case engineer responsible for the intervention. The engineer should respond via email.
8. When a costing prepared externally is returned to the investment planning team, the estimate should be sense checked by an investment planning lead engineer and recorded in the Investment Planning Interventions Register[5]. Any concerns will be resolved via an email exchange between the investment planning team and the external consultant (in most instances ChandlerKBS). In the case of an in-house cost estimate (which is prepared by the investment planning team), the cost estimate will be peer reviewed.
9. Once the costing for an intervention is finalised, the Investment Planning Interventions Register should be populated with details of the capital cost of the intervention.

[5] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*

5 Interdependencies

The Methodology for Intervention Costing has a key interdependency with the Methodology for Optioneering and Intervention Development. The output from the optioneering and intervention development process is a list of uniquely referenced interventions, with accompanying intervention titles and descriptions, which are captured in both the individual investment case registers and Investment Planning Interventions Register[6]. These form the key inputs to the Methodology for Intervention Costing.

The Methodology for Intervention Costing runs in parallel with the Methodology for Benefits Quantification, and both have key interdependencies with the Optimisation Methodology. The outputs from the costing process are capital cost estimates and operational expenditure estimates for each intervention. Both are key inputs for investment optimisation, as described in the Optimisation Methodology.

[6] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*

6 Data Assurance

Data used within the investment planning process as a whole, including the costing process, has been recorded within the Data Request Tracker[7].

Data is assured using the Data Assurance Methodology[8].

ChandlerKBS have their own data assurance process so this is not covered by our Data Assurance Methodology.

[7] Bristol Water, 2018. *Data request tracker.xlsx*
[8] Bristol Water, 2018. *NTPBP-MET-DAT-0099 Data Quality Assurance Methodology.docx*

7 Control Points

The control points shown in Table 1 have been identified. Against each control point, the means of checking is listed, together with any feed back loop which provides further verification of that control point. In all cases, the output from the control point is recorded in the investment case interventions registers.

It should be noted that these control points are not identified on the flow chart in Appendix B. However, the control point names correspond to process steps that are identified.

Table 1: Control Points in the Methodology for Costing

Control Point	Means of Checking	Feedback
Selection of either ChandlerKBS costing or in-house costing.	Peer review within the investment planning team or other originating team , and with internal stakeholders.	Engagement with the supplier of the costing to confirm they can provide the cost.
Output of the costing sub-process.	Checked as part of the sub-process.	Output of the costing sub-process will be sense checked by the investment planning team, or other originating team.

8 Appendices

8.1 Appendix A: In-House Costing Methodology

In-house costing will include the following:

- Studies;
- Changes to operational procedure;
- Expenditure or contributions from New Development;
- Catchment management;
- Base maintenance;
- Instrument Control and Automation & Telemetry;
- Distribution mains - zonal replacement;
- MCERT meters;
- Customer meters;
- Communication pipe replacement;
- Water Resources: Appointed Lakeside Recreations Works;
- Water Resources: Large Raised Reservoirs Proactive and Statutory Maintenance; and
- Management & General interventions.

The broad methodology of estimating costs for each of these categories is described in more detail below.

Studies

- An estimate of direct costs will be based on similar studies or surveys that we have recently commissioned, or on estimates developed by the investment planning engineers of the number of hours needed to complete a study, combined with typically hourly rates for designers.
- ChandlerKBS will be consulted to understand the uplifts that need to be applied to direct costs and these uplifts will then be applied as appropriate, to produce the gross cost estimate.
- The cost estimate will be peer reviewed.
- The cost will be recorded in the Investment Planning Interventions Register[9].

Changes to Operational Procedure:

- The majority of the cost is associated with operational cost. Some capital cost is expected but generally these are low values, circa £20k. The capital cost will be derived through internal stakeholder meetings to agree a value for this capital cost.
- ChandlerKBS will be consulted to understand the uplifts that need to be applied to direct costs and these uplifts will then be applied as appropriate, to produce the gross cost estimate.
- The cost estimate will be peer reviewed
- The cost will be recorded in the Investment Planning Interventions Register.

[9] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*

Expenditure and Contributions from New Development:

- The values will be calculated by our Development Services Manager. The figures will be based on a 5.4% increase in new development over the course of AMP7. This rate has been judged by the Development Services Manager based on various information sources including:
    - Local Authority Local Plans;
    - Knowledge of the current status of the local house building market and current rate of build; and
    - Historic data on new house building in our water supply area.
- The cost estimate will be sense checked by the investment planning team.
- The cost estimate will be sense checked by internal stakeholders for the New Development investment case.
- The cost will be recorded in the Investment Planning Interventions Register[10].

Catchment Management:

- The values will be calculated by our Catchment Strategy Manager. The figures will be derived from historical project data.
- The calculation will be checked by the Head of Water Resources and Environment.
- The cost will be recorded in the Investment Planning Interventions Register.

Base Maintenance:

The method of calculation of base maintenance is described in detail in the following reports:

- Investment Case: Infrastructure Base Maintenance - Technical Approach and Business Case[11]
- Investment Case: Non- Infrastructure Base Maintenance - Technical Approach and Business Case[12]

Instrument Control and Automation & Telemetry:

- The values will be calculated by our Senior ICA Project Manager.
- The calculation will be checked by the investment case engineer responsible for the intervention.
- The cost will be recorded in the Investment Planning Interventions Register.

[10] Bristol Water, 2018. *NTPBP-CAL-INV-0133 Investment Planning Interventions Register.xlsx*
[11] Bristol Water, 2018. *NTPBP-INV-INF-0741 Infrastructure Base Maintenance Business Case.docx*
[12] Bristol Water, 2018. *NTPBP-INV-NON-0742 Non-Infrastructure Base Maintenance Business Case.docx*

Distribution Mains - Zonal replacement:

- An average replacement cost per meter of distribution main will be calculated by taking the average replacement cost per meter generated for a range of distribution main sizes by the ChandlerKBS zonal replacement cost model.
- The total cost per zone will be calculated by the Asset Modelling and Optimisation Manager using the average replacement cost applied to the lengths of mains to be replaced.
- The calculation will be checked by the investment case engineer responsible for the intervention.
- The cost will be recorded in the Investment Planning Interventions Register.

MCERT Meters:

- The unit cost will be calculated by our Network O&M Technical Area Manager and reviewed by the investment case engineer responsible for the intervention.
- The total cost will be calculated by the investment case engineer responsible for the intervention, by applying the unit cost to the numbers of meters.
- The calculation will be checked within the investment planning team.
- The cost will be recorded in the Investment Planning Interventions Register.

Customer Meters:

- We will assess the unit cost for installation of new Automated Meter Reading meters based on the current installation cost of analogue meters, and allowing for the capital cost different between Automated Meter Reading meters and analogue meters.
- The unit cost will be reviewed internally in Bristol Water.
- The total cost values will be calculated by the investment case engineer responsible for the intervention by applying this unit cost to the number of new meter installations assessed by the investment planning team.
- The calculation will be checked within the investment planning team.
- The cost will be recorded in the Investment Planning Interventions Register.

Communication pipe replacement:

- The values will be calculated by the investment case engineer responsible for the intervention using a unit cost calculated by ChandlerKBS and by applying this unit cost to the number of replacements assessed by the investment planning team.
- The calculation will be checked within the investment planning team.
- The cost will be recorded in the Investment Planning Interventions Register.

Water Resources: Appointed Lakeside Recreations Works:

- The values will be calculated by our Recreations Manager. The figures will be derived from historical project costs.

- The calculation will be checked by the investment case engineer responsible for the intervention.
- The cost will be recorded in the Investment Planning Interventions Register.

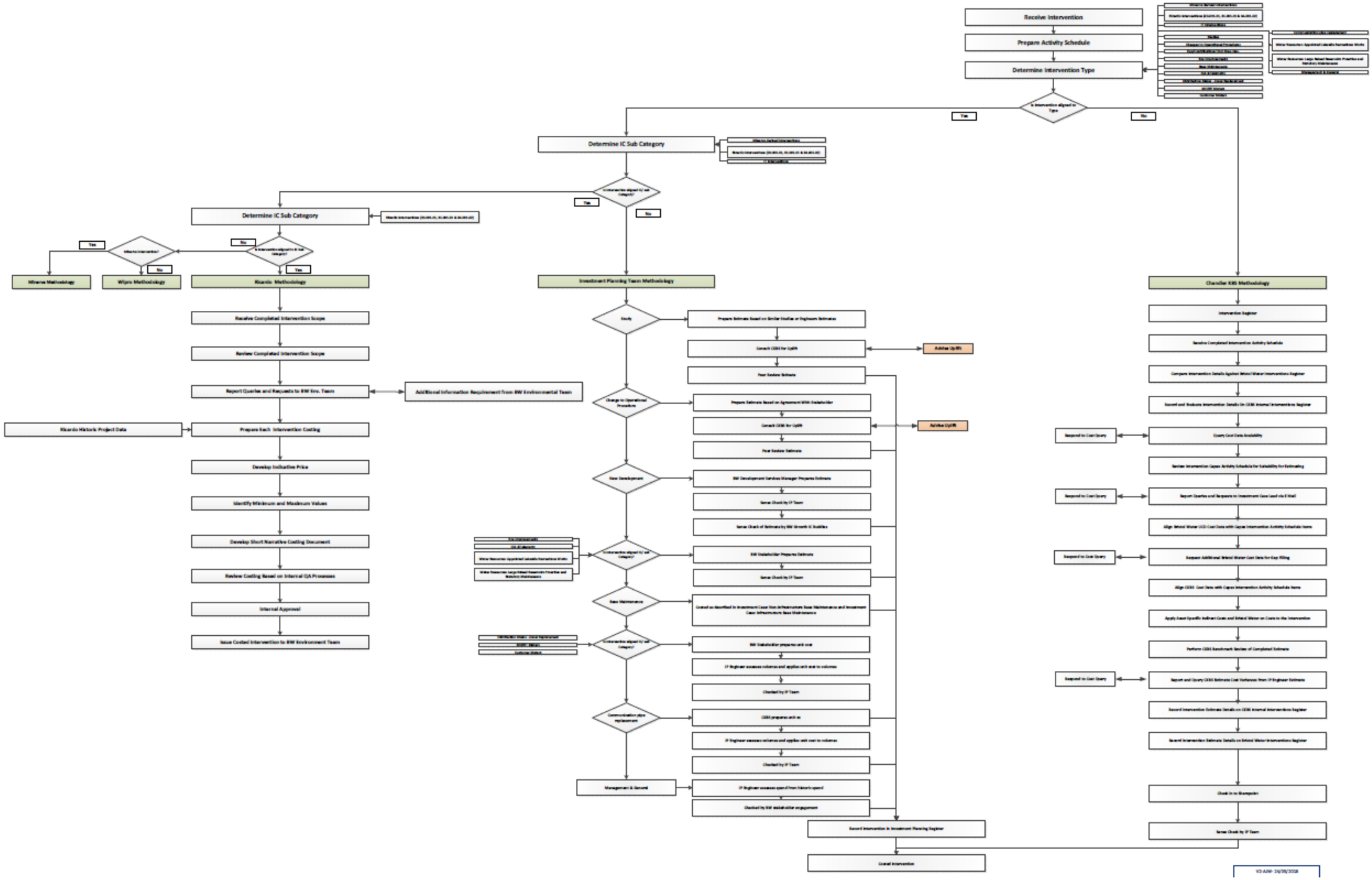
Water Resources: Large Raised Reservoirs Proactive and Statutory Maintenance:

- The values will be calculated by our Reservoirs Project Engineer based on the actions arising from Section 10 inspections.
- The calculation will be checked by the investment case engineer responsible for the intervention.
- The cost will be recorded in the Investment Planning Interventions Register.

Management & General.

- The values will be calculated by the lead investment planning engineer based on historic spend, unless significant investment has been required historically. An example would be our Head Office refurbishment.
- The value will be refined and checked through internal stakeholder engagement with the different asset owners.
- The cost will be recorded in the Investment Planning Interventions Register.

8.2 Appendix B: Flow Chart


Receive Intervention
Prepare Activity Schedule
Determine Intervention Type
Is intervention aligned to Type
Yes
No
Determine IC Sub Category
Is intervention aligned to IC sub category?
Yes
No
Determine IC Sub Category
Where Intervention?
Is intervention aligned to IC sub category?
Minerva Methodology
Wipro Methodology
Ricardo Methodology
Investment Planning Team Methodology
Chandler KMS Methodology
Receive Completed Intervention Scope
Review Completed Intervention Scope
Report Queries and Requests to BW Env. Team
Additional Information Requirement from BW Environmental Team
Ricardo Historic Project Data
Prepare Each Intervention Costing
Develop Indicative Price
Identify Minimum and Maximum Values
Develop Short Narrative Costing Document
Review Costing Based on Internal QA Processes
Internal Approval
Issue Costed Intervention to BW Environment Team
Early
Prepare Estimate Based on Similar Scheme or Engineer Estimate
Consult CEAS for Uplift
Advise Uplift
Peer Review Estimate
Change to Operational Procedure
Prepare Estimate Based on Agreement With Stakeholder
Consult CEAS for Uplift
Advise Uplift
Peer Review Estimate
New Development
BW Development Services Manager Prepares Estimate
Sense Check by IP Team
Sense Check of Estimate by BW Growth IC Buddies
Is intervention aligned to IC sub category?
BW Stakeholder Prepares Estimate
Sense Check by IP Team
New Maintenance
Costed as described in Investment Case Non Infrastructure Base Maintenance and Investment Case Infrastructure Base Maintenance
Is intervention aligned to IC sub category?
BW Stakeholder prepares unit cost
IP Engineer assesses volumes and applies unit cost to volumes
Checked by IP Team
Communication pipe replacement
CEAS prepares unit cost
IP Engineer assesses volumes and applies unit cost to volumes
Checked by IP Team
Management & General
IP Engineer assesses spend from historic spend
Checked by BW stakeholder engagement
Record Intervention in Investment Planning Register
Costed Intervention
Intervention Register
Receive Completed Intervention Activity Schedule
Compare Intervention Details Against Inland Water Interventions Register
Record and Evaluate Intervention Details On CEAS Internal Intervention Register
Response to Cost Query
Query Cost Data Availability
Review Intervention Capex Activity Schedule for Suitability for Estimating
Response to Cost Query
Report Queries and Requests to Investment Case Lead via E Mail
Align Inland Water CEAS Cost Data with Capex Intervention Activity Schedule Items
Response to Cost Query
Request Additional Inland Water Cost Data for Gap Filling
Align CEAS Cost Data with Capex Intervention Activity Schedule Items
Apply Asset Specific Indirect Costs and Inland Water on Costs to the Intervention
Perform CEAS Benchmark Review of Completed Estimate
Response to Cost Query
Report and Query CEAS Estimate Cost Variances from IP Engineer Estimate
Record Intervention Estimate Details on CEAS Internal Interventions Register
Record Intervention Estimate Details on Inland Water Interventions Register
Check In to Blueprism
Sense Check by IP Team

15.5 Appendix E: Benefits Quantification Methodology

C5 B

Cost and Efficiency

Appendix
Methodology for Benefits Quantification

NTPBP-MET-BEN-0168

BRISTOL WATER

Contents

Tables

1 Overview

This methodology is one of six that describe the interrelated activities that demonstrate the detailed development of fully costed and optimised interventions within an investment case.

This methodology forms part of a wider process and should be read in conjunction with the following associated methodologies:

- Methodology for Risk Identification, Verification and Needs Identification
- Methodology for Optioneering and Intervention Development;
- Methodology for Intervention Costing;
- Optimisation Methodology; and
- Data Assurance Methodology.

2 Purpose Of This Document

The purpose of this methodology is to explain the process by which individual interventions are assessed in terms of benefits that are considered to be generated to affect company performance during subsequent AMP periods.

The benefits quantification process follows the intervention costing stage and precedes investment optimisation.

3 Principles Of The Methodology

Benefits can be assessed as either being:

- Direct - savings in reactive capital expenditure (capex) or savings in operational expenditure (opex); or
- Indirect - improvement in performance commitments or other resultant effects on the company's performance such as health & safety and environmental costs or fines.

Performance commitments have been established by the Strategy and Regulation part of our business, and are generally taken from Ofwat guidance on how these are to be measured. Each Intervention with indirect effects will contribute to a discrete number of performance commitments. The links between investment case and performance commitments have been mapped at a high level to establish primary, secondary and tertiary links, and this provides an initial indication of contribution for each intervention that supports the investment case.

In every case the primary link should be understood from the intervention's 'needs' statement.

Once the direct and indirect benefits have been determined, these are captured on the investment optimiser input forms for each investment case[1], which are then input into the investment optimiser to determine the proposed investment programme for AMP7 and beyond.

Deliverables from this methodology are benefits calculations within each investment case and investment optimiser input forms, summarising the data to be taken forward for investment optimisation.

The objectives of this benefits quantification stage are:

- To identify specific inputs to the indirect costs, assessing these in the most appropriate way to support the process; and
- To gather data to enable effective decision making in the subsequent investment optimisation stage.

The following constraints are applied to this methodology:

- Benefits will be quantified in accordance with the most recent definitions, as provided by the Strategy and Regulation team;
- At the strategic level, benefits will align to customer priorities via the performance commitments;
- In addition to mapping benefits to the performance commitments, each benefit will be mapped to the business outcomes that have been developed for AMP 7, as presented in the business plan;
- Benefits will be aligned to the twenty one investment cases that we will develop to support the PR19 investment plan;
- Benefits will be mapped to the interventions within each investment case; and

[1] These registers are saved in the '09 – Optimisation'' folder on the Net+ SharePoint site.

- Benefits will not be monetised at this stage. The subsequent investment optimisation stage will quantify the benefits through the use of a single common currency, in the form of a monetary value. Each benefit will be mapped to the reward/penalty mechanism implemented for AMP6, which will be subsequently updated to include the AMP7 reward/penalty mechanism. This will be undertaken via the investment optimiser.

3.1 Business Outcomes

Our four customer outcomes AMP7 are:

- Excellent Customer Experiences;
- Safe and Reliable Supply;
- Local Community and Environmental Resilience; and
- Corporate Financial Resilience.

3.2 Performance Commitments

3.2.1 PR19 Performance Commitments

Our performance commitments comprise a number that are common to all water companies, set by Ofwat, and a number that are Bristol Water specific. Definitions are subject to change as consultation is undertaken, leading up to the production of our final business plan. The definitions used in this benefits quantification process will be updated as and when necessary, and communicated to the investment planning team, to ensure the latest definitions are used.

3.2.2 Other Benefits

While there are no company performance commitments around other benefits, it is clear that some interventions will be driven by other company requirements, notably legislative obligations such as health and safety and environmental compliance.

3.3 Data

A variety of data is required to calculate the benefits. In all cases, data and cost base should be for the current year 2017/18. All data requests and supply of data is recorded in the Data Request Tracker[2].

Reliability of data shall be considered on an individual basis. Where shortcomings are identified, they will be reflected in the reliability score assigned (refer to section 4.4.2). Shortcomings may include extrapolation of data, known inaccuracies or limited data sets.

[2] Bristol Water, 2018. *Data request tracker.xlsx*

3.3.1 Performance Data

Performance data will be used in the calculation of benefits. This will be requested from the relevant data owner in the business. All data requests and supply of data is recorded in the Data Request Tracker[3]. The use of the performance data will be recorded in the individual benefits calculations for each investment case.

[3] Bristol Water, 2018. *Data request tracker.xlsx*

4 Application

Verified risks and needs determined by this process are aligned to each investment case and recorded in the relevant investment case interventions registers[4] (see Appendix B).

4.1 Identify Performance Commitments not used in Benefits Assessment

It is recognised that for the purposes of investment case development, it is not possible to assess the effects interventions may have on some performance commitments, as no direct links may be identified between the performance data and asset performance, e.g. C-MeX and D-MeX. The full list of performance commitments is contained in Appendix A.

4.2 Mapping Performance Commitments To Investment Cases

4.2.1 Primary, Secondary and Tertiary Links

The performance commitments themselves provide a useful means of assessing indirect benefits that may be accrued by an intervention, as the improvement in company performance may be quantified and hence monetised. The monetisation of a particular performance commitment benefit is calculated within the investment optimiser. Non-performance commitment benefits may also be monetised.

An exercise to map the performance commitments to the investment cases has been undertaken and is presented in the Investment Case vs Performance Commitment Schedule calculation[5]. This defines four levels:

- **Primary:** direct link to performance commitment
- **Secondary:** indirect link to performance commitment
- **Tertiary:** subjunctive link to performance commitment
- **Blank:** no obvious link to performance commitment

For the purposes of this benefits quantification assessment, tertiary links may be ignored. These are only considered to contribute negligible amounts of benefits and the level of detail explored prohibits meaningful assessment. The exception to this is if it is possible to assess broad benefits contributed by an asset class, reduced to individual asset level.

Secondary links are only considered where there is demonstrable benefit accrued, and is often assessed using engineering judgement as defined in the individual investment case methodologies.

This information is used as an initial direction for exploring the possible benefits that may be attributable to an intervention, by understanding the performance data available and the investment case in which it is aligned.

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[4] These registers are saved into the 'Output' folder for each investment case on SharePoint.
[5] Bristol Water, 2018. *NTPBP-STR-INV-0084 IC to PC mapping v0_1.xlsx*

4.3 Identify Direct / Indirect Benefits

4.3.1 Confirmation of Direct Benefits

The capex and opex costs developed in the optioneering and intervention development stage shall be confirmed.

4.3.2 Confirmation of Indirect Benefits

The 'needs' statement shall be reviewed for each intervention, to determine the indirect benefits that are to be assessed. Cross referencing this with the investment case links to performance commitments (set out in section 4.2.1 above) then provides a high level check. Finally, a discussion with relevant stakeholders should confirm that the correct benefits have been identified. Evidence shall then be sought from relevant, or through engineering judgement in some cases, where a risk of deterioration in benefit may be present but not experienced.

4.3.3 Feedback to Needs Statement

If the conclusions of this data analysis does not support the links made in the 'needs' statement, changes to the 'needs' statement shall be fed back to this previous stage.

4.4 Calculation

4.4.1 Investment Optimiser Input Form

Each intervention shall be assessed in terms of both direct and indirect benefits. A calculation shall be generated for each assessment to capture source data and assumptions made. Guidance can be found on the relevant sheet of the input form as to how to generate the values. Outputs from the benefits quantification calculations will be entered onto the investment optimiser input form for each investment case[6].

Additional to the benefits associated with the performance commitments as set out above, there is also a requirement to enter:

- ***Duration of the Benefit:*** a duration shall be entered for each intervention, providing an estimate of the time period over which the benefit may be derived from the intervention. The investment optimiser will then assume that a repeated investment will be made at the end of this duration for the purposes of calculating Whole Life Cost in the investment optimiser. For example, a flushing regime may contribute ten years of benefit, after which a repeated flushing exercise will be undertaken at the cost identified.
- ***Expected capex before (£000s):*** a one-off expenditure if theproject is not completed (Do Nothing). This is the reactive cost that would potentially arise within AMP if the asset failed or the risk materialised . It should contain a likelihood factor. These comprise direct costs attributable to failure and reactive resolution of the issue, and should not include the associated

[6] These registers are saved in the '09 – Optimisation'' folder on the Net+ SharePoint site.

indirect costs, such as compensation payments, fines etc. These are covered by the monetised cost of failure associated with the performance commitments. An example is: the failure of a pump may result in additional costs of pump hire at a premium; temporary connections; temporary power feed; and replacement pump at a premium; all combined with a 50% likelihood of occurrence in the next five years, so multiplying the total cost by 0.5.

- ***Expected capex after (£000s):*** Expenditure to complete the project which can be capitalised. Refer to costs developed for interventions in the previous intervention costing stage.
- ***Expected opex before (Average year £000s):*** Current operational expenditure per year (note only for renewals). This data may be sourced from SAP or Bristol Water Staff.
- ***Expected opex after (Average year £000s):*** Expected operational expenditure per year after the project is completed. If this varies from year to year, enter the average expected opex cost (for renewals only). Refer to costs developed for interventions in the previous intervention costing stage.
- ***Change in opex (Average year £000s):*** The annual expected change in opex if the project is completed. This will be negative if expecting a reduction in opex expenditure.
- ***Performance commitments:*** benefits are to be calculated for each performance commitment utilising the most recent definitions, as provided by the Strategy and Regulation team. Where a benefit is considered to diminish or change with time over the duration of an intervention's effective life, then the average benefit shall be determined and entered into the investment optimiser Input form as an annualised figure. In the case where historic performance data is not considered to be representative of anticipated future performance, i.e. where linear deterioration is not considered appropriate, the investment planning engineer may assess alternative deterioration profiles where industry or experiential evidence exists to support this.
- ***Mutual exclusivity:*** there is a need to establish mutual exclusivity of the interventions to avoid double counting. For example, discolouration may be addressed by our Distribution Operations and Maintenance Strategy or mains rehab interventions. The corresponding intervention references should be recorded in the cell in column C separated by semi colons if more than one intervention is to be excluded, for example, '01.001.23; 01.003.17'.

4.4.2 Reliability

Reliability of each benefit shall be assessed, considering for example data sources, confidence in linkage from intervention to performance commitment, and stated based on the following criteria:

- High robustly modelled/fully costed/site surveys
- Medium basic models/ historic data
- Low based on broad assumptions

The reliability of the benefits shall be recorded in the benefits calculations and in the investment optimiser input form.

5 Interdependencies

This process commences once the output of the optioneering and intervention development stage is completed and the investment case interventions registers is completed for a particular intervention. The process is finalised once the investment optimiser input form is populated and feeds into the investment optimisation process.

Feedback is provided:

- From the benefits identification step back to the 'needs' identification/impact assessment step in the risk identification, verification and needs identification stage, where performance data collected and analysed provides different conclusions to those made in the previous stage; and
- From the calculations step back to the 'identify options' step in the optioneering and intervention development stage, where an option may not be considered to demonstrate the benefits anticipated.

The high level mapping of performance commitments to investment cases is required to assist in the analysis of benefits.

6 Data Assurance

Data used within the investment planning process as a whole, including the benefits quantification process, has been recorded within the Data Request Tracker[7].

Data is assured using the Data Assurance Methodology[8].

Data used in this benefits quantification stage is recorded in individual calculations and this methodology.

[7] Bristol Water, 2018. *Data request tracker.xlsx*
[8] Bristol Water, 2018. *NTPBP-MET-DAT-0099 Data Quality Assurance Methodology.docx*

7 Control Points

The control points shown in Table 1 have been identified. Against each control point, the means of checking is listed, together with any feed back loop which provides further verification of that control point. In all cases, the outputs from the control points are recorded on the cover sheets of the relevant calculations.

It should be noted that these control points are not identified on the flow chart in Appendix C. However, the control point names correspond to process steps that are identified.

Table 1: Control Points in the Methodology for Benefits Quantification

Control Point	Means of Checking	Feedback
Identify Direct/Indirect Benefits	Performance data is interrogated to determine whether there is sufficient evidence to demonstrate a benefit is achievable. Data can be sourced from asset datasets or estimated from modelled relationships	Where a link cannot be identified between datasets and assets, benefits may not be assessed
End of the calculations stage	calculations shall be checked to ensure that assured data is used, assumptions are tested and recorded, and detailed steps are followed correctly	Any departure or non-conformities to be rectified
Optimiser Input Form	input form data shall be checked to ensure that data has been translated correctly from the benefits calculations	Any departure or non-conformities to be rectified

Each individual performance commitment benefit methodology has been developed in collaboration with the internal stakeholders responsible for generating the Annual Performance Report metrics. This ensures that common or congruent methodologies are developed and applied.

8 Appendices

8.1 Appendix A: Performance Commitments Where Benefits Have Not Been Quantified

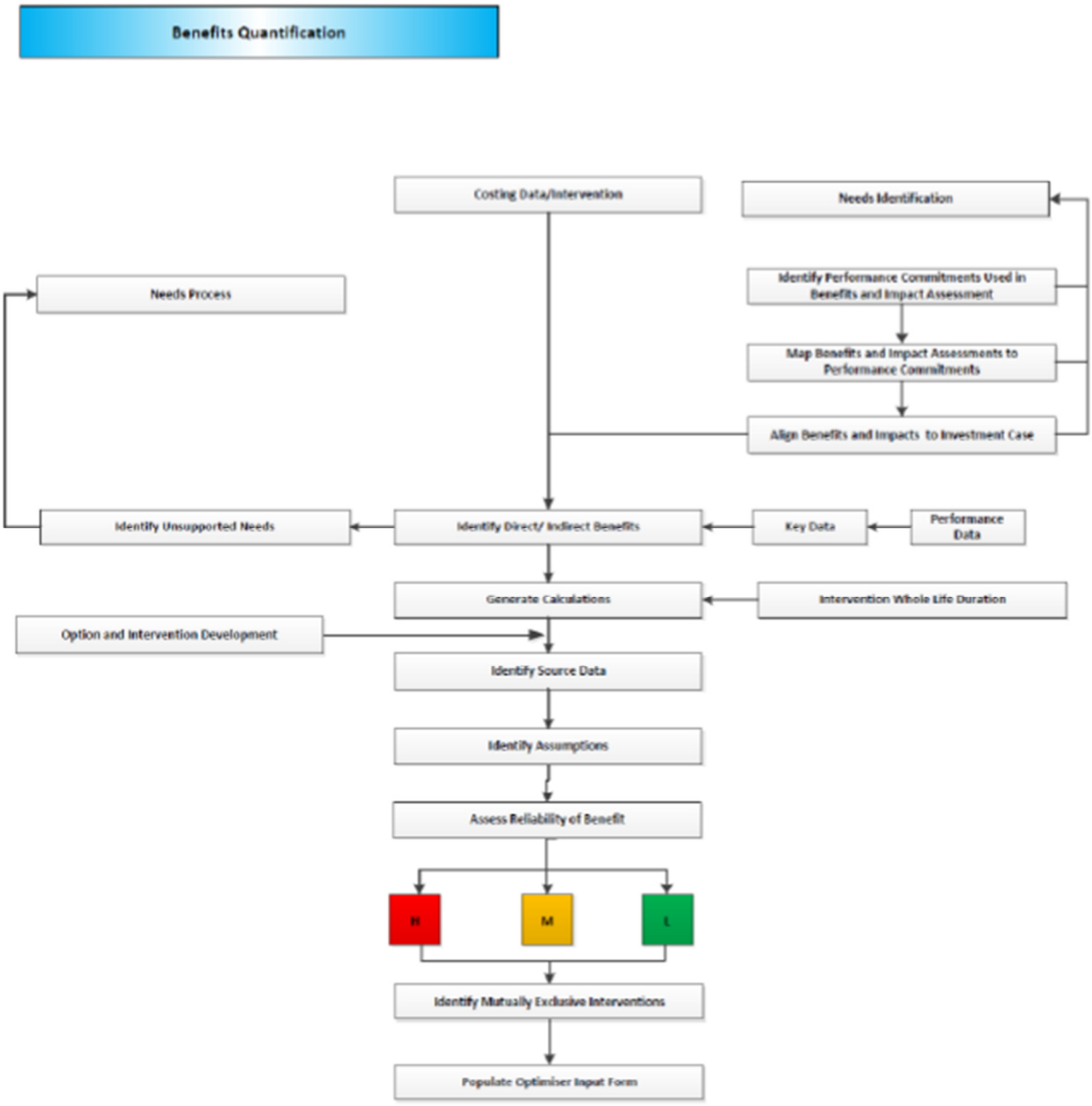
It is not considered possible to quantify the benefit attributable to individual interventions that are associated with the performance commitments listed below. For this reason they will not be quantified as part of this benefits quantification stage.

- C-MeX;
- D-Mex;
- Risk of Severe Restrictions in a Drought;
- Abstraction Incentive Mechanism (AIM);
- Percentage of Customers in Water Poverty;
- Value for Money; and
- Percentage of Satisfied Vulnerable Customers.

8.2 Appendix B: Investment Case Interventions Registers List

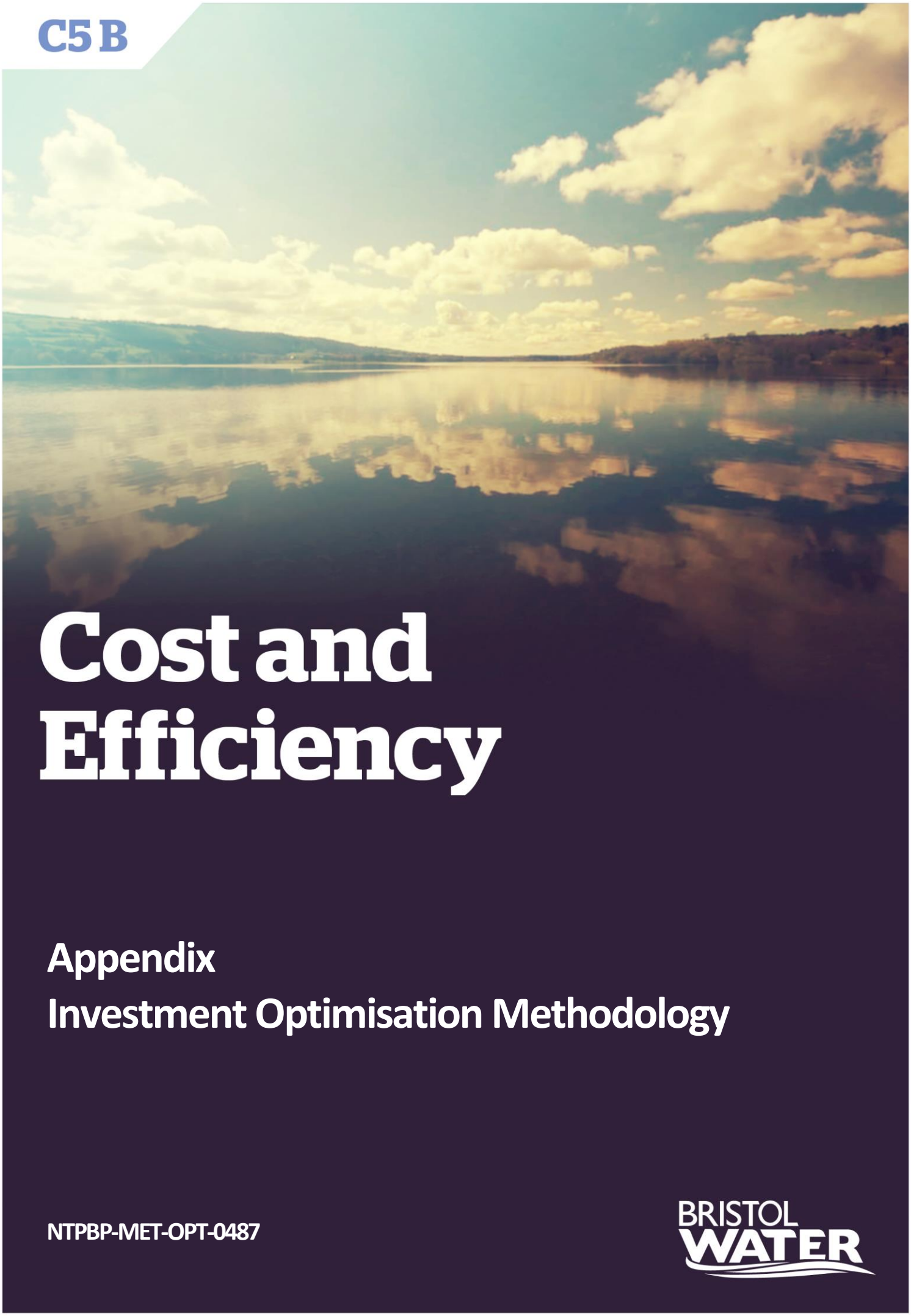
Document ID	Document Type	Document Name
NTPBP-CAL-TRU-0137	Calculation Sheet	Trunk Mains and Pipe Bridges Investment Case Intervention Register
NTPBP-CAL-DIS-0138	Calculation Sheet	Distribution Mains Investment Case Intervention Register
NTPBP-CAL-SER-0139	Calculation Sheet	Service Reservoirs and Towers Investment Case Intervention Register
NTPBP-CAL-WAT-0140	Calculation Sheet	Water Pumping Stations Investment Case Intervention Register
NTPBP-CAL-BUL-0142	Calculation Sheet	Bulk Meters and Pressure Control Valves Investment Case Intervention Register
NTPBP-CAL-CUS-0143	Calculation Sheet	Customer Meters Investment Case Intervention Register
NTPBP-CAL-NET-0144	Calculation Sheet	Network Ancillaries Investment Case Intervention Register
NTPBP-CAL-NET-0145	Calculation Sheet	Network Monitoring Investment Case Intervention Register
NTPBP-CAL-LEA-0146	Calculation Sheet	Leakage Investment Case Intervention Register
NTPBP-CAL-NEW-0147	Calculation Sheet	New Development Investment Case Intervention Register
NTPBP-CAL-WAT-0149	Calculation Sheet	Water Resources Investment Case Intervention Register
NTPBP-CAL-RAW-0150	Calculation Sheet	Raw Water Distribution Investment Case Intervention Register
NTPBP-CAL-RAW-0151	Calculation Sheet	Raw Water Pumping Stations Investment Case Intervention Register
NTPBP-CAL-TW -0153	Calculation Sheet	Treatment Works Strategic Maintenance Investment Case Intervention Register
NTPBP-CAL-ICA-0154	Calculation Sheet	ICA and Telemetry Investment Case Intervention Register
NTPBP-CAL-RES-0157	Calculation Sheet	Resilience Investment Case Intervention Register
NTPBP-CAL-IT -0158	Calculation Sheet	IT Investment Case Intervention Register
NTPBP-CAL-M&G-0159	Calculation Sheet	Management and General Investment Case Intervention Register
NTPBP-CAL-ENV-0160	Calculation Sheet	Environment Investment Case Intervention Register

8.3 Appendix C: Benefits Quantification Process Map


Benefits Quantification
Costing Data/Intervention
Needs Identification
Needs Process
Identify Performance Commitments Used in Benefits and Impact Assessment
Map Benefits and Impact Assessments to Performance Commitments
Align Benefits and Impacts to Investment Case
Identify Unsupported Needs
Identify Direct/ Indirect Benefits
Key Data
Performance Data
Generate Calculations
Intervention Whole Life Duration
Option and Intervention Development
Identify Source Data
Identify Assumptions
Assess Reliability of Benefit
H
M
L
Identify Mutually Exclusive Interventions
Populate Optimiser Input Form

15.6 Appendix F: Optimisation Methodology

C5 B



Cost and Efficiency

Appendix
Investment Optimisation Methodology

NTPBP-MET-OPT-0487

BRISTOL WATER

Contents

Tables

Figures

1 Overview

This methodology is one of six that describe the interrelated activities that demonstrate the detailed development of fully costed and optimised interventions within an investment case.

This methodology forms part of this wider process and should be read in conjunction with the following associated methodologies:

- Methodology for Risk Identification, Verification and Needs Identification
- Methodology for Optioneering and Intervention Development;
- Methodology for Intervention Costing
- Methodology for Benefits Quantification; and
- Data Assurance Methodology.

2 Purpose Of This Document

The purpose of this methodology is to describe the way in which interventions are assessed in terms of costs, benefits (both performance and cost related) and constraints are assessed to provide an optimal solution to meet designated targets.

3 Principles Of The Methodology

An efficient organisation needs to ensure it plans its investment to achieve its targets at the optimal cost. Choosing which intervention options provide the best set of solutions requires a means of selection that delivers the required levels of performance at the lowest cost. The optimisation process provides this facility.

Bristol Water is using the Servelec 'Pioneer' system as its investment plan optimiser.

The optimiser is used to achieve one of a number of sets of objectives. These are generally:

- Assess a set of interventions to determine their ranking in terms of improving performance.
- Assess a set of interventions that achieve a predetermined set of performance targets at the optimal cost.
- Assess a set of interventions that achieve a predetermined set of performance targets at the optimal cost but constrained by cost ceilings (opex, capex, totex)

Each of these assessments selects the most beneficial interventions.

Interventions contain the following data relevant to the optimiser:

- Intervention Id
- Capex related to the intervention (where relevant)
- Capex related to the situation where no intervention takes place ('do nothing') (where relevant)
- Capex repetition frequency (where relevant)
- Opex before the intervention (where relevant)
- Opex after the intervention (where relevant)
- Change in one or more performance measures (performance benefit)
- Monetised benefit not related to a standard performance measure (where applicable)

The performance benefit is monetised within the optimiser for applicable performance measures. This is achieved by applying unit monetary benefit rates to the individual performance benefit (see Benefits Monetisation Methodology).

Constraints may be placed on an individual optimiser analysis (scenario). These may include performance targets and cost ceilings.

The optimiser assesses the available interventions and provides an optimal plan to meet the constraints applied. Different scenarios are applied to provide plans for various constraint specifications. Interventions are assessed primarily on the overall benefit in terms of performance and cost. Priority is given to interventions with the highest net monetary benefit.

Figure 1 - Benefit - Cost Analysis

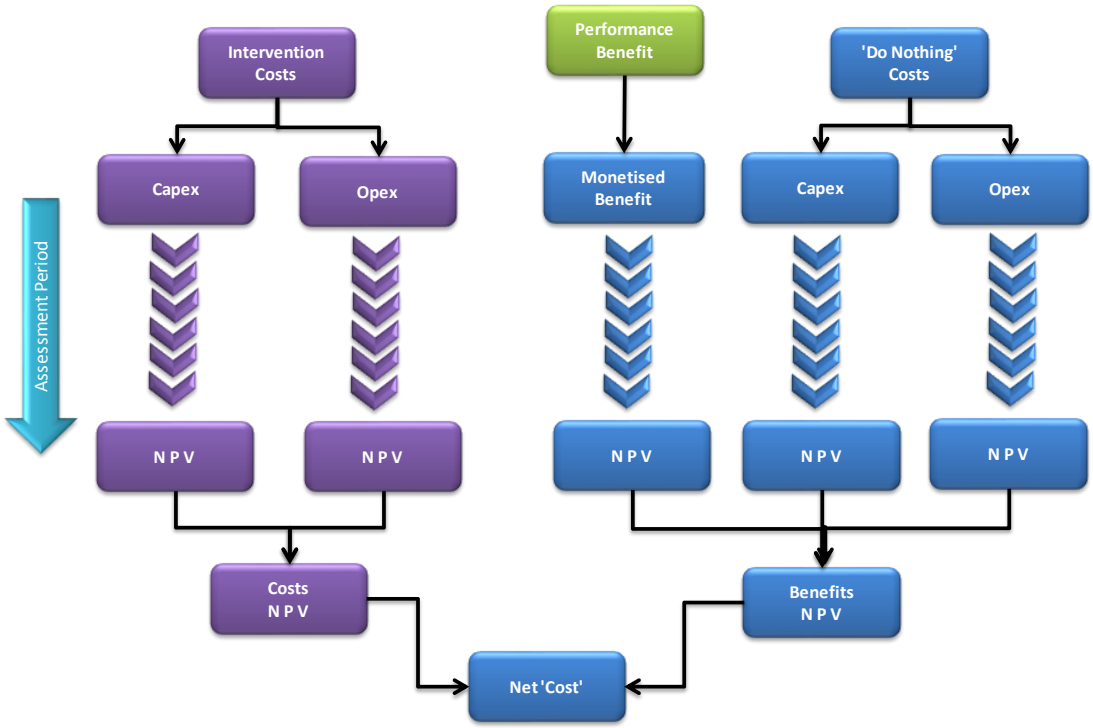


Figure 1 shows the basic principles for assessing the overall net cost (Benefit – Cost). The 'do nothing' costs – the avoidance of which are part of the overall benefit - are generally included in the input data for individual interventions. All costs, whether one-off or repeated are calculated to a net present value.

For scenarios that require performance targets to be met, the optimiser will select the most cost beneficial interventions to provide the required performance levels.

Many interventions provide benefits for more than one performance measure. The optimiser will select the overall optimal plan to meet all targets, where sufficient interventions are being proposed in order to meet targets.

4 Application

The investment optimisation process determines which interventions are selected to provide the optimal AMP7 investment plan, by delivering the targeted performance commitment improvements, at the lowest cost. We have utilised a water industry standard system (Servelec 'Pioneer') to optimise our AMP7 investment plan. Pioneer provides the functionality for us to assess all interventions developed across all of the investment cases. It will assess the interventions both individually and in comparison to other interventions. It is a decision support tool that produces an optimal investment plan to meet the targeted performance commitment improvements required in AMP7.

The Pioneer investment optimisation model assesses interventions primarily on the overall benefit, which takes account of performance and whole life costs. The investment optimisation calculates the whole life cost as the net present value (NPV) over 40 years. This determines if an intervention is cost beneficial.

We will select interventions for one or more of the following reasons:

- The intervention is mandated (i.e. Drinking Water Inspectorate - water quality requirement).
- The intervention is cost-beneficial
- The intervention is required to achieve the performance commitment targets.

Any performance commitment improvement obtained from mandated or cost-beneficial interventions will contribute to overall performance improvement.

The following sections provide more detail on the optimisation steps and functionality.

4.1 Sensitivity Analysis

Pioneer facilitates sensitivity analyses to aid understanding of a particular optimisation scenario, through the adjustment of variables and assessment of the impact on results.

Sensitivities in change in performance targets (and/or performance gaps) can be tested by performing optimisation runs with incremental changes to targets, and reviewing the effect on the interventions chosen.

The sensitivity of result to variations in costs can be tested, according to the reliability assigned to each cost input. A Monte Carlo simulation can also be run over a designated number of repetitions to assess the variability of chosen interventions and costs.

4.2 Inputs and Outputs

Figure 2 illustrates the main inputs and outputs to the optimiser.

Figure 2 - Optimiser - Basic Inputs and Outputs

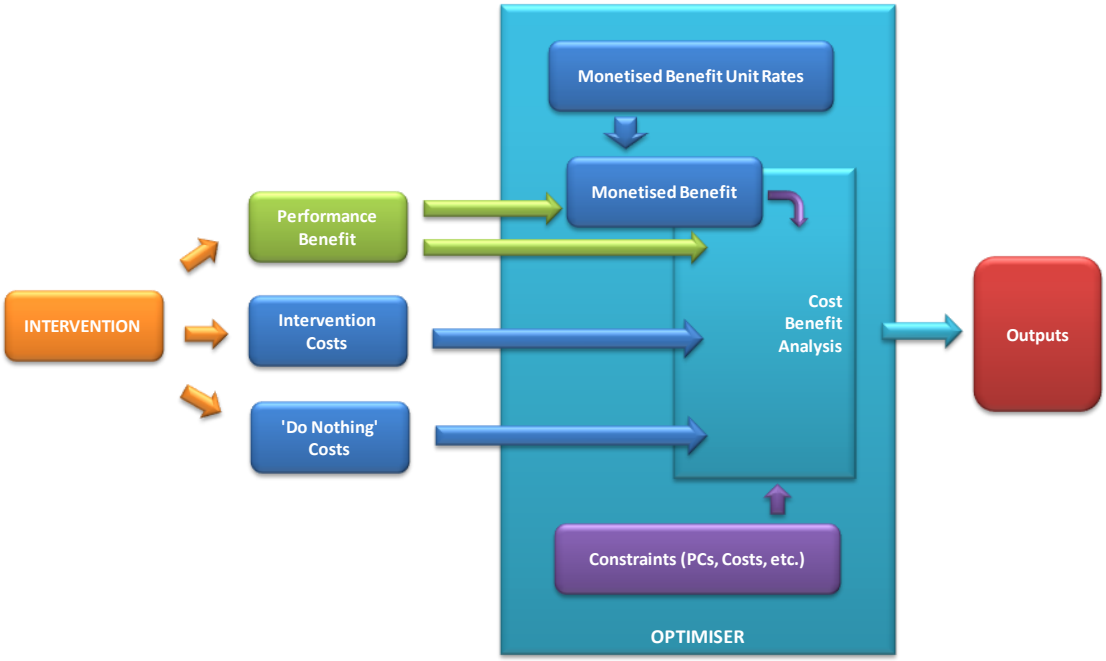
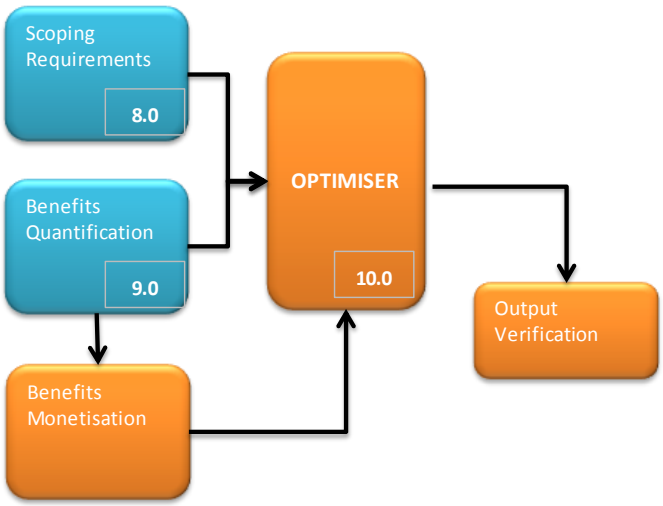


Figure 3 shows the Level 1 process connections to and from the Optimiser.

Figure 3 - Level 1 Connectivity



4.2.1 Inputs

Inputs to the optimiser can be undertaken:

- **Individually,** through input screens in the system;
- **Collectively,** through Pioneer's in-built spreadsheet functionality; or
- **In bulk**, by arrangement with Servelec.

For PR19 interventions, a standard input form has been developed in conjunction with Servelec for bulk loading of intervention data.

For each intervention, the following inputs are required:

- Intervention Id
- Performance benefits in the units relevant to the performance measure (there may be one or more performance measures to input)
- Capex related to the intervention (where relevant)
- Reliability of intervention capex
- Capex related to the situation where no intervention takes place ('do nothing') (where relevant)
- Reliability of 'do nothing' capex
- Capex repetition frequency (where relevant)
- Opex before the intervention (where relevant)
- Reliability of before intervention opex
- Opex after the intervention (where relevant)
- Reliability of after intervention opex
- Monetised benefit not related to a standard performance measure (where applicable)

For each scenario, the following optimiser parameters need to be set:

- Targets for each performance measure relevant to the scenario
- Cost ceilings, where required
- Discount rate for NPV calculations (currently 3%)
- Assessment period over which the analysis is carried out (currently 40 years)
- Unit monetary benefit rates for relevant performance measures
- Variance proportions related to the reliability bands for opex and capex
- Whether a sensitivity analysis is required and, if so, how many cycles the Monte Carlo simulation should undertake.

For many scenarios, the bulk of the input data may not change from one scenario to another. For example, two scenarios may share the basic intervention data but require different performance targets to be set.

Refer to Appendix A: Inputs and Outputs for full input details.

The Inputs are provided to Servelec to import into Pioneer and run the Pioneer optimisation. This data import and optimisation run process step undertaken by Servelec is documented in Servelec's methodology, along with the quality checks performed[1].

[1] Servelec, 2018, 'PIONEER Configuration for Project Optimisation – Bristol Water', J1749_GD003

4.2.2 Outputs

The optimiser produces standard outputs that list for each scenario:

- Interventions chosen (intervention ID)
- Capex Totals
- Opex Totals
- Performance Changes
- Costs per performance measure
- Timescales

For sensitivity analyses, the outputs will show:

- The proportion of simulation runs each intervention is chosen
- Associated costs of each simulation run

Outputs are transformed into AMP7 profiles for use in the PR19 financial modelling process. Refer to Appendix A: Inputs and Outputs for full outputs details.

4.3 Governance

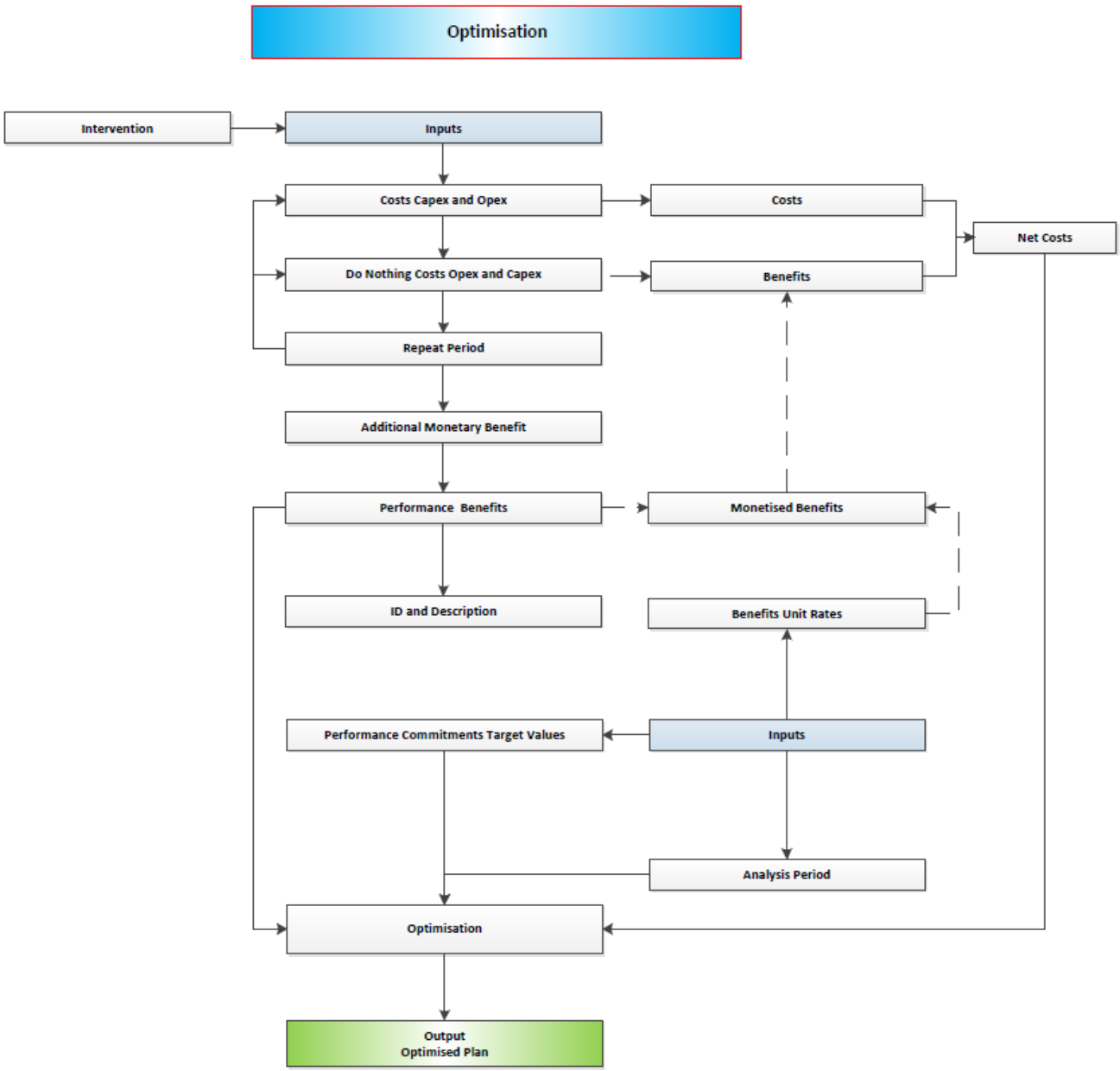
The Pioneer system contains full audit trails for data edits and scenario runs.

SharePoint is used by Bristol Water to store the input and output sheets.

4.4 Willingness to pay

'Willingness to pay' values can be applied in the optimisation process and within the PR19 context. This is explained in Appendix B: Willingness to Pay.

5 Process Overview



6 Appendices

Appendix A: Inputs and Outputs

Appendix B: Willingness to Pay

6.1 Appendix A: Inputs and Outputs

Input and Output Considerations and Actions for PR19 Investment Plans

6.1.1 Introduction

This appendix describes the application of data applied to the optimiser and how the outputs to scenarios are reported within the PR19 context.

In general terms, the optimiser inputs are the data supplied by the investment planning team and the scenario targets and discount rate supplied by the Strategy and Regulation Directorate.

The results of each scenario are the list of chosen interventions and the changes in performance for each performance measure that are provided in total by the chosen interventions. It is also possible to run sensitivity analyses against variations in input data for any scenario.

There are a number of actions that are applied to the inputs and outputs of optimiser runs. These are described in this appendix.

6.1.2 Inputs

Sources

The primary sources of data for inputs to the optimiser are:

- Optimiser input forms stored on SharePoint and completed by the investment planning team. Each investment case has its own form which lists available interventions with their cost details and relevant performance and cost benefits.
- Scenario performance targets for each optimiser run supplied by e-mail by the Strategy and Regulation team.
- Current discount rate for net present value calculations, supplied by e-mail by the Strategy and Regulation team.

Scenario Details

The performance target requirements set out by the Strategy and Regulation team are communicated to Servelec with the optimiser input form.

There may be one or more set of requirements (scenarios) for any optimiser run.

Input form and Checks

The individual investment case forms are combined into one input form for delivery to Servelec.

The following manual checks are undertaken prior to delivery:

- Sense check that all data are aligned in the correct columns in the combined form.
- Check that each investment case is included in the combined form.
- Sense check on inputs to assess that data values are within sensible limits.
- Where potential anomalies are identified, a query is made with the relevant individual investment planner who will confirm or change the data.

In addition, the overall ability of the interventions to meet scenario targets must be checked. Pioneer does not respond well to the setting of targets that have insufficient benefits from interventions. Therefore, the following manual checks and possible amendments must be undertaken:

- Check the sum of available benefits for all interventions for each performance measure. Take account of any mutually exclusive interventions to ensure that alternative benefits are not all counted.
- Check that where an intervention shows a mutually exclusive alternative, the alternative intervention shows a corresponding mutually exclusive input.
- Where, for any performance measure, the sum of available benefits is less than the difference between the starting value and the target value for the AMP7 period, the target value should be changed (for the purposes of the input data only) to a value equal to the starting value plus the sum of available benefits (ensuring that the sense of the improvement is maintained, i.e. the target is higher or lower than the starting value, depending on the direction of improvement).
- Where there are no available benefits for a particular performance measure, the target for that measure should be removed entirely from the scenario targets. Any performance changes resulting from selected interventions will still be shown in the results.
- The optimiser can be affected by a resultant final value (the starting value adjusted by the total benefit being realised) being negative. Where there are more benefits available than required to meet a target, the starting value and target value should be increased by the same amount (e.g. 100) to avoid the resultant final value from being negative. On obtaining the performance changes resulting from a scenario, the original starting value should be adjusted by the change in performance (the resultant 'Company' value should be ignored.
- Pioneer regards performance improvements being shown as reducing values (e.g. bursts performance is better the lower the value). Where, for any performance measure, the alternative is true (i.e. a larger value is an improvement), the target values for a scenario may be adjusted to reverse the values such that the targets show a decreasing need with the same target differences as the original values presented. Note that if this amendment is not undertaken the prioritised results will show a performance change with the wrong mathematical sign (+ or -) and therefore care should be taken when deriving the resultant performance value when comparing the starting target with the performance improvement.

Once the manual checks have been completed the combined intervention input data form and the scenario targets are sent by e-mail to Servelec who will input the data and run the optimiser against the performance targets designated in the individual scenarios. Any particular instructions relevant to the scenarios or optimiser run will be included in the optimiser run request. This will include, where relevant, a change in discount rate to be applied.

Cost Constraints

It is possible to set constraints on costs in a scenario run. This facility has not been applied.

Weighting of Scenario Targets

It is possible to set weightings against individual scenario targets. This facility is not applied.

Referencing of Inputs

Intervention lists and scenario values shall be referenced. There are two referencing requirements:

- Referencing and recording of input sheets:
    - The document register shall be used to provide a reference which should be prefixed to the document which is then stored on the Optimiser Input folder.
    - For Servelec referencing, the log sheet on SharePoint shall be used to provide a unique identifier which is used to classify the particular intervention set. This identifier is passed to Servelec.
- Referencing and recording of Scenario values:
    - The document register shall be used to provide a reference which should be prefixed to the document which is then stored on the Optimiser Input folder.
    - For Servelec referencing, the log sheet on SharePoint shall be used to provide a unique identifier which is used to classify the particular scenario. This identifier is passed to Servelec.

When sending inputs to Servelec, the combination of intervention input sheet and scenario to be run together shall be stated for all combinations of inputs.

The Inputs are provided to Servelec to import into Pioneer. Refer to the Servelec methodology 'PIONEER Configuration for Project Optimisation – Bristol Water'.

6.1.3 Outputs and Results

General

The optimiser performs a standard analysis on any set of interventions and scenario. There is no manipulation carried out within the optimisation process that is not dictated by the input data.
The outputs are therefore able to be treated in a consistent way. Several reports are provided from the output data, as described in this section.

Outputs from the Optimiser

The main outputs from a scenario are:

- List of chosen interventions.
- Changes in performance values provided by the chosen interventions.

These results are normally provided by e-mail from Servelec but are also available to download from the Pioneer system itself.

The results are combined with the input data to provide the organisation with reports on various aspects of the optimised plans.

Checks

The following checks are undertaken on each output to ensure compatibility with input data and requirements:

- Ensure that selected interventions are from the input list.
- Ensure that all mandatory interventions have been selected.
- Ensure that more than one mutually exclusive intervention has not been selected.
- Examine the performance changes to ensure that targets have been met or, if a target is not met, that the reason was insufficient interventions.

Where the checks identify an anomaly, the circumstances are reported back to Servelec for action.

Basic plan

For any scenario output, the list of chosen interventions is matched with the input data (by means of the Intervention ID) to provide basic details of the plan. This initial plan is configured in MS Excel and contains the following headings:

Intervention ID	Intervention Title	Net Cost £	AMP7 Capex £k	AMP7 Opex Change £k

The 'Net Cost' element is produced by Pioneer and represents the overall whole life cost of the intervention based on a cost benefit analysis. The 'Intervention Title', 'AMP7 Capex' and 'AMP7 Opex Change' are derived from the input data.

Finance Table

From the Basic Plan, additional data are added to provide input to a financial model. The extra elements are:

- Profile of expenditure (capex and opex) across each year of the AMP7 five-year period. It should be noted that current outputs from the optimiser are for five year periods.
- Financial and Tax coding details for individual chosen interventions.

<u>Profiling</u>

Profiling of expenditure across the five years of the AMP7 period is required for financial modelling. This provides sufficient information for establishing effects on such aspects as bill levels and funding.

The profiling is currently carried out manually and does not, therefore, produce a strictly repeatable plan.

The following rules are used as guidance for producing the expenditure profile:

- For groups of similar interventions such as mains replacement and zonal mains replacement, the total capital expenditure for the group is calculated and interventions are placed in five annual clusters each having a total expenditure of approximately one fifth of the overall total.
- For individual interventions that relate to types of work on multiple assets (rolling programmes), the capital expenditure is apportioned equally across the five years.

- For other individual interventions, where operational expenditure savings are forecast, the capital expenditure is placed early in the five year period, with the highest benefits steering capital expenditure placement in the first year.
- For other individual interventions, where operational expenditure increases are forecast, the capital expenditure is placed later in the five year period, with the highest increases steering capital expenditure placement in the last year.
- For other individual interventions, where no operational expenditure changes are forecast, the capital expenditure is placed as evenly as possible to balance interventions already catered for.
- Notwithstanding the above requirements, it is reasonable to group expenditure on single sites together.
- Also notwithstanding the above requirements, it is reasonable to spread expenditure on similar activities across the five years.
- It is important not to heavily overload or underload any one year in terms of capital expenditure.
- In most cases, it is assumed that operational cost changes occur the year after the corresponding capital expenditure and every year after that. The exception to this rule is when the operational expenditure is all or part of the solution when it must be apportioned in accordance with the sense of the intervention. For rolling programmes, operational expenditure increases year by year until the year after the programme is completed when the full amount is realised.

Coding

Additional coding is supplied in relation to categorising expenditure to support the financial modelling process. The coding categories are recorded on the outputs retained for subsequent use against chosen interventions.

The following basic categories are added:

Depreciation Life	Business Unit	Expenditure Type	Tax Info	Tax Category Proportions
	Water Resources, Raw Water Distribution, Water Treatment, Treated Water Distribution	*Enhancement, etc.*		*Lists the proportions of each intervention's expenditure in each potential tax category.*

Where interventions that have not previously been included in the outputs report (because they are new or have not been chosen previously), there will be no finance coding information. This fact must be reported into the financial modelling process so that when the finance coding data are added to the new intervention, they should be added to the intervention data.

The complete report is provided to as inputs to the financial modelling processes.

Summaries

Summary reports are required that list the total capital expenditure for each scenario by investment case category. This report is generated from the input and output data of the optimiser.

Performance

Pioneer produces a standard report detailing the changes in performance generated by a scenario.

This output is used in conjunction with the scenario target data to determine the resultant absolute performance achievements. For each performance measure, the calculation is simple and is represented by:

Resultant Performance = Starting Performance Value + Change in Performance

For example, for AMP7 meter penetration target, the resultant absolute performance achievement is:

Starting Performance Value	Change in Performance	Resultant Performance
66.0% meter penetration	**9.0% improvement**	**75.0% meter penetration**
This is the end of AMP6 baseline	*This is the performance improvement achieved in AMP7 through the selected interventions*	*This is the end of AMP7 performance*

Care must be taken to take account of the sense of the change in performance (i.e. is improvement an increase or decrease in value).

It is important to use the values associated with the change in performance and not the resultant or 'Company' values as the latter may be affected by changes to input values and misinterpretation of how the changes affect the final value.

The report provided to Strategy and Regulation shows, for each scenario and for each performance measure, the original starting value, the target value and the resultant value.

Apportionment of Capital Expenditure to Performance Improvements

A requirement of the Strategy and Regulation department is to have capital expenditure apportioned across relevant performance improvements. This report is particular to each scenario, owing to the unique relationship between performance targets, interventions and intervention costs and benefits, all of which may change from one scenario to another.

This report requires no more data than are supplied with the inputs and outputs. It is a manipulation of the data that signifies how much expenditure can be assigned to each performance measure.

The methodology takes account of the fact that many interventions have multiple benefits and that some performance measures are not required to improve or, alternatively, have no improvement owing to insufficient interventions being available.

For any scenario result, the analysis is based on the following provisos:

- The optimiser has to meet all targets (where there are sufficient interventions).
- Many interventions have multiple benefits. This means that some targets will be exceeded.
- The analysis takes the actual targeted improvement or the actual improvement, whichever is the smaller into account.

- The costs allocated are only for performance improvements. Therefore, where no improvements are required or forecast, there will be no cost allocation to that particular performance measure.

The methodology for the calculation is based on the following process:

- For each performance measure included in the optimiser run:
    - Determine the forecast performance gain (Pa)
    - Determine the targeted performance gain (Pf)
    - Take the lesser of the two values (Pm) = min(Pa, Pf)
    - Take the starting value at the end of AMP6 (Ps)
    - Determine the proportional gain from the starting value (Pp) = Pm/Ps
- For each chosen intervention:
    - The total cost of the intervention is (Ic)
    - For each benefit value (Bv): Multiply the benefit value by the relevant performance proportional gain (Bx) = Bv x Pp
    - For all benefits add all the Bx values (Bs) = ∑(Bx)
    - Apportion the total cost of the intervention across each relevant performance measure by multiplying the total cost, Ic, by the ratio of Bx/Bs.
    - Check that the total cost of all apportionments equals the original total cost of the intervention.

The resultant analysis and report provides a detailed breakdown of the costs that are apportioned from each relevant intervention to achieving performance gains.

A summary report is required that lists performance gains against individual investment cases.

It must be recognised that not all interventions provide performance gains. Therefore, there will be expenditure that needs to be allocated to a separate category for non-performance

6.2 Appendix B: Willingness to Pay

Application of Willingness to Pay for PR19 Investment Plans

6.2.1 Introduction

This appendix describes the application of 'willingness to pay' values in the optimisation process and within the PR19 context.

In terms of its use in the planning of investment, willingness to pay is a monetary value that can be assigned to a particular performance measure and represents the aggregate value customers are willing to pay to increase that performance by one unit. For example, customers in total may be willing to pay £x to reduce leakage by 1 Ml/d.

As such, it is possible in any set of interventions, to establish how much investment and thereby how much improvement in performance customers are prepared to fund.

Customer consultation itself does not provide valuation data for all performance measures used in the optimisation process. Therefore, monetary values for willingness to pay can be applied to a subset of measures.

In terms of the optimiser runs (which produce investment plans), willingness to pay analyses inform the company of the effect of customer preferences on performance targets. The explanation of how willingness to pay is applied is provided in this appendix.

6.2.2 Application of Willingness to Pay in the Optimisation Process

Willingness to pay is used to value customers' preparedness to contribute towards improvements in service. This is translated into monetary terms. The valuations can be used to inform the Company about how much customers' preferences can contribute towards investment to raise performance.

The use of willingness to pay in the optimisation process is in two stages:

1. Calculation of unit rates that reflect the contribution customers are willing to pay towards relevant performance improvements.
2. The application of those rates to inform the investment planning process of the levels of performance benefits driven by customers' willingness to pay.

6.2.3 Inputs

Sources

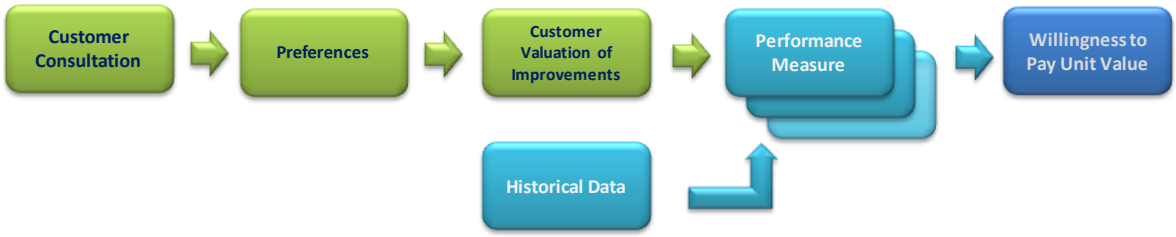
Information is derived from two main sources:

- Customer consultation data
    - This provides the valuation of customers' preferences in terms of a number of objectives
- Historical incident and cost data
    - This provides data to produce frequency and costs of incidents and activities related to customer objectives
    - In turn, this provides information to calculate unit monetary benefits for performance measures related to customer objectives

Use of Information

The information is combined to provide a unit monetary benefit rate for all relevant performance measures. Figure 4 shows the basic process.

Figure 4 - Production of unit rate for willingness to pay benefit



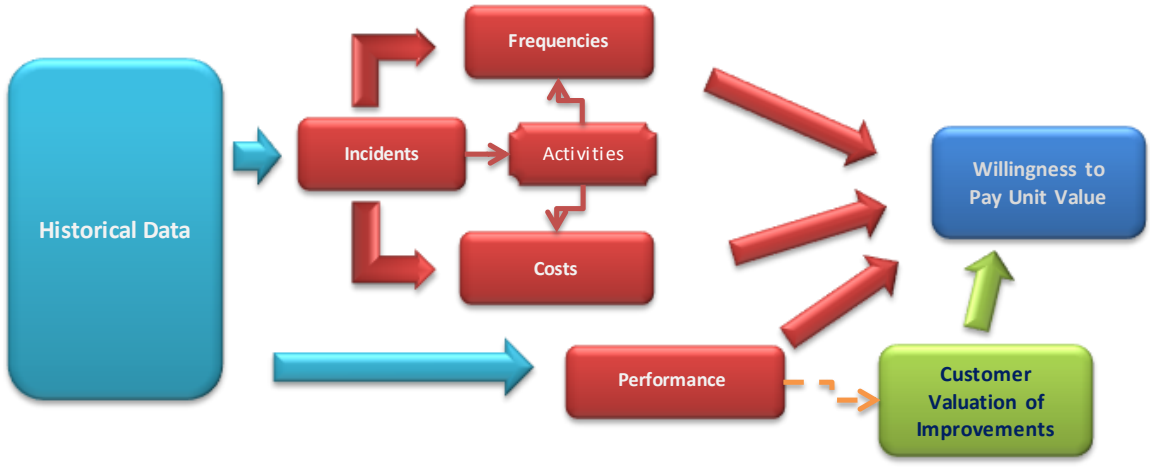
Customer consultation results provide valuations that customers place on a number of objectives. Historical data regarding incidents and their associated impacts, costs and frequencies provide information on the factors affecting performance.

Figure 5 shows the way the Company's historical data and the customer valuations are combined to produce a unit rate for the monetary benefit associated with willingness to pay. This unit rate can be applied in the optimisation process as a monetary benefit to any relevant performance benefit associated with an intervention.

Customer valuation of improvements relates to a series of factors derived from a consultation process. These factors provide monetary values that customers place on particular improvements to service. There are several ways in which these factors and their monetary values relate to the performance measures used in the optimisation process:

1. There is a direct link (e.g. customer valuation of an improvement of 1 Ml/d of leakage)
2. There is an indirect link (e.g. customer valuation of an incident leading to a supply interruption)
3. There is no direct link (e.g. low pressure issues linked to incidents)
4. There is no value provided (e.g. bursts contribute to supply interruptions; so no additional customer value is provided)

Figure 5 - Calculation of Unit Rate for a Single Performance Measure



The conversion of customer values to willingness to pay unit rates for performance measures is as follows for points 1 and 2:

1. Convert the customer value to performance measure value by multiplying the customer value by the number of customers. Ensure that the units are compatible.
2. Convert the customer value to performance measure value by analysing the historical data to provide a statistical view of the relevant circumstances as shown in Figure 5.

6.2.4 Outputs

General

The outputs from the analyses are unit monetary values for those performance measures that can be related directly to customer valuations from the customer consultation process.

The analyses are described in reports on SharePoint.

The set of performance measures and willingness to pay unit values that have been produced are:

Table 1 - Current willingness to pay unit rates

Performance Measure	Unit	Willingness to pay unit value (£/unit)	Method
Supply Interruptions	minute	266,348	*Statistical analysis*
Leakage	Ml/d	320,225	*Customer value x No. Customers*
Per capita Consumption	l/hd/d	4,483,147	*Customer value x No. Customers*
WQ - Discoloured water contacts	1 contact	101,405	*Statistical analysis*
WQ - Taste & Odour contacts	1 contact	357,584	*Statistical analysis*
Meter penetration	1%	26,685	*Customer value/10 x No. Customers*

6.2.5 Attributable Benefit of Willingness to Pay

Background

Willingness to pay provides guidance for testing and setting performance targets and for setting ODIs.

However, once performance targets have been set and defined in an investment planning scenario, the optimisation process is designed to deliver the optimal solution to meet those targets. Adding willingness to pay monetary benefits to interventions does not, generally, provide a better cost solution and does not add support to any case for customer support. In most cases, the addition of a non-material benefit such as willingness to pay to a scenario where targets are already constrained, results in a more expensive plan than that produced without that additional benefit.

The approach taken is to analyse an unconstrained plan (i.e. one without any performance or cost targets) with the aim of understanding the amount of performance benefit that is supported by customers. This process is described in section 0.

Approach

The approach taken is to analyse a set of interventions to establish how willingness to pay drives additional performance gains.

Each intervention in a particular set will have costs and benefits associated with it. Costs of an intervention are primarily the cost of the activity and any additional operating expenditure associated with it. Benefits are largely associated with the avoidance of costs of not doing the activity including any monetary value of the benefits gained.

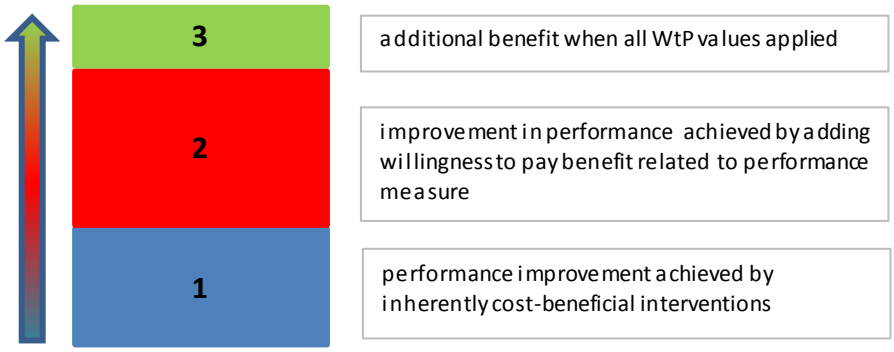
In an unconstrained scenario, the value of performance benefit achievable over a set period is established at three levels, as set out below, and as illustrated in Figure 6:

Level 1: Performance benefits achievable through inherently cost-beneficial interventions Some interventions have benefits that outweigh the costs over the analysis period.

Level 2: Additional performance benefits achievable through the application of willingness to pay for an individual performance measure. The addition of the extra monetary benefit will establish further performance gains.

Level 3: Additional performance benefits achievable through the application of willingness to pay for all relevant performance measures. Because some interventions have multiple benefits, applying all willingness to pay monetary benefits will have subsidiary effects on performance.

Figure 6 - Stepped analysis of interventions for willingness to pay effects



It is important to note that the analysis is dependent on and unique to a particular set of interventions and, notably, their data related to costs and benefits.

The methodology employed in this process is:

1. Establish the full list of current interventions with all cost and benefit data. Ensure all costs are shown at the same level (e.g. whole £, £000s).
2. Establish the analysis period (currently 40 years).
3. Establish the discount rate (currently 3%).
4. Include the current monetised unit benefit rates associated with the relevant performance measures. These are separate from the willingness to pay unit rates and represent direct cost avoidance.

5. For each intervention, using the discount rate over the analysis period:
    a. Calculate the net present value (NPV) of the capital cost; we have labelled this as '**capex after**'. This is the expected capital cost of the intervention if we deliver it in a planned way.
    b. Calculate the NPV of the 'do-nothing' capital cost; we have labelled this as '**capex before**' if applicable. This is the reactive cost that would potentially arise if we had to deliver the deliver the intervention in an unplanned way. This is classed as a benefit.
    c. Calculate the NPV of the change in operating cost ('**change in opex**') if applicable, noting that a positive value is an increase, a negative value represents a decrease. This is classed as a cost.
    d. Calculate the monetary value of any relevant performance benefit attributed to the intervention. This is classed as a benefit.
    e. Calculate the NPV of that monetised benefit.
    f. Repeat steps d and e for other relevant measures if necessary.
    g. Calculate the NPV of any additional monetised benefit ('**other monetised benefits**'). This is classed as a benefit.
    h. Establish the Net Cost of the intervention (Costs – Benefits).
6. Establish which interventions have a zero or negative net cost.
7. For those that have a negative or zero net cost, include all the (physical, e.g. Leakage Ml/d) performance benefits gained.
8. For the whole intervention set, calculate the sums of those included performance benefits.
9. This set of performance gains represents the improvements available from those interventions that are inherently cost-beneficial over the analysis period ('Blue' interventions in the stepped analysis presented in Figure 6).
10. For the next steps, include the current willingness to pay unit benefit rates associated with the relevant performance measures (see Table 1).
11. For each of the relevant performance measures in turn:
12. for each intervention, using the discount rate over the analysis period:
    a. Calculate, if applicable, the willingness to pay monetary value of the relevant performance benefit attributed to the intervention. This is classed as a benefit.
    b. Calculate the NPV of that benefit.
    c. Establish the new net cost of the intervention.
13. Establish which interventions now have a zero or negative net cost.
14. For those that have a negative or zero net cost, include the performance benefit gained for the particular measure being analysed.
15. For the whole intervention set, calculate the sums of those included performance benefits.
16. This set of performance gains represents the improvements available from those interventions that are cost-beneficial over the analysis period either inherently or as a result of the addition of the single willingness to pay benefit. The difference between this value and the corresponding one derived in step 9 represents the additional performance gained through the application of customer willingness to pay for the particular measure ('Red' interventions in the stepped analysis presented in Figure 6).
17. Repeat steps 12 to 16 for all the other relevant performance measures.

18. For the last part of the analysis, all relevant willingness to pay benefits are included together. Therefore step 12 is applied to all relevant performance measures. This provides an indication of how secondary benefits may be achieved.
19. For each intervention, using the discount rate over the analysis period:
    a. Calculate, if applicable, the willingness to pay monetary value of all the relevant performance benefits attributed to the intervention. This is classed as a benefit.
    b. Calculate the NPV of the benefits.
    c. Establish the new net cost of the intervention.
20. Establish which interventions now have a zero or negative net cost.
21. For those that have a negative or zero net cost, include the performance benefit gained for all measures.
22. For the whole intervention set, calculate the sums of those included performance benefits.
23. This set of performance gains represents the improvements available from those interventions that are cost-beneficial over the analysis period either inherently or as a result of the addition of all willingness to pay benefits. The differences between these values and the corresponding ones derived in step 16 represent the additional performance gained through the application of all customer willingness to pay values ('Green' interventions in the stepped analysis presented in Figure 6).

Figure 7 illustrates how the methodology steps link to the values in Figure 6.

Figure 7 - Representation of Methodology

This analysis may be used to inform decisions on target and ODI settings

15.7 Appendix G: Data Quality Assurance Methodology

C5 B

Cost and Efficiency

Appendix
Data Quality Assurance Methodology

NTPBP-MET-DAT-0099

BRISTOL WATER

Contents

Tables

1 Overview

This methodology is one of six that describe the interrelated activities that demonstrate the detailed development of fully costed and optimised interventions within an investment case.

This methodology forms part of this wider process and should be read in conjunction with the following associated methodologies:

- Methodology for Risk Identification, Verification and Needs Identification
- Methodology for Optioneering and Intervention Development
- Methodology for Intervention Costing
- Methodology for Benefits Quantification
- Optimisation Methodology

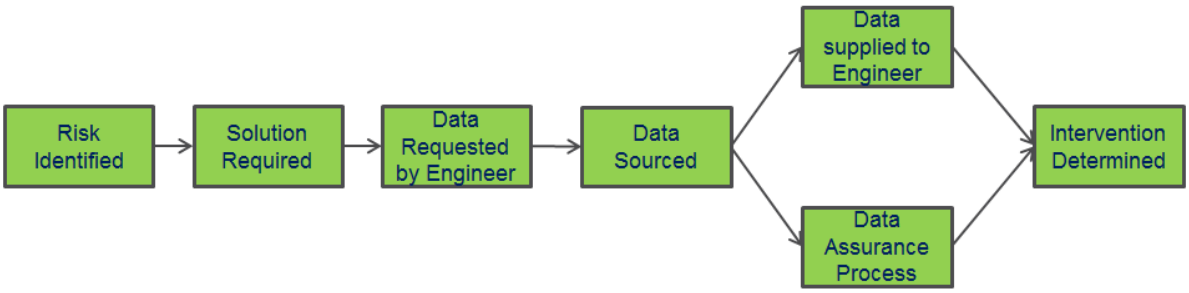
2 Purpose Of This Document

Data quality and its assessment and improvement defines the degree to which data can be a trusted source for all required uses and accepted as one of the most valuable of assets that enhances internal and regulatory confidence in how assets are managed and business plans produced.

> *"The ability to create, collect, store, maintain, transfer, process and present data to support business processes in a timely and cost effective manner requires both an understanding of the characteristics of the data that determine its quality, and ability to measure, manage and report on data quality".* [1]

The aim of this document is to define the methodologies utilised in quality assessment activities, in order to determine the confidence levels of the data utilised for decision making, and provide an understanding of the level of risk associated with the utilised data

The data assurance process fits into the overall risk / intervention process as illustrated below:



[1] ISO/TS 8000-100:2016, Data Quality. Part 100: Master Data: Exchange of characteristic data: Overview

3 Application

3.1 Identification of data

The first step in the data assessment process is to identify what asset data does the business currently own, where it is stored, who collects it and who manages it – this is followed by an assessment based on criticality and context, which influences the assurance activities.

Within identification of data, the next step is to identify the primary location where it's saved, as well as secondary locations and ideal Master location. This is to define what improvement activities need to happen in order to have all asset data in its ideal location. Another step within identification of data is the identification of accountabilities and responsibilities related to the data. For that the roles defined within ISO 8000-2[2] will form the basis of the work:

- Data Manager (Strategic)

  Responsible for the organisational factors for data quality management and the overall running of the framework. Includes delivery of the three high level processes of Data Architecture Management, Data Quality Planning and Data Stewardship/Data Flow Management

- Data Administrator (Tactical)

  Responsible for controlling and coordinating the work of data technicians and aligning to the direction set by the Data Manager. Includes delivery of the three mid-level processes of Data Design, Data Quality Criteria Setup and Data Error Cause Analysis

- Data Technician (Operational)

  In general the data technician is responsible for the actual data changes that are undertaken, specifically as part of the low level processes of Data Processing, Data Quality Measurement and Data Error Correction. Activities will be undertaken under the guidance of the Data Administrator.

The assessment of data is undertaken using the process described below with a criticality assessment and 'CART' (complete, accurate, reliable and timely) determination. From these results an equivalent OFWAT confidence grade and risk assessment value are determined. The results of the assessment are recorded and made available to data users.

[2] ISO 8000-2:2017: Data quality - Part 2: Vocabulary.

3.2 Data criticality assessment

The criticality of asset data is based on the business drivers that rely on said data. A criticality index has been developed and the business drivers have been grouped based on it, as set out in Table 1.

Table 1: Criticality bands

Criticality Rating	Score	Description
Very Low	1	Data is not materially critical to any Regulatory, Statutory, Health & Safety or Operational Drivers.
Low	2	Low level business operations requirement (i.e. business operations would be lightly affected by issues relating to this data).
Medium	3	Moderate business operations requirement (i.e. business operations would be impacted by issues relating to this data).
High	4	Data is critical to business operations and strategic decision making (i.e. business operations would be fundamentally compromised by issues relating to this data).
Very High	5	Regulatory and / or Statutory compliance would be compromised by issues relating to this data.

3.3 Data quality assessment

The assessment of data quality is achieved through the application of a CART process, as set out in Table 2.

Table 2: CART definitions

Dimension	Definition	Method	Examples
Completeness	The measure of the availability of data or information compared to the total number of potentially available data or information	To examine the numbers of cells within a row which contain data or information divided by the total number of rows which are included – to be shown as a percentage. E.g. 15 rows have data versus 20 total available rows. 15/20 = 75%	If a dataset has 25 data points and only 15 of them have a value, than the completeness score would be 60%.
Accuracy	Refers to whether the values stored for an object are the correct values. To be correct, a value must be represented in a consistent and unambiguous way. It is heavily tied to how the data is collected, therefore data fields that require manual input are more likely to be less accurate;	This examines how true the data or information that has been collected is compared to the real world. In order to do this either a data expert will examine the full dataset make an assessment of the accuracy, or as an alternative, 25 rows are randomly selected and these are assessed.	When assessing a formatted field (i.e. date, ID or diameter) the accuracy will be based on logical testing of the data points sample. For example, if a data point defined as “date” includes a date of 01/01/0000 it means the field is complete, but not accurate. With other types of fields (i.e. materials, chemicals or other components) the accuracy testing will be based on expert judgement, with consultation with the asset owner(s) and the data owner(s).

Dimension	Definition	Method	Examples	
Reliability	Data is reliable when it's sufficiently complete and error free and variation within values must be small. A highly reliable piece of data is usually collected through automated process and it's validated again when being introduced to a database. On the other hand, unreliable data presents itself in the form of extrapolations, out of date assessments, verbal reports or ungoverned databases;	This uses the Ofwat confidence grades (see below) to assess how the data or information has been documented. This will be as shown as a percent. Reliability testing will be based on expert judgement, with consultation with the asset owner(s) and the data owner(s), aligned with the data input methods.	For example, a data point collected by a calibrated meter and system validated is more reliable than verbal records. Similarly, a verbal record of an expert will be more reliable than an uncalibrated meter.	
Timeliness	The measure of time between data or information capture and data or information availability	Is measured on the time between data capture and data availability. A piece of data with a high timeliness score will be real-time data, captured constantly through an automated process. On the other hand, untimely data relies on the manual capture of data and then its translation to databases (i.e. surveys or inspections)	Real time	100%
			1 minute	99%
			1 hour	95%
			1 day	90%
			1 week	85%
			1 month	75%
			6 months	50%
			1 year	20%
			5 years	5%
			5+ years	0%
Overall Confidence	Overall data quality value, as an average of all assessed values.	An average percentage of the CART analysis.	e.g. (80+75+90+95)/4 = 85% average	

Where a sample of data is taken a software package will be used to select the random sample.

The CART assessment is done in liaison with the data provider to allow any issues to be identified and resolved if possible.

3.4 Ofwat Confidence Grades

Table 3 below shows the combinations of different grades for the Ofwat confidence measures. The accuracy bands do not show how much of the data is accurate; instead they relate to the margin of error within the data used i.e. band 1 shows the error range being between 0 and 1% - meaning the data is 99-100% accurate. There are 7 levels of accuracy as shown below. Level X is not used within the Bristol Water assessment.

Table 3: Ofwat Accuracy Bands

Accuracy Band	Accuracy to within +/-	But outside +/-
1	1%	
2	5%	1%
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Outside +/- 100%	

The reliability bands indicate how reliable the data being provided is and point towards the proportion of data used within the assessment as shown in Table 4.

Table 4: Ofwat Reliability Bands

Reliability Band	Description
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from **limited** sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Table 5: Overall Confidence Grades

Ofwat Accuracy bands (%)	OFWAT Reliability bands[3]			
	A	B	C	D
[1] 0-1	A1	++	++	++
[2] 1-5	A2	B2	C2	++
[3] 5-10	A3	B3	C3	D3
[4] 10-25	A4	B4	C4	D4
[5] 25-50	++	++	C5	D5
[6] 50-100	++	++	++	D6

NOTE: '++' highlights grades which are not appropriate

By doing our own assessments of data quality, we are able to make an assessment of what Ofwat confidence grade would be applied to the dataset. For example, if a reliability measure is 75% and the accuracy measure is 75%, the Ofwat confidence grade will be B4.

The results of the CART assessment are used to determine the equivalent Ofwat data confidence level

3.5 Data Risk Assessment

Data risk is an assessment based on data criticality and data quality – for example, a highly critical piece of data that is of low quality could be a potential high risk for the business:

Table 6 - Risk assessment matrix

Criticality Rating	100-90	90-80	80-70	70-50	50-0
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Data Quality index (%)

[3] ISO 24511:2007, Activities relating to drinking water and wastewater services - Guidelines for the management of wastewater utilities and for the assessment of wastewater services

Assessing levels of data risk will allow for mitigation plans to be developed, in order to minimize the business impacts of low quality data.

Regular quality, criticality and risk assessments form part of data lifecycle management, which is an integral part of best practice data and information management[4].

The risk assessment level for each assessed dataset is determined using a combination of the average CART assessment level combined with the criticality of the data it is being used for. This allows quick identification of any dataset which could have a significant sensitivity on any results it is used for.

3.6 Ownership

This methodology and its governance are owned by the Asset Management Director.

3.7 Reviews

This methodology shall be reviewed no later than one year after the latest version approval date or when changes are made to the text of the document. All versions shall be recorded in the document header and in the version control system of the relevant document management system.

[4] Bristol Water, Information Management Policy and Information Strategy