# TA 14.4 Bottom-up Cost Estimation
# Technical Annex

September 2018

Version 1.0 (with redactions)

Southern Water

# Contents

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**Purpose:** This Annex summarises our approach to bottom-up cost estimation for the wholesale programme. It describes the process we have undertaken to gather cost data, the analysis we have undertaken, and how we have interpreted the data to ensure that our wholesale cost projections are accurate, assured and robust. It also describes how we have collated the various cost estimation data into a single bottom-up wholesale investment plan.

This is a Technical Annex to the Whole Cost Efficiency Chapter 14 of our Plan. It is also a relevant aid to understanding the Wholesale Water and Wholesale Wastewater Chapters of the Plan and supporting Technical Annex investment cases. It should therefore be read in conjunction with:

- Chapter 14, Wholesale Cost Efficiency
- Chapter 11, Wholesale Water
- Chapter 12, Wholesale Wastewater
- TA.14.5 PR19 Approach to Optioneering
- TA.11.WR01 Business Case - Raw Water Pumping
- TA.11.WR02 Business Case - Impounding Reservoirs
- TA.11.WR03 Business Case - Catchment Management Solutions
- TA.11.WN01 Business Case - Supply Demand Balance
- TA.11.WN02 Business Case - Nitrate
- TA.11.WN03 Business Case - Water Treatment
- TA.11.WN04 Business Case - Water Networks
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- TA.12.WW06 Business Case - Wastewater Environmental Programme
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- TA.12.BR01 Business Case - Bioresource Treatment & Growth
- TA.12.MG01 Business Case - M&G Fleet
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- TA.12.MG03 Business Case - M&G Buildings
- TA.12.MG04 Business Case - M&G Research & Development
- TA.12.MG05 Business Case - M&G Central Costs and PR24

The table below summarises the Ofwat tests that are addressed by this Annex.

**Table: Relevant Ofwat tests**

| Ref | Ofwat test | | Comment |
|---|---|---|---|
| **Primary Focus Areas** | | | |
| CE1 | How well evidenced, efficient and challenging are the company's forecasts of wholesale water expenditure, including water resource costs? | High quality plan: The company will submit an efficient level of total expenditure in all areas. | Our forecasts of wholesale water and wastewater expenditure are set out in the main water and wastewater Chapters (including expenditure for water resources and bio-resources). |
| CE2 | How well evidenced, efficient and challenging are the company's forecasts of wholesale wastewater expenditure, including bioresource costs? | | This Annex provides more granular information on our approach to cost-estimation for the bottom-up wholesale plan build. The work we have done on the top-down efficiency challenge is discussed separately. |
| **Secondary Focus Areas** | | | |
| CA4 | Securing confidence and assurance | | |

# Introduction

This Annex summarises our approach to cost estimation for the wholesale programme. The Annex is structured in the three 3 key areas of our process:

1. **Defined Solution Based Cost Estimation** – The approach used to provide robust, accurate and valid scheme and programme capital costs (overall, 44% of the wholesale plan). 94% of defined solution based cost estimates are at a high or very high investment data confidence rating levels.
2. **Opex cost estimation** – The approach used to derive operating expenditure estimates (overall, 32% of the wholesale plan). 94% of opex based cost estimates in the plan are at a high or very high investment data confidence rating levels.
3. **Non-Defined Solution Cost Estimation** – The approach used to assess historic spend data, deterioration modelling, developer charges, and other investment data such as IT costs (overall, 24% of the wholesale plan). 92% of non-defined solution based cost estimates in the plan are at a high or very high investment data confidence rating levels.

shows the breakdown of our wholesale totex costs across these three approaches.

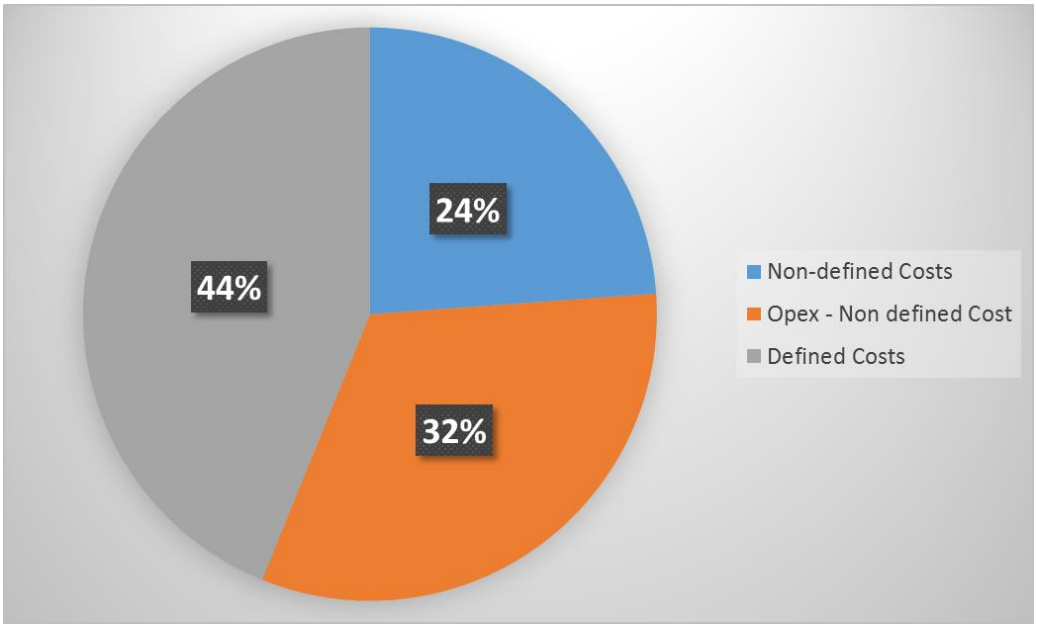


**Figure 1: Wholesale cost estimation approaches utilised (% of investment total totex**

# Overall Cost Estimation Approach

Southern Water's cost estimation principles and processes have been designed to deliver a high quality business plan with cost estimates that are reliable, accurate, efficient, and appropriately allocated.

## Cost Estimation Process

Cost estimation is part of the wider Southern Water Asset Lifecycle Process (ALP). The ALP was first introduced in 2012, following an independent external assurance review of our asset management processes, and has been continuously improved since.

Figure 2 shows the overall ALP governance structure. Cost estimation and investment plan development fall within the "Identifying Notional Solutions" and "Developing Portfolios" stages. However, they are also closely linked to "Setting Strategic Objectives" and "Understand Asset Needs".

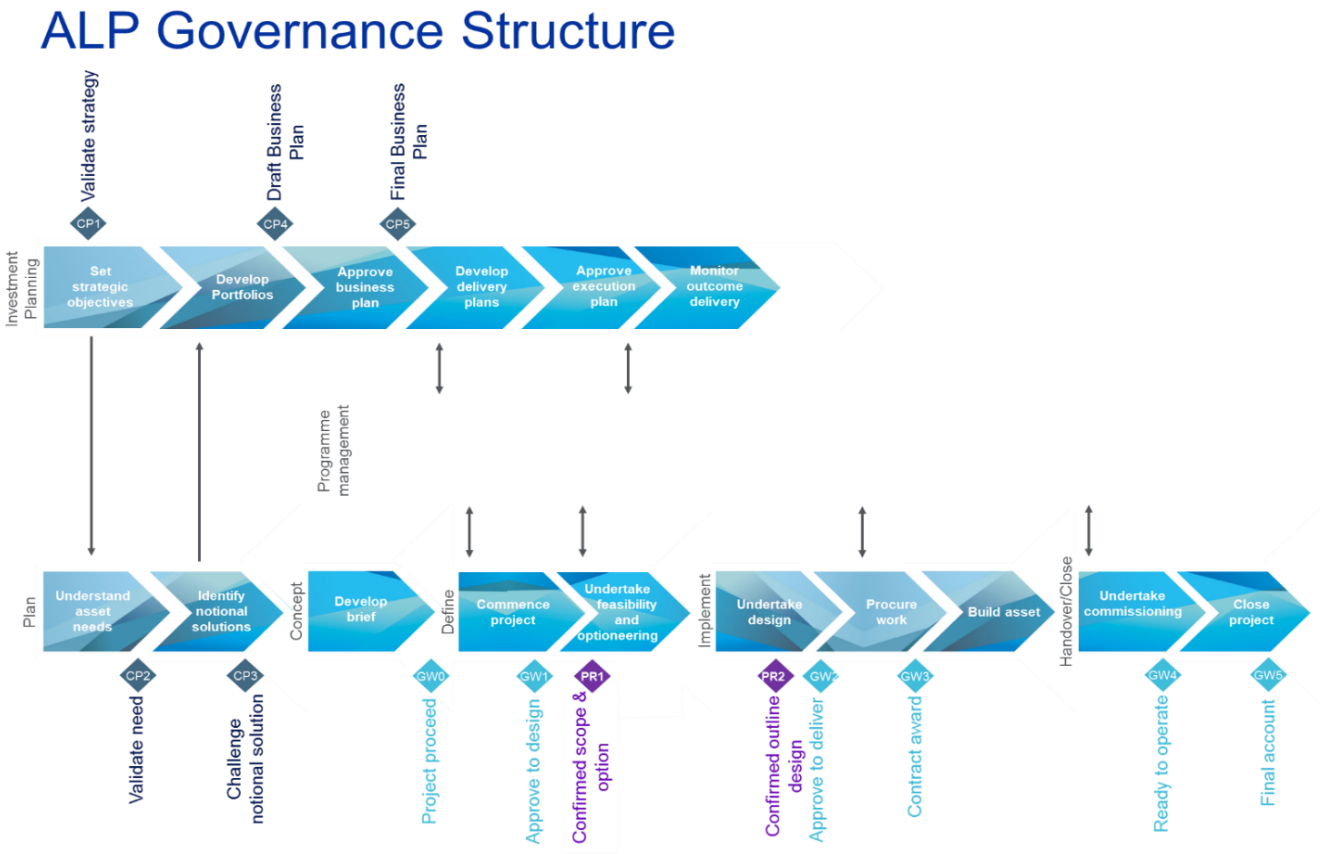


**Figure 2: Southern Water asset lifecycle process (ALP) governance structure summary**

Naturally, this process is supported by more detailed process maps, procedures, tools and templates.  provides an example snap shot of the more detailed process information that forms part of the main cost estimation processes followed for PR19 estimation of costs.

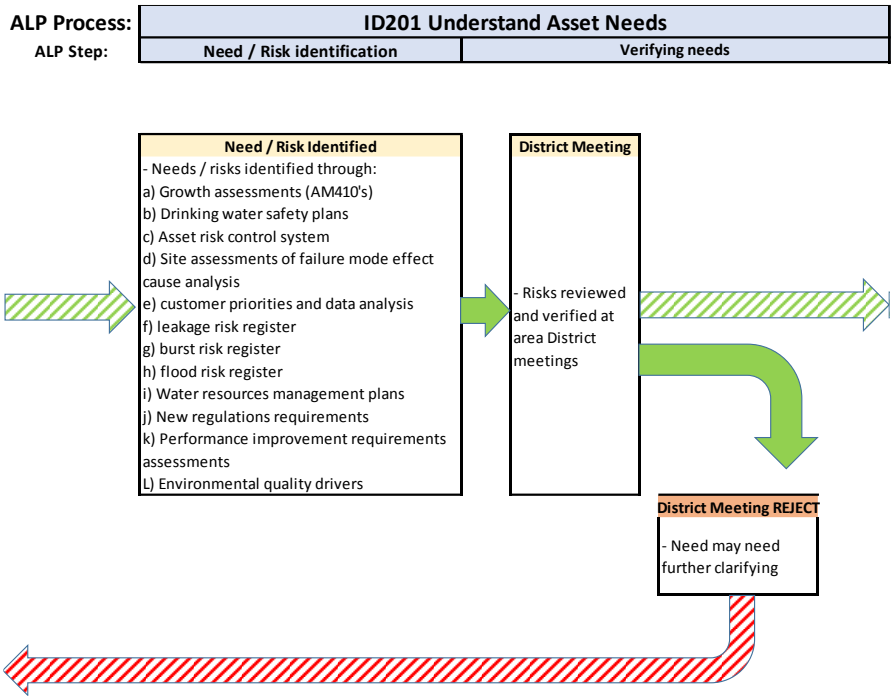


**Figure 3: Asset lifecycle process (ALP) example of part of a detailed process diagram**

There are 2 main cost estimation processes involved in validating investment needs and estimating costs for inclusion in the Business Plan. The 2 processes are summarised as follows:

1. Defined Solutions Cost Estimation Process

*Understanding Asset Needs*

This process begins where asset needs and risks are identified within the business:

- As shown in Figure 3**Error! Reference source not found.**, needs / risks are identified from many different sources (e.g. growth, flood risk register, drinking water safety plans etc.)
- Needs and risks are understood and validated at the local District meetings. This meeting includes local area managers from Operations, Asset Management, Strategy and other key Southern Water personnel.
- Validated needs and risks for PR19 are confirmed by a quorate set of multi-disciplined skilled people at the PR19 Asset+ meeting. This meeting includes managers from Operations, Asset Management, Engineering Technical Solutions (ETS) team, Cost Estimation Team (CET), Strategy and other key Southern Water personnel that can confirm that the need / risk is relevant for investment in PR19 (and not a need / risk for resolution in AMP6 or longer term AMP8).

*Identify Notional Solutions*

Once the needs and risks are confirmed, a notional solution scheme(s) design is carried out by the Engineering team.

- The notional scheme design will look to meet the needs / risk requirements.
- As described in the TA.14.5 PR19 Approach to Optioneering, Engineering designers will consider different totex solutions to resolve the needs / risks; for some schemes they may produce more than one viable option for consideration in the plan.

- Once the scheme design is complete the scheme asset requirements are entered into Pioneer Schemebuilder[1], and then the Cost Estimation Team review the scheme details and provide a validated cost estimate.
- Once the Cost Estimation Team have produced a valid cost estimate the scheme will go back to (an Assets+ meeting of) subject matter experts to assure the scope is acceptable and the solution is acceptable to go forward into the PR19 Investment Plan.
- The final Asset+ meeting ensures that the solutions going forward into the plan are deemed to be valid and are understood by key people in the business.
- All validated costs then go through to the business plan and are subject to optioneering and further assurance.

This cost estimation approach process is consistent for all water and wastewater defined solution schemes / programme costs going through to the plan.

2. Opex costs estimation and non-Defined Solution (Non-Schemes Based) Cost Estimation

The non-defined solution investment cost estimation approach also follows the Southern Water ALP. Similarly, this entails confirmation of the strategy or need, development of the cost. Proposals go through significant challenge to confirm that the costing is concise, appropriate and based on good, clear and accurate evidence. However, non-defined solutions do not go through a formal Assets+ meeting stage before going through to plan optioneering, optimisations and significant challenge, review and assurance.

Opex investments also go through the non-defined solution cost estimation approach process.

### Process Assurance

Jacobs were commissioned to provide an independent review of the cost estimation process. Jacobs' initial independent assurance of wholesale investment cases (May to June 2018) assessed the cost estimating process and method as being worthy of the top mark in their assessment. Jacobs noted:

*"The detailed process has been explained and the steps described. This appears to be comprehensively covered in the Asset Lifecycle Plan (ALP) which is contained within the Business Management System. The use of the ALP was evidenced in a session where the PR19 tracker was demonstrated - clearly showing the stages of cost evolution and progress through gateways."*

## Defined Solution Cost Estimation

This section provides detail on how specific schemes and specific programme costs ('defined solutions') have been derived. It describes the process of defined solution cost data gathering, interpretation and analysis and the development of costs forecasts based on "cost curves" at both 'Equipment Set' and 'Function' level (see section 2.2.2.1 and 2.2.2.2). This process provides assurance that a foundation of accurate direct costs has been used in the estimation of new build, replacement, and refurbishment assets, as well as site specific complexities and 'one-off' items.

Building on this foundation, the section describes how overheads and on-costs, covering project preliminaries, programme specific complexities, risks and corporate overheads have been calculated, validated and applied. Furthermore, this section outlines the validation and assurance activities which have been employed, building on the lessons learnt from PR14 and subsequent programme delivery throughout AMP6, to ensure a robust, accurate and deliverable investment plan. This sections looks at sensitivity and industry benchmarking analysis that was carried out to provide further confidence in the cost estimates are efficient.

[1] Pioneer is a system that Southern Water introduced as an investment planning tool at PR14. This tool is used to manage asset risk (through Asset Risk Management – ARM), carry out notional scheme design and cost estimation (through Schemebuilder), and carry out asset deterioration modelling and optimisations.

Southern Water's Cost Estimation Team (CET) are responsible for cost collection, data analysis, cost validation, and estimation functions. This team provides us with an internal ability to manage the above activities and to provide a "single source of the truth" by centralising all costing activities based on application of a consistent estimating methodology and a single source of validated data.

### PR19 Defined Solution Pricing Strategy

The cost estimation approach follows a four-step approach.

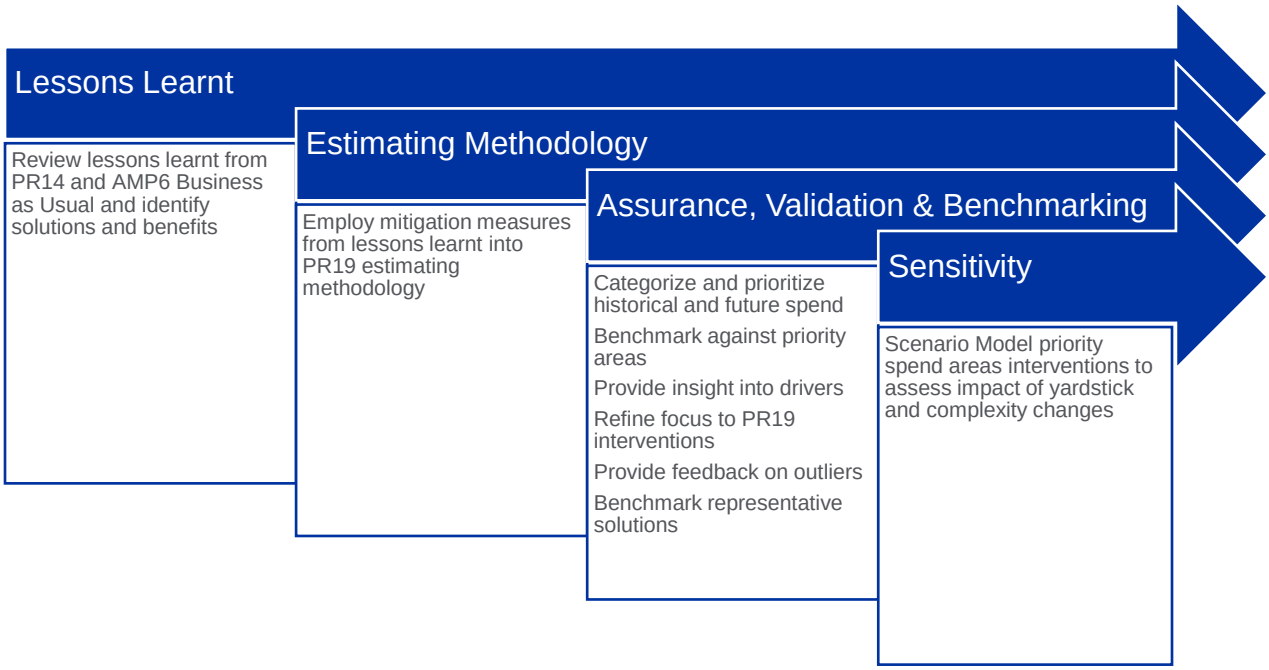


**Figure 4: High level view of PR19 cost estimating strategy**

In turn, the estimating methodology (the second step in this process) can be broken down into three primary stages:

- Net Direct Costs: Cost associated with Installing an asset, typically labour, plant materials
- Contractor Project Related Costs (PRCs) and Client On-Costs & Overheads: Cost of design, project, programme and site management and site accommodation etc.
- Risk and Corporate Overheads: Programme level uplifts

Each of these stages is broken down into further activities as shown in Figure 5 below. More detail is provided on each of these cost estimation steps below.

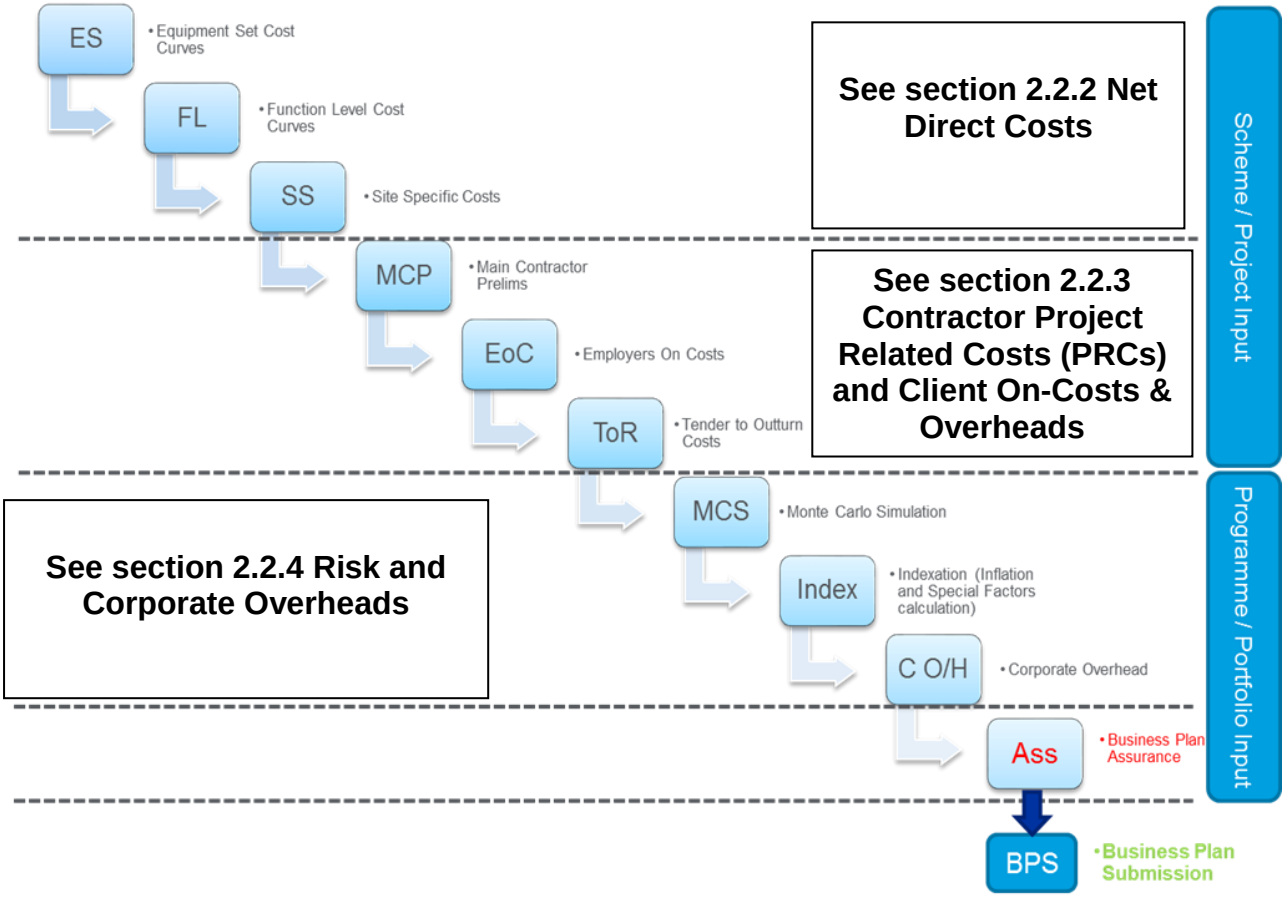


**Figure 5: Building blocks of the business plan submission for defined solution cost estimations**

The flow diagram shown in Figure 6 illustrates how the PR19 defined solution estimating methodology improves on the approach followed in PR14. Red text indicates improvement activities identified as part of the 'lessons learnt' exercise where mitigation measures have been implemented.

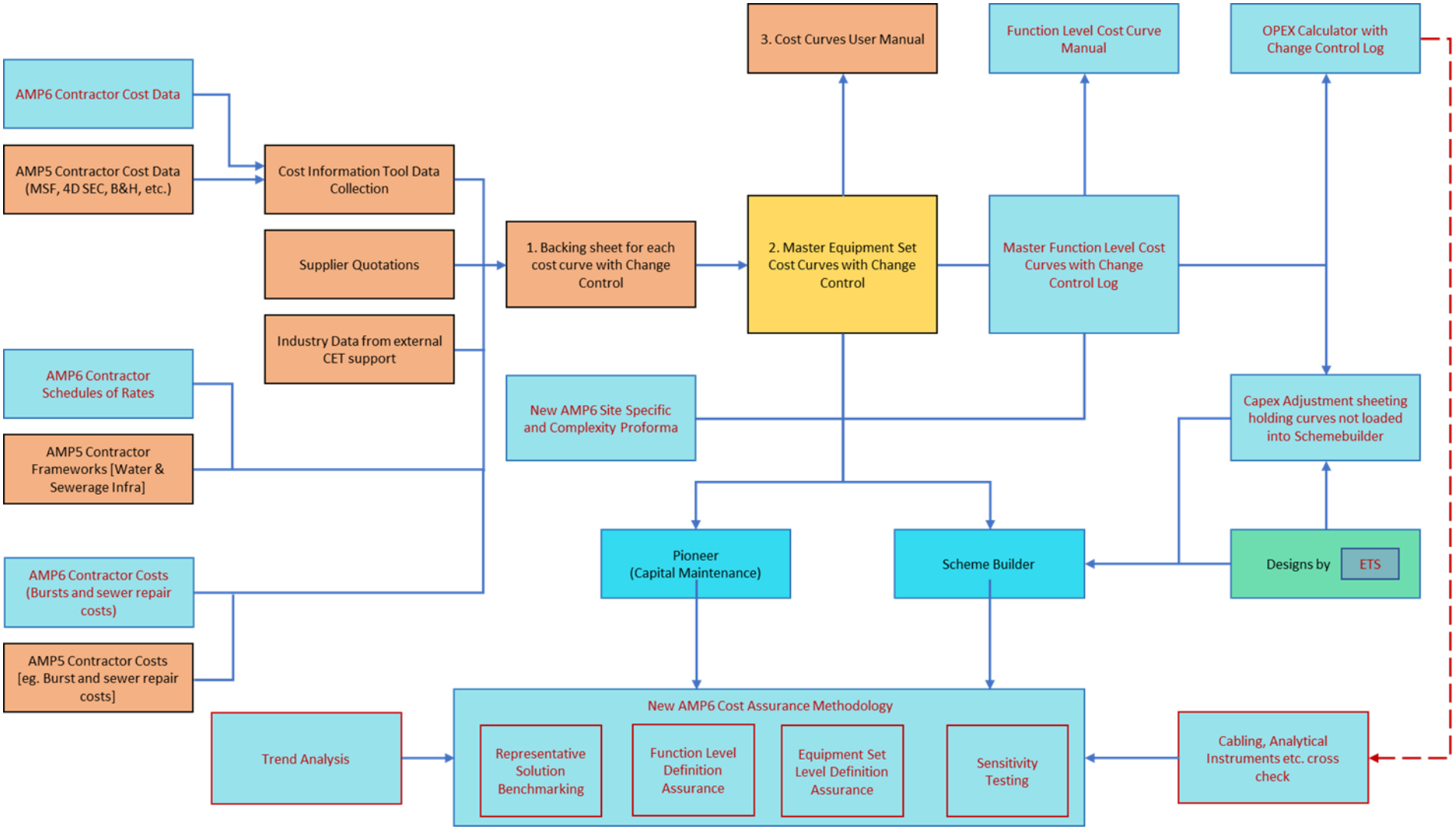


**Figure 6: PR19 Estimating Methodology Flow**

## Net Direct Costs

The net direct works costs are defined as the direct cost of installing an asset, including the cost of the asset and the installation of that asset. These costs are made up of labour, plant and materials costs. Net direct works exclude overheads and on-cost (dealt with separately). The value of the net direct works costs are derived through the use of equipment set or function level cost curves combined with any site specific and one-off complexity costs; more information on these elements are provided below:

### *Equipment Set Level Cost Curve Updates*

The Equipment Set Cost Curves, representing the cost of installing new assets, was updated with new data points obtained from AMP6 projects (see section 2.2.7 for further notes on how AMP6 delivery data was utilised). Where gaps were identified, the Cost Estimation Team augmented as necessary with industry data obtained from external sources, including benchmarking studies. Once Equipment Sets were updated, they were included within the base data of the Function Level Cost Curves and uploaded into Pioneer for the estimation of scheme and deterioration model costs. Figure 7 shows an example of an equipment set cost curve taken from the Southern Water cost curve user manual.

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**Figure 7: Example equipment set cost curve**

### *Function-level Cost Curve Updates*

Early in the design process, it can be difficult to get an accurate fix on some cost estimates. Drawing on our experience of PR14 the Cost Estimation Team has developed a suite of function-level cost curves. These function-level curves are easier to apply early in the design process.

Function level cost curves have been developed based on the equipment set level cost curve data. Essentially function curves have been developed by amalgamating or interconnecting several or many equipment set level curves to describe the type of function that the curve is looking to provide a cost for. So, for example, a cost curve for a nitrate removal plant will be based on many different equipment sets that make up the nitrate removal plant function, such as: pumps, valves, pipe lines, sampling equipment, instrumentation, nitrate removal treatment etc. The function curves were developed based on actual SWS sites, supported through the blending of historically captured cost data points. Figure 8 shows an example of a function level curve.

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**Figure 8: Example function level cost curve**

Function-level cost curves cover assets which are difficult to scope and cost, particularly at the notional costing stage; such as cabling, roads, and analytical instruments.

A representative sample of the new function cost curves were checked and tested against previously delivered schemes and notional costs. Review showed that the function curves would provide more reliable notional costs than using equipment set curves for the same type of notional costing design work. See section 2.2.6 for more info on cost validation and benchmarking of cost curve data.

### *Site Specific and One-Off Costs*

Site specific costs are those costs which inflate the cost of a project due to the site-specific conditions and requirements. These can include, but are not limited to: power upgrades; ground

improvements, such as piling, or dewatering; asset integration and environmental or constructability issues. We do not always have standard cost curves for these costs.

Wherever possible, these costs have been estimated using set level cost curves. If cost curves are not available, we have deployed a "bottom-up" estimation process using the Commercial team's in-house expert estimators, or a quotation has been utilised.

The approach, and cost build up, has been captured on the scheme specific capex adjustment sheets prior to input into Pioneer Scheme Builder[2]. Identification and inclusion of site specific costs is an area of significant improvement from PR14, as it has ensured that solutions are less likely to be underestimated due to missing scope / cost associated with one-off and site specific costs. A standardised pro-forma has been developed and employed (see Figure 9). The proforma was completed alongside the project solution development, and revisited as part of the Assets + PR19 reviews and challenges.

| Scheme Complexity | Action | Detail of Additional Requirement |
|---|---|---|
| Power Upgrade | | |
| Site Access | | |
| Environmental Constraints | | |
| Planning Permission | | |
| Working Access | | |
| Working Conditions | | |
| Service Diversions (Excl' Over Pumping) | | |
| Temp Chemicals / OPEX | | |
| Temp Plant Hire (Excl' Over Pumping) | | |
| Disconnection of Existing Assets | | |
| Adjacent Property Issues | | |
| Disposal of Excavated Material | | |
| Imported Fill Requirements | | |
| Power & Water Availability | | |
| 3rd Party Service Diversions | | |
| Public Consultation | | |
| Land Acquisition | | |
| Compensation | | |
| Traffic Management | | |
| **Asset Complexity** | **Action** | **Detail of Additional Requirement** |
| Ground Improvement Requirements | | |
| Ground Dewatering Requirements | | |
| Asset Integration / Interface Issues | | |
| MCC Upgrade / Mod Requirements | | |
| SCADA Upgrade / Integration | | |
| Removal / Demolition of existing Assets | | |
| Other | | |

**Figure 9: Site Specific / Complexity Cost Pro-Forma**

## Contractor Project Related Costs (PRCs) and Client On-Costs & Overheads

The contractor project related costs (PRCs) and client project on-costs and overheads are the other costs associated with capital scheme delivery. They include costs such as main contractor project related costs (or preliminaries), employer and programme on-costs, tender to outturn ratio, project on-costs and corporate overheads. More information on each of these elements are provided below:

### *Contractor Project Related Costs (PRCs)*

Total project costs are defined as the directly attributable net costs associated with a particular project, including where applicable Early Contractor Involvement [ECI] and pre-construction works, such as topographic or site condition surveys.

[2] Schemebuilder is the part of the Pioneer system where scheme details are entered in a consistent way by ETS and cost estimates are validated by CET.

Southern Water Delivery Partners and main contractor on-costs and project/programme preliminaries overheads have been analysed for inclusion within the on-cost and overhead multiplier.

### *Client Project On-Costs*

Further to the main contractor's project related costs, preliminaries and overheads, Southern Water's project/programme costs have been included to ascertain the Total Project Costs. Southern Water's (client) employer and programme project on-costs include programme management, specialist programme costs [e.g. Audits] and other costs not specifically attributable to individual project costs, are applied as an overall programme allowance. To maximise consistency and ensure accurate alignment to opex capital recharges data, analysis of these costs has been carried out as part of the PR19 pricing strategy, in conjunction with Southern Water Project services and Finance departments.

### *Tender to Outturn Ratio*

Tender to Outturn Ratios (TOR) cover changes that occur after projects have been priced by a contractor (Tender) which influence the final account (Out-turn). Changes to the costs can result from:

- Additional scope (more valves, additional pipe lengths)
- Change in Scope (larger tank, larger pipework)
- Ground Conditions (i.e. rock is higher than limited Site Investigation (SI) showed, good ground is lower than SI showed so piling now required)
- Power connection was delayed etc.
- Delays due to Planning Approvals

Whilst some of these items are identified as complexities during the design development phase, TOR is calculated separately, covering additional risks that occur after contract award. These are costs that are considered to be excluded from the outturn costs used to develop the costs curves. Therefore, TOR costs have been analysed for inclusion within the on-cost and overhead multiplier.

## Risk and Corporate Overheads

The final uplifts necessary to derive a defined solution business plan submission includes the application of a Monte Carlo, or equivalent, risk simulation, indexation and corporate overhead calculations.

### *Risk Simulation*

A risk simulation, in line with that undertaken at PR14, has been undertaken to ensure suitable allowances for programme level risks are included. This analysis derived suitable allowances for risks not accounted for elsewhere in the estimating process. The areas of risk this simulation addressed included risks such as;

- missed or incorrectly specified design elements
- missed scheme complexity
- unforeseen or incorrectly specified ground conditions
- inadequate site services
- planning and environmental impacts

### *Southern Water Corporate Overhead*

The final on-cost added to the capital programme pricing is the Southern Water corporate overhead. This overhead is calculated from costs supplied by Southern Water Finance department and includes a review of actual yearly costs as well as a projection of future overhead costs in line

with the Business Plan with regard to potential overhead fluctuations over the AMP period. More information is provided on overhead alignment in section 4.

## Carbon Accounting & Opex Arising from Capex

### *Carbon Accounting*

Southern Water developed a suite of carbon models that are aligned to the equipment set level cost models. These models derive a volume of embedded carbon (Kg/Co2) against which an economic value is attributed to support the Totex assessment of a design solution. All CET tools are designed to accommodate inclusion of the carbon models and the notional functional level data points have been developed to accommodate a carbon model addition; effectively developing a pseudo suite of carbon models.

Carbon modelling remains a key piece of information that is produced for equipment set and function level cost estimations. The operational and embedded carbon data is calculated in Schemebuilder as part of scheme design and estimation process. This information can then be utilised for cost benefit analysis and for forecasting energy and carbon impacts of schemes being put forward for PR19.

### *Opex Arising from Capex*

During the cost design phase, for both function and equipment set level cost estimations; ETS designers carried out a detailed review of the opex arising from capex. ETS designers use a standard Southern Water opex arising from capex calculation tool template to fill in the required opex fields within Schemebuilder. The tool template and the opex calculation fields in Schemebuilder have been calibrated using up-to-date opex unit cost data. The opex arising from capex is assured and validation checked through the investment case assurance process.

## Cost Assurance, Validation, and Benchmarking

To provide confidence in our capital cost estimation methodology we have undertaken cost assurance, validation and benchmarking activity.

Over 60% of our defined works solution costs have been benchmarked through the benchmarking activity. This means that we can have good confidence that our defined solution costs are robust and are priced at or close to upper quartile levels of delivery.

### *Net Direct Works*

We commissioned Mott Macdonald to undertake benchmarking and validation activity on our net direct works costs.

In terms of benchmarking activity, they looked at our high value and high volume net direct work costs in our plan and benchmarked those costs. This accounted for more than 20% of the total net direct works included within the plan (i.e. a good proportion of the net direct works value was benchmarked). This benchmarking activity looked at:

- Southern Water past delivery in AMP5 and AMP6
- Industry comparison data for median to upper quartile (taken from Mott Macdonald's own vast water industry estimation database)
- Non-water sector comparator data (taken from Mott Macdonald's own non-water sector estimation database).

This net direct works benchmarking activity firstly showed that current AMP6 delivery costs are not optimal and that these capital costs are not efficient (see section 2.2.7 for more detail on the impacts of understanding this benchmarking analysis).

Mott Macdonald carried out sensitivity testing on our net direct works costs. **In summary, this Mott Macdonald benchmarking work confirmed that the pre efficiency capex costs going into the plan are deemed to be at median to upper quartile levels of delivery efficiency. We have adjusted our costs downwards to target the level of efficient costs.**

***On-cost and overhead multipliers***

Southern Water carried out a sensitivity and benchmarking review of the indirect cost multipliers used to derive capital costs. This sensitivity work covered 100% of the capital costs as all capital costs are essentially devised using these multipliers (i.e. this covered a large proportion of the overall capital programme costs). In summary, for this piece of work we took the Southern Water performance and estimation multipliers that we are using and compared these, using water industry data, to indirect cost performance achieved across other companies in the industry and outside of the industry (road, rail, buildings and aviation). We compared companies with similar delivery models to ours and those companies with different delivery models too. This gave us a range of values for the capital projects.

**This benchmarking data told us that the pre efficiency multipliers being used to cost our PR19 capital schemes are at median to upper quartile levels of delivery efficiency. We have adjusted our costs downwards to target the level of efficient costs.**

### PR19 Pricing Strategy Decision Making

The Cost Estimation Team, with support from commercial subject matter experts from Mott Macdonald, carried out a review of the delivery cost data since the PR14 submission (as noted in section 2.2.6). Southern Water's plan prior to further review was to utilise new AMP6 delivery cost curve data points, delivery data, and uplift factors for pricing defined solutions at PR19. Use of Pioneer schemebuilder and benchmarking of industry data enabled these teams to compare PR14, previous delivery costs, to current delivery costs.

Comparison data and benchmarking activity has shown that delivery costs have gone up in real terms since PR14. A root and branch review has been undertaken to create a clear understanding of the root causes for these changes and to identify where delivery savings can be made in the current delivery approach.

We have recognised that there is a clear need to ensure that Southern Water aim at being at industry upper quartile, and where possible frontier, in terms of cost efficiency levels. Therefore, **to ensure better value for money for customers, we have capped the cost curve and uplift factors at the efficient level used at PR14 business plan submission.**

**As noted in section 2.2.6, by moving to this method of capital costing at PR19 we ensure that our capital costs being put forward are at upper quartile delivery efficiency levels. Further work beyond this on optioneering ensures that our capital costs are even more confidently positioned at upper quartile.**

## Opex Cost Estimation

The following steps are taken to define the opex for PR19 (as described in Figure 11):

1) Baseline Opex – The baseline Opex is derived from the Southern Water opex budget forecast (as at March 2018) for 2019/20 and effectively flat-line the expenditure for the next 5 years to 2024/25. Noted that further efficiency adjustments are included later (see step 5).
2) New opex investments – This is where new opex budgets are included that will increase or decrease the baseline opex (e.g. new catchment management or studies & investigation activities). These line adjustment increases and decreases are included within the general Opex baseline, which is why there is a potential step change in opex in 2020/21.
3) Non-inflationary changes to power & business rates - We carry out a review of power costs and potential business rate increase which are added into the opex baseline.
4) Opex arising from capex (AFC) – Increases or decreases in opex as a result of a capital scheme being delivered are included in the baseline budgets.
5) Opex efficiency – The opex efficiency has been applied to the 2019/20 baseline (i.e. opex budgets are 10% less in 2024/25 than the same baseline in 2019/20).

Figure 10 illustrates the estimating process steps followed to derive the opex budgets for PR19. This process remains in line with the ALP process noted in the Cost Estimation Process section.

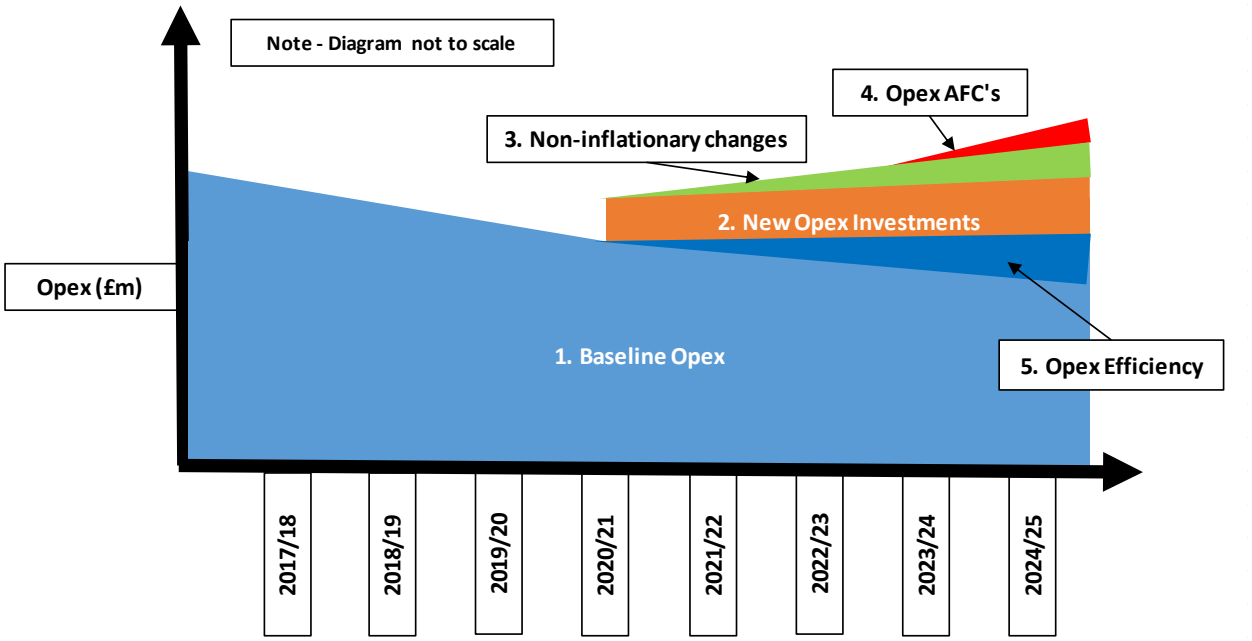


**Figure 10: Illustration of how Opex budgets are updated at PR19**

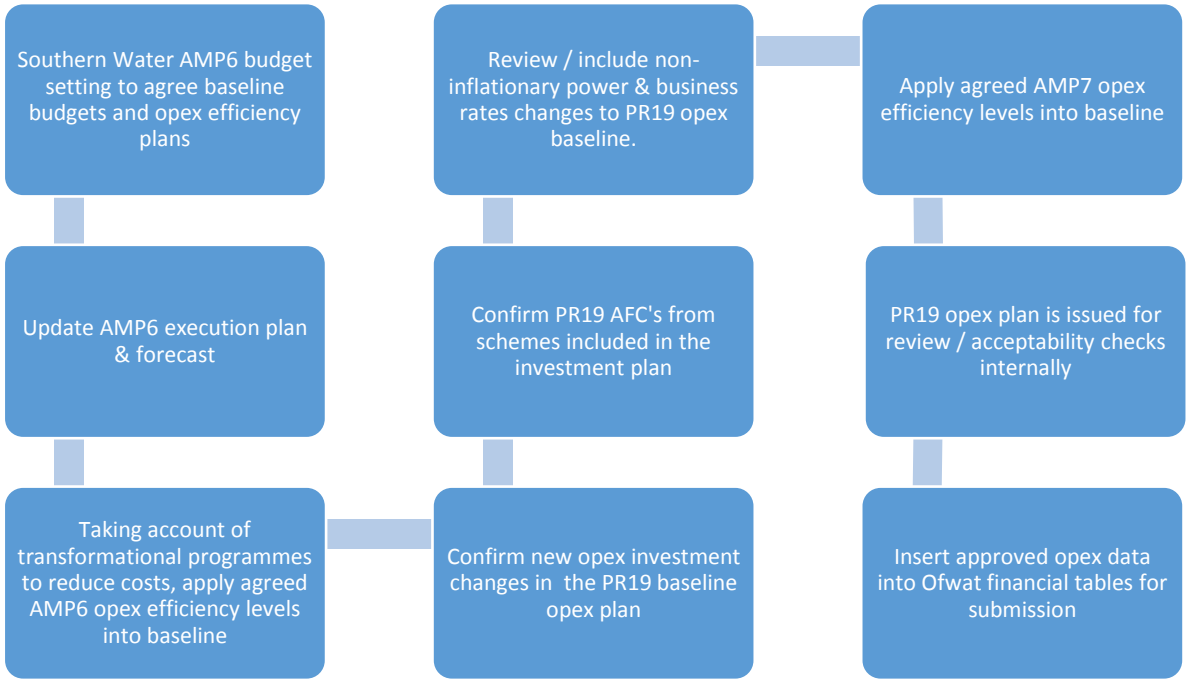


**Figure 11: Simple process map illustrating how Opex is included in the PR19 Investment Plan**

# Non-Defined Solution Cost Estimation

Remaining non-defined solution cost estimation methods include:

1. Deterioration modelling cost estimation
2. Historical cost estimation
3. Subject matter expert and consultancy cost estimation
4. Developer charges cost estimation

## Deterioration Modelling

Our Pioneer investment planning tool has a deterioration modelling module that we have been using and continuously improving since 2012. This looks at the potential future cost of deteriorating assets and the potential impact on service of failing assets. This cost information has been used in the derivation of some of our key investment areas (e.g. sewer rehab, water mains replacements etc.) and to support programme level cost decision making.

The Pioneer deterioration models use the equipment set and function level cost curve data used for defined solution costing. Deterioration modelling determines the probability of failure and the optimal remedy / intervention to contend with that failure which includes repair, refurbishment or replacement. The cost curves are used in deterioration modelling in a number of ways:

- Repair cost may be defined in terms of percentage of the cost of a new asset
- Refurbishment cost is defined as a proportion of the cost of a new asset
- Replacement cost is defined as the cost of a new asset multiplied by a replacement factor which takes into account de-commissioning, removal and disposal of the old asset.

Each asset type has a number of attributes that define the characteristics of that asset type. All assets will have characteristics to define their operating status, installation date, renewal / maintenance periods etc., but specific attributes will also define their size or performance. Cost yardsticks have been defined which are used by Pioneer to place specific assets on the curve according to the specific values attributed to that asset. So, for example, a specific pump kW rating of 500 will be placed at different level on the cost curve versus one with a specific kW rating of 1000. Where the specific asset has no value for the cost yardstick defined, alternative yardsticks may be available or the use of a default value will be applied.

As well as being run to determine levels of investment in key areas, such as sewer rehab and mains renewal, the deterioration model has also been run at the programme level to look at many different scenarios such as:

- What are the performance implications if costs are fixed at a certain level
- What are the cost implication of different levels of performance and service levels (e.g. cost implications of reduced sewer flooding)
- What are the cost implications of different weather scenarios that can impact service levels (e.g. what if conditions are drier or wetter – what are the service and cost impacts)
- What are the cost implications if assets deteriorate faster or slower than currently expected

These scenario and sensitivity runs have helped to provide a balanced, consider and more robust set of investment numbers in key areas of investment (e.g. sewer rehab, water mains replacements etc.). More information on these optioneering and sensitivity checks are discussed in TA.14.5 PR19 Approach to Optioneering.

Deterioration modelling investment data is checked and assured.

### Historical Costs

There are some investment areas where subject matter experts have used historic spend data to determine the required spend in the future.

In many cases, where this historic information is used directly there are no plans to alter the needs and requirements in the future; so the use of historic investment data is a straight-forward projection of the future investment levels. A good example of this would be manhole cover repairs. Investment in manhole cover repairs has been assessed in terms of need - there is no evidence to suggest a changing requirement to do more or less repairs in the future.

Historical investment data is checked and assured.

### Subject Matter Expert / Consultancy Costs

Some areas of investment have been derived by a subject matter expert or through the use of external consultancy support. These are typically areas of investment that have the required expertise and industry knowledge to understand needs, create cost effective solutions and provide industry comparable costs. The main areas where this approach has been undertaken include:

- Water Resources Management Plan schemes costs (Atkins review of needs, schemes and costs)
- Wastewater Studies and Investigations programme (several external consultancies supported review of needs, schemes and costs)
- IT Investment (Accenture supported review of strategy, needs, schemes, programmes and costs)

Wherever external consultancy investment appraisal data has been used Southern Water have, where appropriate to do so, ensured that these costs have been reviewed, benchmarked and / or validated by our Cost Estimation Team. The Water Resources Management Plan (supply-demand) scheme costs, for example, were assessed by Atkins. These costs were then checked, benchmarked and validated by the Cost Estimation Team. The Southern Water CET validated investment data are the numbers that have gone forward to the PR19 investment plan.

Subject matter expert and external consultancy data is created, checked and assured.

### Developer Charges

From April 2018, New Connection Charges have been published for both water and wastewater new connections. Southern Water have published fixed charges for the majority of work carried out to connect new homes to the existing network. This enables developers to estimate the cost before they make an application. Southern Water's new charging arrangements are in line with Ofwat's New Charging Rules, which affect all English water and wastewater companies. It is noted that these connection charges are based on expected activity cost levels and are reviewed annually.

Further information on the Developer charging mechanism can be found on the Southern Water website where the above information was copied from:

**https://beta.southernwater.co.uk/infrastructure-charges**

This charging data has been used to derive much of the build-up detailed in the PR19 plan. Our current Infrastructure Charge levels are detailed below.

| | Charge | How is this applied? |
|---|---|---|
| Current infrastructure charge (until 31 March 2018) | £379.62 | Per property |
| New infrastructure charge (from 1 April 2018) | £200 | Per property |
| New infrastructure charge (water efficient development) | £0 | Per property |

**Figure 12: Water connections**

| | Charge | How is this applied? |
|---|---|---|
| Current infrastructure charge (until 31 March 2018) | £379.62 | Per property |
| New Infrastructure Charge (development size <20) | £550 | Per property |
| New Infrastructure Charge (development size >20) | £765 | Per property |

**Figure 13: Wastewater connections**

The charging arrangements include:

- new infrastructure charges for water and wastewater connections (which cover the cost of reinforcing the existing network to support development-related growth)
- site specific charges which cover the work needed to connect new homes to the existing network, including new water and wastewater connections, lateral drains, new water mains and sewers, diversions and associated activity such as traffic management.

For PR19, within the Wastewater Network+ price control, we have developed a new projection of what our infrastructure charges will be in PR19. These charges are based on our AMP7 calculation method and reflect the projected levels of expenditure on Network Reinforcement.

For water infrastructure charges we have again developed a base calculation that sets the charge to align with expenditure over the AMP7 period. In both water and wastewater cases this aligns with the rule that charges should be designed to cover expenditure on Network Reinforcement over a rolling 5-year period.

The income offsetting approach is changing in AMP7 where the mechanism is being transferred from the Section 41 and Section 98 requisition mechanism to be incorporated within the Infrastructure Charge. We have been able to accommodate this within our Wastewater Charge as our expenditure on Network Reinforcement is higher than the income offset that we have historically offered. Within the Water Network+ price control, the value of income offset per new property connected is significantly higher that the level of Network Reinforcement per new property connected. As a result, we have lowered the charge to zero, but we cannot make the full adjustment, as this would result in a negative charge. We are aware that this is not fully aligned with the principle of 'maintaining the balance' between developer customers and existing bill payers, but we are not clear how such a charge can become negative and still be fair between existing and developer customers.

Population forecast data, which is based on the latest available growth statistics from the office of national statistics (ONS); is received from Experian (growth forecast Experian 7.1 has been used). This data has been compiled by the Demand Strategy team and is used to calculate the new growth in the Southern Water area. Furthermore the Experian data covers the next 4 -5 AMPs as

well so that SWS is able to review any emerging growth trends and adjust its investment with the expected requirements.

The new Infrastructure Charges are developed by calculating the programme levels of income that would have applied under the old delivery mechanism, and subtracting this from the levels of Network Reinforcement expenditure. Dividing this total figure by the number of new connections leads to the unit charge per property charge to be levied.

Our current projection on Infrastructure Charges for AMP7 are detailed below.

| | Charge | How is this applied? |
|---|---|---|
| AMP7 Water Infrastructure Charge | £0 | Per property |
| AMP7 Wastewater Infrastructure Charge | £619 | Per property |

**Figure 14: Projected infrastructure charges**

It should be noted that developers are charged .approximately £735 per new water connection. This charge is 100% recovered through the cost of the connection and is therefore net zero in the investment plan.

It is also noted that in our investment plan we have assumed that water and wastewater requisitions will be 100% billed to the developer in AMP7 and as such this means that 100% of the cost is recovered in the plan; again this means that this element of cost is net neutral in the plan.

# Application of Overheads

All capital schemes and programmes coming into the investment plan include an uplift to cover the Southern Water corporate overheads. This ensures that the capital investment is inclusive of all overheads and on-costs (as required in submission to Ofwat).

Overheads have been calculated as a single figure based on 2019/20 budgets rebased to 2017/18 prices. This overhead is applied to the 2020-25 capital programme as a percentage multiplier uplift to all capex lines. This overhead is applied evenly to all capex lines.

# Data Confidence

We have developed a confidence grading system for the wholesale investment plan data to allow us to understand overall confidence levels and data accuracy. This system allows the business to understand how confident it is in the investment numbers being provided.

The confidence grades are used for Monte Carlo modelling. Each data line in the investment plan has a level of cost estimation confidence which can be used to run a programme level Monte Carlo simulation. The Monte Carlo model then allows us to review the acceptable investment range and confidence thresholds at a programme level. This was used to inform business decisions in relation to the plan and for assurance purposes.

| Confidence Grade | % of Water Plan | % of Waste Plan | % of M&G Plan | Divergence | Explanation |
|---|---|---|---|---|---|
| Very High / High Confidence | 93% | 92% | 63% | Very High +/- 5% | Project cost at target cost stage; provided by a delivery partner / supplier. Typically based on actual tender costs. All costs for this fully validated and checked by SWS CET. |
| | | | | High +/- 15% | Process / function or equipment set level scheme design at the notional solution cost stage. Cost fully validated and checked by CET. Alternatively, cost is based on sound and auditable data (e.g. detailed opex budgets, sound historic cost, sound deterioration model data). Costs validated by SWS business experts or SWS CET. Alternatively, cost provided by an external consultancy or third party that has been benchmark checked or validated by SWS CET. |
| Good / Medium Confidence | 7% | 7% | 37% | Medium +/- 25% | Cost is based on potentially less accurate but still reliable data sources or cost is based on a sound Expert view – Costs validated by SWS business experts. Alternatively, cost provided by an external consultancy or third party that has not been SWS CET validation checked. |
| Low / Very Low Confidence | <1% | <1% | <1% | Low +/- 50% | Cost derived from expert formed estimate based on some potentially less reliable data. Cost not validated but may be accepted by SWS experts as a good initial estimate of cost. |
| | | | | Very Low +/- 100% | Cost based on a very high level initial early stage expert estimate with high uncertainty. Cost not validated. |

**Figure 15: Confidence grade system used for investment planning**

To ensure comparability in approach, all investment lines were graded in a consistent way. **Error! Reference source not found.** provides the confidence levels being employed.

**The data shows that less than 1% of the plan has a low or very low confidence rating. Over 90% of the water and wastewater parts of the plan has a high or very high confidence rating. The fact that over 99% of the plan is deemed to be at Good or High levels provides greater confidence that costs are robust and accurate.**

# Allocations

Appropriate allocations are one of the foundations to ensuring that we deliver a high-quality business plan.

The Ofwat investment tables that directly link back to cost estimation data include:

- WS1 - Wholesale water operating and capital expenditure by business unit
- WS2 - Wholesale water capital and operating enhancement expenditure by purpose
- WS2a - Wholesale water cumulative capital enhancement expenditure by purpose
- WS9 - Wholesale water special cost factors
- WS10 - Transitional spending in the wholesale water service

- WWS1 - Wholesale wastewater operating and capital expenditure by business unit
- WWS2 - Wholesale wastewater capital and operating expenditure by purpose
- WWS2a - Wholesale wastewater cumulative capital enhancement expenditure by purpose
- WWS9 - Wholesale wastewater special cost factors
- WWS10 - Transitional spending in the wholesale wastewater service

These tables above also interlink with other Ofwat tables, such as the Appointee tables.

Every investment line has been entered and allocated into the correct Price Control categories: Retail, Bioresources, Water Resources, Wastewater Networks+, or Water Networks+. For the Bioresources investment the investment data is further split into Sludge Transport, Sludge Treatment and Sludge Disposal. For Wastewater Networks+ the investment is further split into Sewage Collection (infrastructure investment) and Sewage Treatment (non-infrastructure investment). For Water Resources the investment data is further split into Water Resources. For Water Networks+ investment the data is further split into Raw Water Distribution (raw water infrastructure investment), Water Treatment (non-infrastructure investment) and Treated Water Distribution (treated water infrastructure investment).

The capex and opex costs are provided and allocated between price controls in line with the Regulatory Accounting Guidelines (RAG).

Every investment line has to be entered into the correct data table line as per the Ofwat methodology description. The assurance process for ensuring this is done accurately is described in the assurance chapter of this document.

At PR19 Ofwat require companies to provide future investment data using the Consumer Price Index (Household) rather than the traditional method of using the Retail Price Index (RPI). All investment data has been appropriately indexation adjusted to 2017/18 price base. We acknowledge from 2017/18 onwards costs will be converted using CPIH indexation mechanisms.

# Programme Planning

One of key stages of the investment planning process is ensuring that all investment is well planned out over the whole planning period. We have developed a profile of spend for each scheme and programme investment line in the investment plan. The PR19 Totex profile of spend is compiled using the following information:

1. Schemebuilder data: based on expert knowledge, required benefit date, and experience the ETS design engineer will enter the delivery spend profile as part of scheme design
2. P6 system data: The programme management software has standard delivery curves that can be used to profile spend if required
3. Subject matter expert defined profile of spend: Where information from Schemebuilder or P6 is lacking it has been necessary to work with subject matter experts to define the delivery profile of spend (e.g. Asset Planning Team, Portfolio Management Team or Construction Planning Team).
4. Assume linear profile of spend: For those investment lines that are not defined by any of the above, or where it is appropriate to do so (e.g. like for like replacement reactive spend), the default position is to allocate the investment evenly over the 5 year period.

The profiles of spend for each scheme / programme line and the decision on when to start / finish a scheme or programme spend were defined and optimised under the following criteria (in order of importance):

1. Statutory, regulatory, or legal compliance requirement deadline

2. Non-statutory requirement deadline but with potential compliance failings, customer complaints, or loss of reputation associated with delayed delivery
3. Performance improvement whereby late delivery could lead to greater potential for penalties, failures and fines
4. Risk resolution criticality / resilience impact whereby late delivery could lead to increased risk and higher costs
5. Ordering whereby one scheme needs to be delivered before another scheme needs to be delivered.

Every plan optimisation and adjustment changed the level of opex arising from capex that needed to be included in the plan. Understanding these movements formed part of the plan optimisation decision making.

Collaboration between the aforementioned teams helped to ensure the programme remained efficient and deliverable.

# Assurance

Our cost forecasts have been subject to multiple layers of assurance..

Investment data went through a 3 stage assurance process (see

Figure 17):

1) First line of defence – Assurance checks and sign-off on data in the investment plan were carried out by PR19 investment case leads and other key internal stakeholders.
2) Second line of defence – Assurance checks by Finance (with support from the Investment Strategy team) and Economic Regulation on investment data going into the Ofwat tables.
3) Third line of defence – Independent assurance carried out by:
    a. Jacobs on understanding the source, credibility and accuracy of the investment data provided in investment cases and cost estimation approach. This Jacobs review of investment cases and cost estimation approach was carried out as a 2 stage process whereby they provided initial assurance feedback for improvement and then final assurance post feedback.
    b. Deloitte on investment data provided in the Ofwat tables.

Prior to final lockdown of investment numbers, all investment was fully justified in an investment case. The investment case assurance process provide detailed, strong and credible evidence to justify all of the investment going forward in the PR19 investment plan. The investment case assurance approach involved a staged process:

- Bronze – First draft of the investment case, setting out the justification detail, but lacking some areas of evidence.
- Silver – Further development of the investment case to provide good and improved justification detail, but lacking a few areas of evidence.
- Gold – This is the final approved investment case that is fully justified, is full of detail, provides credibility and fully supports the case for investment required in PR19 and beyond.

There were other challenges and reviews on investment cases, including:

- Executive Leadership Team (ELT) Challenge and Review – This allowed ELT to understand the differing programme level options in terms of cost, impact, risks and benefits. At the end of this session, a decision was made on whether the selected level of investment was appropriate and agreed.

- Challenge Team Review – This was a challenge and review session on specific key topic areas or investment cases carried out by senior independent industry professionals (e.g. Board members, CCG member etc.). These sessions ensured that investment case or key topic areas were well justified and being articulated appropriately. The sessions highlighted areas for evidence improvement or alterations required to investment cases to make them more robust to external audiences.
- Star Chamber Review – Similar to the Red Team Review, but this review was carried out by ELT members.
- Board Engagement Days – These provided Board with an overview of the wholesale bottom-up investment plan compared to top-down modelling. This allowed Board to shape decision making on affordability of the plan overall which was then translated into potential need for further programme level and scheme level review of options and investment levels.

The Jacobs final assurance report into our investment cases summarised in Figure 16 shows that overall they felt that our investment cases were good (low to medium risk) or excellent (low risk). This provided the Board with good levels of assurance that our wholesale investment was well justified and based on sound evidence. In summary, the Jacobs final assurance report into our cost estimation approaches found the following:

> We have reviewed the cost evidence, cost curves, corporate overheads and on-costs information, including governance associated with the schemes subject to the in-depth review. Particular focus has been given to the areas that will have the greatest impact during AMP7. Generally we observed that the approach developed and employed by the team is appropriate, managed and controlled. With minor exceptions we consider that the methodology is clearly defined and we found that where processes have been established for some time there was a good understanding of what is required and that these processes generally have appropriate controls which are effectively documented.

More information on assurance is provided in Chapter 2 Trust, Confidence and Assurance.

| IC Reference | Name | General | Need for / level of Investment | Optioneering | Costing Info** | Customer Engagement | Interests of the Customer | Securing Long Term Resilience | OVERALL |
|---|---|---|---|---|---|---|---|---|---|
| WN01 | Supply Demand | B | B | A | | A | B | B | B |
| WN02 | Nitrates | B | A | A | | A | A | B | B |
| WN03 | Water Treatment | B | B | A | | A | B | B | B |
| WN04 | Water Networks | B | A | A | | A | A | B | B |
| WR01 | Raw Water Pumping | B | A | A | | A | B | B | B |
| WW01 | Wastewater Treatment | B | A | B | | A | B | B | B |
| WW02 | Network Pumping Stations and Pollution | B | B | B | | A | B | B | B |
| WW04 | Sewers and flooding | B | B | B | | A | B | B | B |
| WW05 | Wastewater Growth | B | B | B | | A | B | A | B |
| BR01 | Bioresources | B | B | B | | A | B | A | B |

| Score | Risk Band | Meaning |
|---|---|---|
| A | Low risk | Observed substantial evidence in support of the IC. Evidence considered to be robust. |
| B | Low to medium risk | Reasonable degree of evidence readily available to support the IC. Some areas for further substantiation identified |
| C | Medium to high risk | Limited evidence or gaps in the evidence used to support the IC. A number of areas identified where further substantiation would be appropriate |
| D | High risk | Considered to be insufficient evidence / lack of robust evidence to support the IC. |

**Figure 16: Jacobs final assurance feedback summary on investment cases**

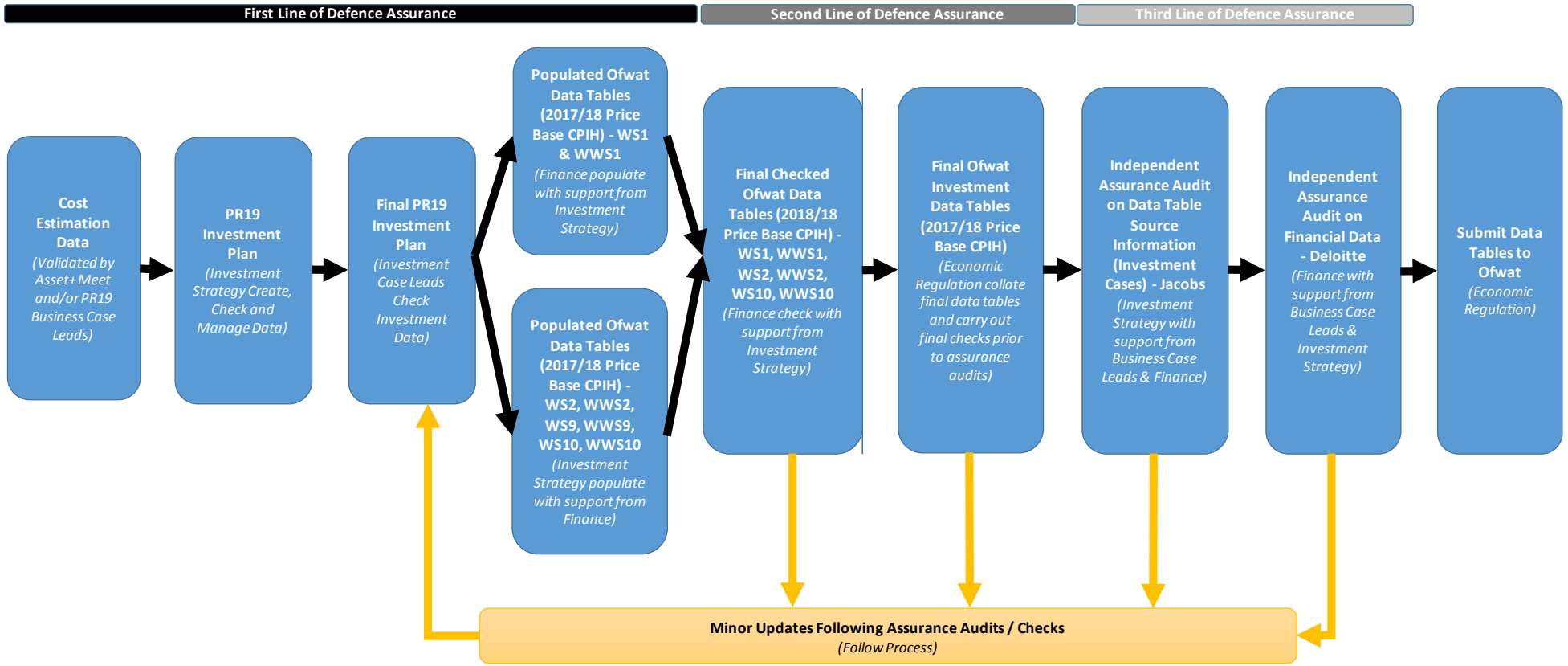


**Figure 17: Diagram illustrating the 1st, 2nd, and 3rd Lines of defence assurance of investment data before submission to Ofwat**