Reckon LLP
Data analysis | Economic regulation | Competition law

December 2017

Water resources annualised unit cost model: explanatory note

Introduction and summary

Through its Water 2020 programme, and its PR19 methodology, Ofwat has been developing a new approach to the regulation of incumbent water companies' water resources activities. This is intended, in part, to support and accommodate the development of bilateral water resource markets in England. Ofwat will introduce a separate control for water resources from 1 April 2020 and will apply a different regulatory approach to post-2020 investment in new water resources. Ofwat is also developing new arrangements for setting access prices for the services required from incumbents by third party providers of water resources in bilateral markets.

In this context, Ofwat identified the need for a new cost measure to be developed for water resources. This is a measure of the annualised unit cost of post-2020 water resources capacity. It is a bespoke measure of the unit costs of water resources, intended specifically for use in Ofwat's regulatory framework.

In the light of stakeholder responses to Ofwat's PR19 draft methodology, which raised concerns about consistency and sought greater clarity on annualised unit costs, Ofwat asked Reckon to develop an illustrative model to show how a measure of the annualised unit costs of post-2020 water resource capacity could be calculated. This calculation needs to be compatible with the new water resources control and Ofwat's planned access pricing arrangements.

The model we have developed[1] is intended as an example of a tool that could help incumbents calculate the annualised unit cost estimates required by Ofwat for their PR19 business plans.

As far as we are aware, our model presents the first published attempt at specifying the calculation of a unit cost measure of post-2020 water resource capacity for use in Ofwat's PR19 water resources control and future access pricing arrangements. It is a step forward but not the end point. It should be treated as a starting point and a basis for future development. We have benefitted substantially from review and feedback from Ofwat, but we have not had opportunity to test and refine the approach with water companies or other stakeholders.

[1] Reckon LLP, '*Water resources annualised unit cost model*', December 2017.

This document is structured into four main sections:

- First, we provide background information on the role of the unit cost measure required by Ofwat.
- Second, we introduce the illustrative Excel model we have developed for the calculation of the annualised unit costs for post-2020 water resource capacity, and provide guidance on the input data required and calculation steps.
- Third, we describe an illustrative example of the application of the model. We have pre-populated the model with illustrative input data for this example.
- Fourth, we highlight some of the limitations of the illustrative model and identify opportunities for extension and refinement in the future.

1. Background to the unit cost measure

Ofwat has identified the need for a new annualised unit cost measure to be developed for an incumbent's post-2020 water resource capacity in a specific water resource zone (WRZ). This would play two roles:

- **In-period adjustment for bilateral market entry**. Ofwat plans to include an in-period adjustment mechanism for bilateral market entry, as part of the water resources control from 1 April 2020. The mechanism will mean that the total regulated revenue allowance for an incumbent's water resource activities would adjust according to the degree (if any) of entry to bilateral water resource markets in the WRZs it supplies. The adjustment will help protect those customers remaining with the incumbent from paying additional money to compensate it for the effects of new entry in these markets. A measure of the unit cost of the incumbent's post-2020 water resources capacity will be a key input to the calculation of the adjustment.
- **Water resources access pricing arrangements**. In the context of bilateral markets for water resources, the access pricing arrangements are regulatory rules that govern the charges for certain services provided by incumbents which will enable retailers to supply non-household customers using raw water provided by a third party. The need for a new access pricing regime for English incumbents has arisen from the Water Act 2014. Ofwat's approach is still under development, but a key feature of it is the introduction of equalisation payments, which would provide a discount against the cost-based charges for services that third parties may require from incumbents (e.g. charges for the use of the incumbent's distribution system and its treatment facilities). A measure of the annualised unit cost of post-2020 water resource capacity would be used as part of the calculation of the equalisation payment and is intended to provide a cost benchmark against which a third party could compete on an equivalent footing.

For further information on these issues see sections 4.5 and 4.2 respectively of Appendix 5 to Ofwat's consultation on its PR19 methodology,[2] and the corresponding appendix published alongside Ofwat's final PR19 methodology.

There is no existing unit cost measure suitable for the two roles above within either Ofwat's regulatory reporting arrangements for incumbents or their water resource management plans (WRMPs). Figure 1 provides a brief comparison between the annualised unit cost measure for post-2020 capacity now needed by Ofwat and two more established measures of water resources unit cost that are used as part of the WRMP processes in England and Wales: the average incremental cost (AIC) and the average incremental (and) social cost (AISC). Ofwat said previously that it did not expect these measures to be easily applicable to its access pricing arrangements.[3]

Figure 1 Comparison against AIC and AISC cost measures

The AISC measure takes account not only of the financial cost incurred by a water company to develop and operate a water resource scheme, which form part of the AIC, but also wider social costs and benefits (e.g. carbon emissions and amenity benefits). The annualised unit cost of post-2020 water resources capacity is more comparable to the AIC than the AISC, because it too focuses on the financial costs to the company of the water resources and not wider social costs and benefits. Nonetheless, there are key differences between the AIC and the annualised unit cost measure for post-2020 capacity:

- The AIC is not focused on the costs of water resources. The AIC includes costs for activities and assets that may fall within Ofwat's definition of "network plus water" (e.g. water treatment and treated water distribution). The AIC is also calculated for schemes that involve no water resources costs at all (e.g. demand-side initiatives).
- The unit cost measure needed for the bilateral market entry adjustment mechanism is a measure of the unit costs of the cumulative capacity (to date) across all water resource schemes in the WRZ that is developed in the period from 1 April 2020. In contrast, the AIC is defined separately at the level of each individual scheme or option.
- The AIC is a unit cost measure that is defined in terms of the costs per cubic metre of additional water available at the point of entry into the treated water distribution system (water available for use or WAFU). In contrast, the bilateral market adjustment mechanism envisaged by Ofwat would make adjustments according to variations in the water resource capacity (defined by Ofwat as water resource yield). The corresponding unit cost measure needed for the adjustment mechanism is a measure of costs per year per unit of water resource yield, not costs per unit of WAFU.

Despite the points above, we expect there to be considerable overlap between the data and information needed to calculate an annualised unit cost measure for post-2020 water resource capacity and the data needed to calculate AICs across the set of schemes contributing to that capacity.

[2] Ofwat (2017) Delivering Water 2020: consultation on PR19 methodology - Appendix 5: Water resources control.

[3] Ofwat (2016) Water 2020: Our regulatory approach for water and wastewater services in England and Wales, page 147.

2. Illustrative model for unit cost measure

Reckon has worked with Ofwat to prepare an illustrative Excel model for the calculation of the annualised unit costs for post-2020 water resource capacity. This section provides guidance and an explanation of the model. It is organised as follows:

- Model design features.
- Model structure.
- Input data.
- Intermediate calculations.
- Results.

Model design features

Ofwat set out some specific expectations on the annualised unit cost measure for post-2020 water resource capacity in its PR19 draft methodology.[4] We have subsequently worked with Ofwat to further develop the way in which the annualised unit cost measure could be calculated in practice. We set out below the main features of the illustrative cost model we have developed, in terms of the nature of the annualised unit cost measure that it calculates and the model's functionality.

On the scope of costs covered by the unit cost measure:

- These costs only include costs that fall within Ofwat's regulatory definition of water resources, and should exclude any costs attributable to network plus water activities (e.g. water treatment).
- These costs are for water resource schemes which are to be treated as part of the incumbent's post-2020 water resource capacity. The costs of pre-2020 water resource capacity should be excluded.

In terms of the level of granularity for the calculation of the unit cost measure:

- It is calculated separately for each WRZ. For simplicity, the model covers a single WRZ.
- The cost measure reflects the aggregation of costs for all post-2020 water resource schemes that contribute to the WRZ. It is *not* intended to represent the costs of the "marginal" scheme.

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[4] Ofwat (2017) Delivering Water 2020: consultation on PR19 methodology Appendix 5: Water resources control, pages 28-29.

- The cost measure is calculated separately for each year.

The denominator in the unit cost measure is based on Ofwat's concept of capacity (water resources yield). Depending on the planning scenarios used for WRMP purposes in the WRZ, the water resources yield may be expressed either in terms of dry year annual average (DYAA) capacity only or in terms of both DYAA capacity and dry year critical period (DYCP) capacity.[5] The model allows the cost measure to be calculated using two alternative measures of capacity: cost per unit of capacity on a DYAA basis or cost per unit of capacity on a DYCP basis. However, as a simplification, the model does not allow for post-2020 water resource costs to be allocated between both dimensions of capacity (see section 4).

On the calculation of annualised costs, we highlight the following features of the model:

- The model allows for input data on schemes that may become operational at any stage over a 25-year period, which is consistent with the minimum timeframe for water resource management planning. This does not mean that all input data need to be completed for the full 25-year period. If unit cost measures are only needed for, say, the first five years, then the only input data needed are for schemes that become operational during that five-year period.

- The cost measure is "annualised" in the sense that it involves an annualisation of the costs of any upfront capital investment that forms part of the scheme. The model calculates annualised capital costs using Excel's PMT function, which determines a stream of payments (in this case, annual) that would fully recover a loan to cover the upfront investment, over the life of that investment, taking account of the cost of capital. This calculation is conceptually similar to the way that annual payments would be calculated for a repayment mortgage on a house. This approach to capital costs has been used in cost-based charging models in other regulated sectors such as electricity distribution and telecoms.

- The calculation of the annualised costs for capital assets is completed separately for different categories of capital assets, within each scheme. This allows for differences between different types of assets, such as in the assumed economic life.

- The costs of any upfront capital investment in a scheme only form part of the unit cost measure once the scheme becomes operational. Since there may be costs during the development and construction phase of the scheme, the model incorporates allowances for the financing costs for capital expenditure in the period before it becomes operational.

[5] Ofwat (2017) Delivering Water 2020: consultation on PR19 methodology Appendix 5: Water resources control, Annex 1.

- The model includes the functionality to allow the annualised capital cost of each asset category to change over time at a rate that is above or below the rate of inflation (measured by CPIH). This allows the profile of the unit cost measure calculated at the end of the process to reflect forecast trends in the costs and prices of the underlying capital inputs, which may differ from the general rate of inflation captured by CPIH.

- The cost measure includes an allowance for operating expenditure in each year (including maintenance of assets before the end of assumed asset lives).

Model structure

The Excel spreadsheet has a single worksheet. This is split into several parts, containing input data, intermediate calculations and the final results from the annualised unit cost calculations. Figure 2 provides a high-level overview of the structure of the model as presented in Excel. This shows the five main parts of the model. The distinction between zone-level input data and scheme-level input data reflects the simplification of the model covering a single WRZ. In practice, for companies needing to cover multiple WRZs, it may be the case that some or all of the zone-level inputs are common at the company level.

Figure 2 Overview of model structure

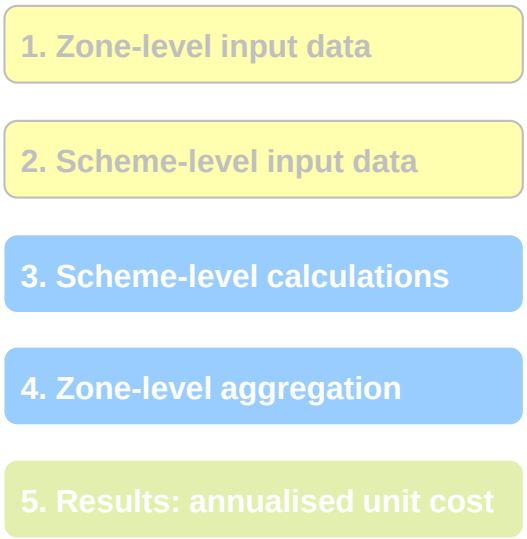
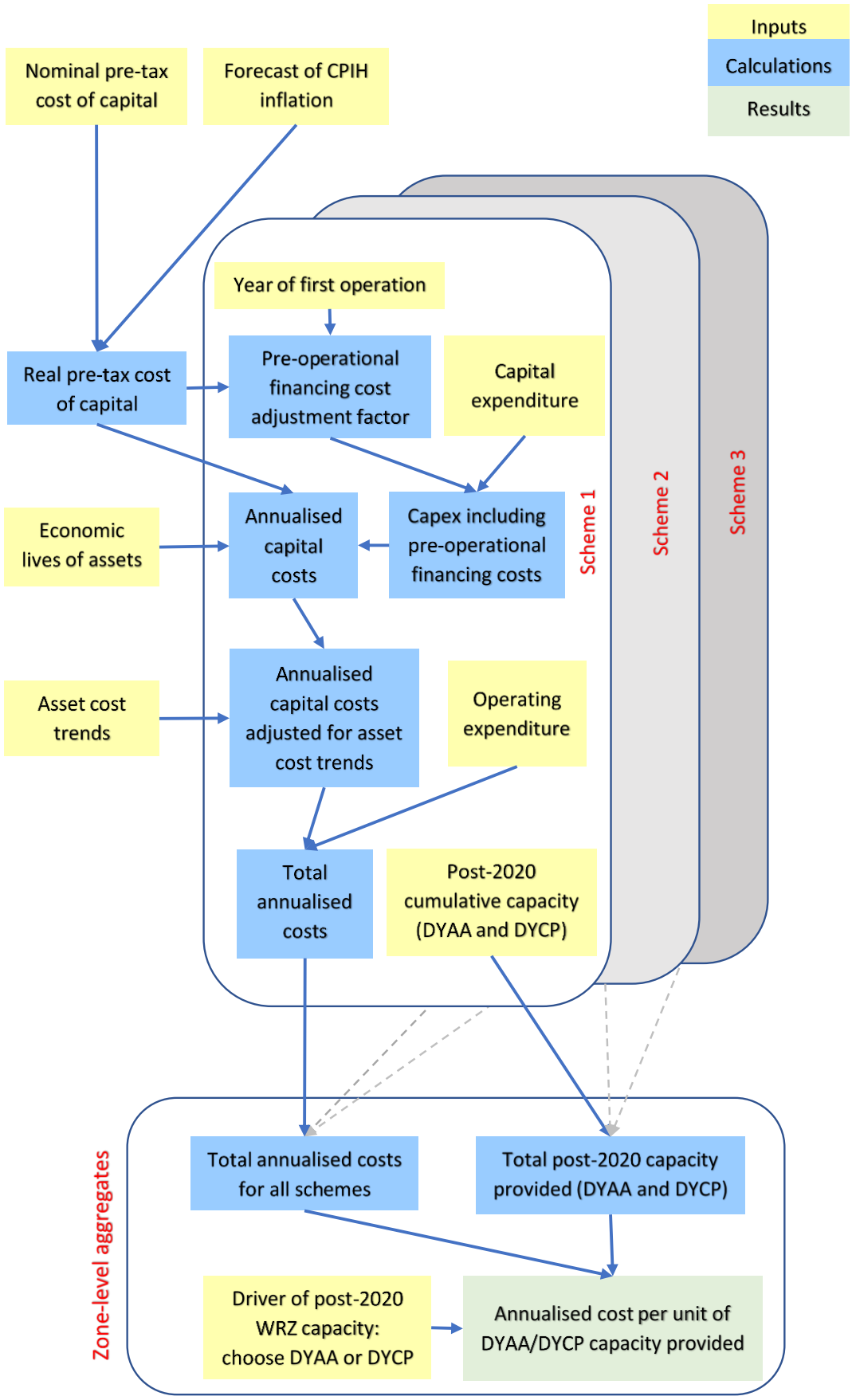


Figure 3 provides a diagram of the calculation flow of the model. It highlights the relationships between the various input data items, intermediate calculations and the main results. It is simplified as it only shows the calculations for one water resource scheme (scheme 1). The illustrative model covers up to three schemes and the calculations for schemes 2 and 3, and their contribution to the zone-level aggregates, work in the same way as for scheme 1 (see grey dashed lines).

Figure 3 Calculation flow



Input data

The input data items required by the illustrative model relate to the capacity provided by post-2020 water resource schemes and various aspects of the costs of these schemes.

Table 1 provides guidance on the common input data items across all post-2020 water resource schemes within the WRZ and Table 2 provides guidance on the scheme-specific items. Some or all of the items in Table 1 may, in practice, be common at the company level for those companies calculating unit costs for multiple WRZs.

In all the explanatory tables in this document, we use bold font to identify references to items that are explained elsewhere in the tables.

Further to the tables, the following are two general explanatory points for the input data:

- All costs should be in 2017-18 prices (the price base for PR19).
- For water resource schemes that involve the creation of new capacity in stages, through multiple development phases, each phase should be treated as a separate scheme in the model if there are separately identifiable costs for each phase.

All input data in the model are for illustrative purposes only and no inferences should be drawn from it. See section 3 for an explanation of the illustrative input data that the model is pre-populated with.

Table 1 Input data for parameters that are common across the WRZ

Input data item	Description	Role and further comments
Nominal pre-tax cost of capital	This is the weighted average nominal pre-tax cost of capital (%) for the incumbent's investment in post-2020 water resource capacity. For simplicity, a single value is used for all years.	The cost of capital is used as an input to calculate the element of the annualised unit that reflects the costs of capital assets. It is used to allow for the financing costs of investment over assets' lifetime and to allow for the additional financing costs in any period between expenditure first being incurred on a scheme and the scheme becoming operational.
Forecast of CPIH inflation	This is the forecast of the annual rate of CPIH inflation (%). For simplicity, a single value for forecast CPIH inflation is used for all years.	In the model, CPIH is used to convert the nominal pre-tax cost of capital to a real pre-tax cost of capital (relative to CPIH) and to provide a reference point against which cost inflation for capital inputs are considered. Ofwat's PR19 draft methodology proposed to move away from indexing price controls to the RPI, and to use CPIH as the core measure of general price inflation.

Input data item	Description	Role and further comments
		The model is specified to use input data in constant prices (2017-18 prices) and draws on forecasts of CPIH to produce estimates of unit costs in nominal terms.
Asset category definitions	This allows for the definition of up to seven different categories of capital asset types to be used in the model. For example, there might be separate categories for land, various types of civil engineering assets and various types of mechanical and electrical assets.	Separate assumptions on asset lives and asset cost trends can be made in the model for each of the categories defined.
Economic lives of assets	This is the expected economic life of assets (in years) for each of the defined categories of assets. The asset life assumptions should generally be consistent with those used throughout the company's WRMP and PR19 business plans.	This is used for the annualisation of capital costs. The economic life should take account not only of the technical life or asset replacement cycles but also of other factors that may constrain the economic life. For example, if a water resource is only expected to be available for a ten-year period due to abstraction licensing restrictions, the economic life of assets may need to be restricted to ten years.
Asset cost trends (relative to CPIH)	This is the forecast price/cost inflation for each asset category relative to CPIH. For simplicity, the asset cost trend for each asset category is assumed to be the same for all years, representing a long-term trend, rather than varying over time. A positive figure represents an assumption that nominal prices for the asset category will grow at a faster rate than CPIH and a negative figure implies either a slower rate of growth than CPIH or falling nominal prices (asset price deflation).	This is used to calculate a profile over time for capital costs (and hence the annualised unit cost measure) that reflects the expected underling rate of change in prices/costs for the defined asset categories. For example, suppose that there is an asset category for a type of civil engineering asset and that the costs of this type of assets is forecast to grow at a rate of 1% per year faster than CPIH (e.g. an annual rate of 3% nominal growth if CPIH inflation is 2%). In this case, the figure for the input data on the asset cost inflation rate would be 1%. If there is no reason to expect the prices/costs for a particular category of capital assets to grow faster or slower than CPIH, then this input data item can take the value 0%.
Driver of post-2020 water resource requirement in zone	This is a drop-down menu to specify the nature of the requirement (or driver) for post-2020 water resource capacity: whether it is a requirement for additional DYAA capacity or a requirement for additional DYCP capacity.	This is used to determine whether the annualised unit cost measure calculated by the model is a cost per unit of DYAA capacity or a cost per unit of DYCP capacity. The illustrative model does not allow for the more complex scenario where the requirement for water resources in the zone

Input data item	Description	Role and further comments
		is a requirement for both additional DYAA capacity and additional DYCP capacity (in which case the applicable unit cost measure may need to be specified in two dimensions: see section 4).

Table 2 Input data specific to each water resource scheme within the WRZ

Input data item	Description	Role and further comments
Year of first operation	This is used to identify the year in which the scheme (or phase of scheme) is expected to become operational. In the model, year 1 corresponds to 2020-21, year 2 to 2021-22, etc.	This is used as part of the calculations to allow for financing costs of investment incurred in the period before a scheme becomes operational
Post-2020 cumulative capacity (DYAA)	This is the additional capacity (Ml/d, water resource yield) expected to be created by the scheme, in terms of DYAA yield.	This is used as a denominator for the unit cost measure. Where the scheme is an addition to an existing scheme, this should be the additional capacity expected to be created by the addition.
Post-2020 cumulative capacity (DYCP)	This is the additional capacity (Ml/d, water resource yield) expected to be created by the scheme, in terms of DYCP yield.	This is used as a denominator for the unit cost measure. It may be zero if no DYCP scenario is used for the WRZ for WRMP purposes. Where the scheme is an addition to an existing scheme, this should be the additional capacity expected to be created by the addition.
Capital expenditure	This is the total amount of upfront capital expenditure forecast to be incurred to develop or construct the scheme (£000s). The capital expenditure is entered separately for each year and for each asset category.	This is used for the calculation of the capital cost element of the unit cost measure. These amounts should only include costs falling within the water resources control. The input data should be expressed in 2017-18 prices. If the available capital expenditure forecasts are in nominal prices, then these should be deflated to 2017-18 prices, using a deflation rate representing the combined effect of the **forecast of CPIH inflation** and the **asset cost trends (relative to CPIH)**. This should only include expenditure up to the point at which the scheme is operational (any subsequent phase of expenditure to extend capacity should be treated as a

Input data item	Description	Role and further comments
		separate scheme in the model). These amounts should not include any expenditure to maintain assets for which the upfront cost has already been included. The costs of future asset replacement at the end of the assumed asset life are automatically allowed for as part of the calculation of the annualised capital costs for each year, which are rolled forward beyond the assumed asset life.
Operating expenditure	This is the total amount of operating expenditure forecast to be incurred for the scheme during each year of its operation (£000s).	This is used for the calculation of the operating cost element of the unit cost measure. These amounts should only include costs falling within the water resources control. The input data should represent a forecast of nominal operating expenditure in future years (taking account of input price trends and efficiency gains over time), deflated by the **forecast of CPIH inflation** only. Any expectations of increases in operating expenditure at a faster or slower rate than CPIH should be reflected in the input data. The total operating expenditure for a scheme might be seen to comprise a fixed element and a variable element, with the former reflecting operating expenditure driven by asset size/capacity and the latter driven by the volume of water produced by the scheme. If so, then, to produce a forecast of the variable element of operating expenditure in a future year may require consideration of operating expenditure for different scenarios for that year (e.g. the volumes of raw water produced and the associated variable costs may be greater in dry years) and calculation of a weighted average which reflects the probability of each such scenario.

Intermediate calculations

The calculations in the illustrative model are structured in three parts. First, a set of initial calculations is carried out at the level of each individual post-2020 water resource scheme within the WRZ. This produces an estimate of the annualised total cost for each scheme in the WRZ. Second, intermediate calculations are carried out at the level of the WRZ, which involve the aggregation of annualised costs and of capacity across all the post-2020 schemes within the WRZ.

Third, the final results from the model, representing estimates of the annualised unit costs of post-2020 capacity for the WRZ, are calculated from the zone-level aggregations. We elaborate on the first and second parts in Table 3 and Table 4, before turning to the calculation of the results.

Table 3 Calculation of annualised total costs for each scheme

Stage of calculation	Guidance and comments
Real pre-tax cost of capital	This is calculated by deducting the **forecast CPIH inflation** from the **nominal pre-tax cost of capital**.
Adjustment factor for pre-operational financing costs	This factor is calculated separately for each year, and used to make an allowance for financing costs for investment carried out in years before the scheme is operational. The calculation of the adjustment factor for a specific year takes account of the **real pre-tax cost of capital** and the time period between that year and the **year of first operation**.
Capex including pre-operational financing costs	For each asset category, the capex, including pre-operational financing costs, is calculated by applying the **adjustment for pre-operational financing costs** to the series of **capital expenditure** for that asset category. This reflects the costs of all capital expenditure incurred up to and including the year in which the scheme is expected to become operational. It includes an allowance for the financing costs for the capital expenditure incurred in years before the scheme becomes operational.
Annualised capital costs	The model calculates an annualised capital cost for each asset category, using Excel's PMT function. This function determines a stream of payments (in this case, annual) that would fully recover a loan to cover the upfront investment (in this case, the upfront **capex adjusted for pre-operational financing costs**), taking account of the applicable interest rate and the time period over which the loan is to be recovered (based on the **economic lives of the assets**). The model uses the **real pre-tax cost of capital** for the interest rate but, for each asset category, adjusts this to deduct the assumed **asset cost trends (relative to CPIH)**. This adjustment is done to avoid double counting when the annualised cost is extrapolated over time in the subsequent calculation step. Because the input data used for the cost of capital are on a pre-tax rather than post-tax basis, the annualised capital cost calculation will include an allowance for the corporation tax liabilities on the profits attributable to the financing of the upfront investment costs.
Annualised capital costs adjusted for asset cost trends	The model calculates an annualised capital costs (adjusted for asset cost trends) for each asset category in each year by taking the **annualised capital costs** calculated above and extrapolating these over time, using forecast **asset cost trends (relative to CPIH)**. For instance, if the costs of certain civil engineering assets are forecast to grow at a rate of CPIH plus 1% per year, then the 1% per year uplift factor is applied to extrapolate the annualised capital cost over the time period covered by the model. This adjustment allows the profile of the annualised unit cost calculated at the end of the process to reflect forecast trends in asset costs/prices (relative to CPIH). This calculation is completed separately for each year.

Stage of calculation	Guidance and comments
Total annualised costs	The total annualised costs for each scheme are calculated by aggregating the **annualised capital costs** across the different asset categories and then adding in the forecast **operating expenditure**. This calculation is completed separately for each year.

Table 4 Aggregation across post-2020 schemes in the WRZ

Stage of calculation	Guidance and comments
Total annualised costs for all post-2020 water resource schemes in the zone	The total annualised costs for post-2020 capacity are calculated by taking the aggregate of the **total annualised cost** for each scheme, drawing on the scheme-level calculations above. This calculation is completed separately for each year.
Post-2020 DYAA capacity provided	The post-2020 DYAA capacity provided is calculated by summing across the **Post-2020 cumulative capacity (DYAA)** provided for each scheme. This calculation is completed separately for each year.
Post-2020 DYCP capacity provided	The post-2020 DYCP capacity provided is calculated by summing across the **Post-2020 cumulative capacity (DYCP)** provided for each scheme. This calculation is completed separately for each year.

Model results

The final results from the calculation process are, depending on the selected option for the driver of the post-2020 water resource requirement, either:

- the annualised cost of post-2020 water resource capacity in the zone, per unit of DYAA capacity provided (in £000s per year per Ml/d of DYAA capacity); or
- the annualised cost of post-2020 water resource capacity in the zone, per unit of DYCP capacity provided (in £000s per year per Ml/d of DYCP capacity).

The annualised unit costs are reported in both 2017-18 prices and in forecast nominal prices (which shows how costs are expected to evolve over time after allowing for forecast CPIH inflation). We describe these calculations in Table 5.

The annualised unit cost is calculated separately for each year. The unit cost in 2017-18 prices will vary from year to year, depending on: the set of schemes which are operational in each year (the capital costs of schemes only feed into the unit cost measure when they become operational); any variations over time in the operating expenditure across schemes in the zone; the forecast rate of

change in asset prices/costs relative to CPIH; and any variations in the measure of capacity used as the denominator for the unit cost measure. The variations over time in the annualised unit cost in nominal prices will reflect these factors as well as the forecast rate of CPIH inflation.

Table 5 Model results: annualised unit cost at the level of the WRZ

Result	Guidance and comments
Annualised cost of post-2020 water resources per unit of DYAA capacity provided (2017-18 prices – deflated by CPIH)	If the input data item for the **driver of the post-2020 capacity requirement in the zone** has been set to "DYAA", the annualised unit cost on a DYAA basis (in 2017-18 prices) is calculated by taking **the total annualised costs** for all post-2020 water resource schemes in the zone and dividing this by the **post-2020 DYAA capacity** provided in the zone. This calculation is done separately for each year. If the input data item for the **driver of the post-2020 capacity requirement in the** zone has been set to "DYCP", no result is reported here.
Annualised cost of post-2020 water resources per unit of DYCP capacity provided (2017-18 prices – deflated by CPIH)	If the input data item for the **driver of the post-2020 capacity requirement in the zone** has been set to "DYCP", the annualised unit cost on a DYCP basis (in 2017-18 prices) is calculated by taking the **total annualised costs** for all post-2020 water resource schemes in the zone and dividing this by the **post-2020 DYCP capacity provided** in the zone. This calculation is done separately for each year. If the input data item for the **driver of the post-2020 capacity requirement in the zone** has been set to "DYAA", no result is reported here.
Annualised cost of post-2020 water resources per unit of DYAA capacity provided (forecast nominal prices)	The annualised cost of post-2020 water resources per unit of DYAA capacity provided in (forecast) nominal prices is calculating by combining the **forecast of CPIH inflation** rate with the **annualised cost of post-2020 water resources per unit of DYAA capacity provided (2017-18 prices – deflated by CPIH)**.
Annualised cost of post-2020 water resources per unit of DYCP capacity provided (forecast nominal prices)	The annualised cost of post-2020 water resources per unit of DYCP capacity provided in (forecast) nominal prices is calculating by combining the **forecast of CPIH inflation** rate with the **annualised cost of post-2020 water resources per unit of DYCP capacity provided (2017-18 prices – deflated by CPIH)**.

3. Example application of the model

To help illustrate the approach to the calculation of the annualised unit cost measure we have pre-populated the model with illustrative input data for two hypothetical schemes that deliver post-2020 water resource capacity to a WRZ. These example schemes were provided by Ofwat, drawing in part on examples from past WRMPs. In Figure 4 we provide an overview of the schemes and summarise the application of the illustrative model to calculate the annualised unit costs. The full set of assumptions on the input data for the schemes, covering items such as operating and capital expenditure, asset lives, the cost of capital and input price trends, is provided in the model.

For the avoidance of doubt, all input data and results are for illustrative purposes only and should not be taken to reflect the views of either Reckon LLP or Ofwat.

Figure 4 Key features of illustrative water resource schemes and modelling results

Scheme 1: development of a borehole source to pump groundwater into an existing impounding reservoir

- Capital costs include development of a borehole pumping station and transfer pipeline.
- Operating expenditure relates principally to pumping costs. The operating expenditure input data reflect forecast requirements over the remainder of the 25-year planning period, following installation of the capacity. Variable operating expenditure is based upon a probability-weighted average of flows over this period.
- All of the scheme's costs are within the water resources control.
- The scheme provides a water resource capacity of 2 Ml/d (DYAA).
- The scheme is constructed in year 1 of the planning period and the first year of scheme operation is year 2 of the planning period.

Scheme 2: extension of an impounding reservoir to increase available capacity

- Capital costs include extension of an impounding reservoir to increase available capacity.
- Operating expenditure reflects forecast requirements over the remainder of the 25-year planning period following installation of the capacity. Variable operating expenditure is based upon a probability-weighted average of flows over this period.
- All of the scheme's costs are within the water resources control.
- The scheme provides a water resource capacity of 10 Ml/d (DYAA).
- The scheme is constructed in years 2, 3 and 4 of the planning period, and the first year of scheme operation is year 5.

Model results

The model calculates annualised costs for each scheme in the WRZ and annualised unit costs for the WRZ as a whole. These costs are calculated separately for each year.

Taking the year 2024-25 as an example:

- The total annualised costs for scheme 1 are calculated as £111,388 per year to provide post-2020 DYAA capacity of 2 Ml/d.
- The total annualised costs for scheme 2 are calculated as £196,534 per year to provide post-2020 DYAA capacity of 10 Ml/d.
- The total annualised costs for the WRZ as a whole are £307,922 per year to provide post-2020 DYAA capacity of 12 Ml/d. This is the sum of the two annualised costs above.

- The annualised unit cost of new post-2020 water resource capacity in the WRZ is **£25,660** per year per Ml/d of DYAA capacity (2017-18 prices). This is calculated as the total annualised cost of £307,922 divided by the total DYAA capacity provided (12 Ml/d).

The results in the model show the profile of the annualised unit cost measure over time. In the example, the calculated annualised unit cost is higher in the period before scheme 2 becomes operational. In that period it reflects only the unit costs of scheme 1, which are relatively high per Ml/d of DYAA capacity compared to scheme 2. Scheme 2 is a lower-cost scheme which takes longer to deliver than scheme 1; scheme 1 has the benefit of a relatively short delivery time which might be desirable in some cases (e.g. where there are reductions in abstraction licences or deterioration of sources).

4: Potential modelling extensions

This final section identifies areas where the modelling approach could be extended. It is not required to understand how the illustrative model works.

The illustrative model we have developed is a beta version. It is intended as an example of an approach to calculating annualised unit costs and the aim was to keep it relatively simple so as to provide all potential users with a clearer understanding of the concepts involved. It provides a basis for future development.

We have identified a number of specific limitations of the illustrative model and potential areas for refinement and extension in the future. These relate to the following:

- Wider user testing.
- WRZs requiring more schemes.
- Requirements for DYAA and DYCP capacity.
- Input data on the cost of capital, forecast CPIH and asset cost trends.
- Capacity provided versus capacity required.
- Corporation tax.

We discuss each point in turn below. These items are not intended to be comprehensive.

Wider user testing

The illustrative model was developed relatively quickly and, while it has benefitted from testing by Ofwat, it has not been tested more widely by water companies or other stakeholders.

Wider testing of the illustrative model is likely to improve the model and the approach and identify further potential improvements.

WRZs requiring more schemes

The illustrative model only provides calculations for a single WRZ. It would be straightforward to extend the model to cover additional WRZs; this could be implemented through duplicate worksheets. The model only allows for three schemes that provide post-2020 capacity in the WRZ. The input data and calculations may need to be extended if a company is planning more than three water resources schemes in the same WRZ.

Requirements for DYAA and DYCP capacity

The illustrative model allows for the scenario in which the requirement for post-2020 capacity is only in respect of DYAA capacity or for the scenario in which it is only in respect of DYCP capacity.

To keep the illustrative model relatively simple we agreed with Ofwat to exclude the functionality to accommodate the scenario in which post-2020 water resource capacity in a WRZ is driven by a requirement for additional DYAA capacity and additional DYCP capacity. In the latter scenario, we think that the annualised unit cost measure should be calculated in both dimensions of capacity and involve an allocation of costs between them. This would reflect the idea that costs may be partly driven by DYAA requirements and partly driven by DYCP requirements and not wholly attributable to either of them. Implementing such an allocation is not straightforward, partly because, in some (perhaps most) cases, DYCP capacity would also contribute to DYAA capacity, and vice versa, and there are consequent risks of double counting.

Input data on the cost of capital, forecast CPIH and asset cost trends

The model includes a single input data item for the pre-tax cost of capital input, which is taken to apply to all years. This was done to help simplify the model. In practice, the cost of capital may vary over the time period covered by the model, due to factors such as the variation over time in yields in corporate debt markets that arise from central bank interventions. The model could be amended so that the forecast cost of capital is a separate input data item for each year covered by the model.

A similar point applies to the input data for forecast CPIH and asset cost trends (relative to CPH). The model uses a single input data item for all years but the model could be extended to allow these forecasts and assumptions to vary over the time period covered by the model.

Capacity provided versus capacity required

The illustrative model calculates a measure of the cost of post-2020 water resource capacity, per unit of post-2020 capacity provided. An alternative measure could be the cost per unit of post-2020 capacity required, or something that represents an approximation of this. The need for post-2020 capacity will reflect a range of factors, such as forecast demand and the capacity of pre-2020 water resources.

Suppose that the annualised cost of a company's post-2020 water resource capacity was £1,000 and this provided 100 units of DYAA capacity. The cost per unit of DYAA capacity would be £10. Now suppose that demand and available pre-2020 capacity mean that only 80 units of post-2020 capacity are actually needed in the WRZ. The cost of post-2020 capacity per unit capacity required would be £12.50. If the company were to recover its costs from charges for the 80 units of capacity that are actually required, it would need to charge £12.50 per unit.

Particularly if the unit cost measure is to be used for equalisation payments, the cost per unit of capacity required seems a more relevant measure than the cost per unit of capacity provided. For instance, the relative efficiency of an incumbent's post-2020 capacity may be over-stated if it is to be compared against third parties on the basis of the cost per unit of capacity provided, ignoring the costs of capacity that is provided but not actually needed in full over the relevant timeframe.

In agreement with Ofwat, the illustrative model focuses on the cost per unit of capacity provided, so as to limit the complexity of the model and due to the lack of an established measure of the demand for, or need for, post-2020 water resource capacity. For example, in WRMPs water resources options are measured in terms of their contribution of available water to WAFU, which is more closely related to the forecast demand requirements.

If such a measure was developed, the model could be extended to apply an adjustment factor to apply to the cost per unit of capacity provided (at the WRZ level). In the simple example above, the adjustment factor could be calculated as 100/80 = 1.25 which could be applied to adjust the unit cost from £10 to £12.50. In practice, it may be appropriate for any adjustment to be made in a way that takes an average across a number of years (so that the calculated unit cost is less sensitive to timing issues associated with lumpiness in investments).

This is an area that will need further consideration as bilateral market arrangements are developed.

Corporation tax

The illustrative model makes allowances for estimated corporation tax liabilities through the pre-tax cost of capital, which feeds into the calculation of the annualised capital costs. There may be some inaccuracy from using this approach, compared to an alternative approach involving a more explicit calculation of the corporation tax liabilities relating to profit on investment in capital assets (e.g. as

used in Ofwat's price control financial models and based on estimates of applicable capital allowances).

The pre-tax approach is used for the illustrative model because it is much simpler (the tax element of price control financial models tends to be particularly complex).

The illustrative model could be adapted to allow for an explicit calculation of the corporation tax liabilities, which could then be combined with input data on the post-tax rather than pre-tax cost of capital. A method may then be needed to allocate the corporation tax liabilities appropriately over time to avoid fluctuations in the profile of the unit cost measure. This more explicit approach to corporation tax liabilities would add substantial additional complexity and there is an open question over whether it would be proportionate.