# Aquarius 3 financial model rule book

January 2006 version

A technical paper

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Appendices

## LIST OF FLOWCHARTS

# 1 Introduction

1.1 This rule book explains the principles adopted in the financial model (Aquarius 3) that we use to determine price limits for water and sewerage services.

1.2 This version of Aquarius 3 (released in January 2006) is based on the methodology for the price review in 2004 as set out in 'Setting water and sewerage price limits for 2005-10: framework and approach'.[1] It has been extended to examine possible price limits beyond the current review period.

1.3 This rule book details the inputs and outputs of Aquarius 3 and describes the calculations performed. It does not explain how the input values are derived. For example, any assumptions about costs of meeting EC quality directives or the scope for efficiency improvements are derived outside Aquarius 3. Nor does this paper discuss the scenarios or sensitivities which we may perform.

1.4 The principles and logic outlined in this document are applicable to all companies. The calculations in Aquarius 3 are generic, only the input values are company specific.

1.5 RSM Robson Rhodes, a firm of chartered accountants, completed an independent audit of the May 2003 version of Aquarius 3 to ensure that it was fit for purpose, where:

- It is in accordance with generally accepted accounting principles (UK GAAP), our regulatory accounting guidelines (RAGs) and known tax regulations as at April 2003; and
- It complies with our methodology for the 2004 review.

1.6 There have been changes to the model since the 2004 price review. These were required to undertake research into possible future price limits over the next 25 years – the "Water Industry Forward Look" project. The differences do not affect the underlying approach to setting price limits, and are described in section 2.

[1] Published in March 2003 and henceforth referred to as 'Setting water and sewerage price limits for 2005-10'

## 2 Aquarius 3

2.1 Aquarius 3 has been developed to support the price setting process for the 2004 price review and beyond.

2.2 It comprises two spreadsheet models linked by a database and graphical user interface. The two models are the:

- Tariff basket model; and
- Financial model.

2.3 The structure of Aquarius 3 is shown in flowchart F0. The equations in the financial model do not link directly to the equations in the tariff basket model. The financial model retrieves the information it needs from the database once the tariff basket model has been run and a revenue dataset created.

2.4 This version of the model (released in January 2006) is based on the methodology for the price review in 2004 as set out in 'Setting water and sewerage price limits for 2005-10: framework and approach'.

2.5 The November 2004 version of the financial model was used to determine price limits for 2005-10.

2.6 This latest version of the model is a development of that which was used to model the price limits for 2005-10. It incorporates modifications to permit interim determinations of K (IDoKs) to be reflected more accurately, and extended to calculate price limits over a longer period (25 years).

2.7 Although there have been substantial changes to the system to improve the speed and efficiency of calculation over this extended period, the underlying logic is substantially unchanged. The two major exceptions to this are that:

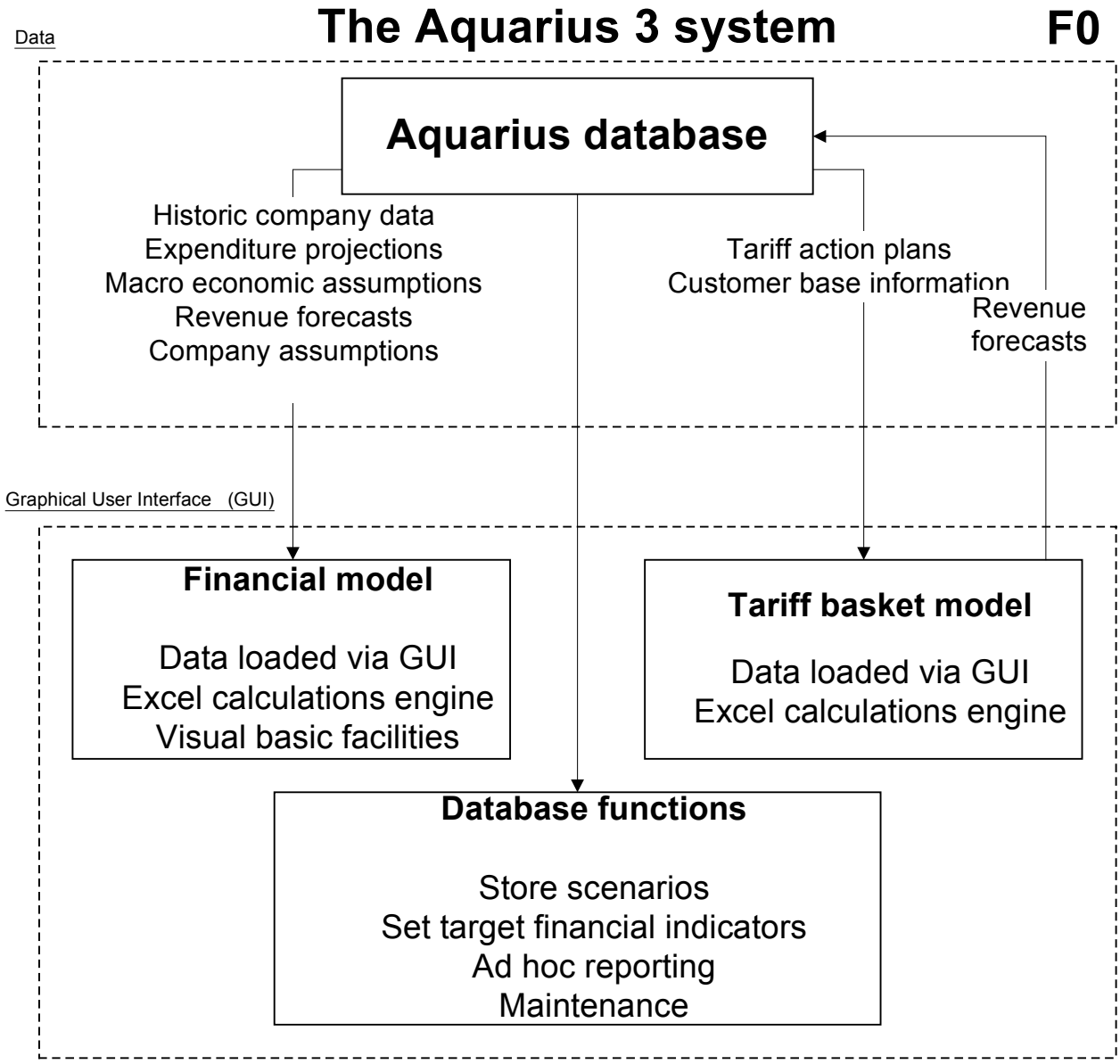
- In the extended "forward look" model, the depreciation adjustment (F7) has been removed and replaced with an input; and
- Efficiencies (F4) have been amended to reflect a succession of 5 year reviews during the 25 year range. These changes are detailed in the relevant sections.

2.8 The format of data inputs are described in this document in terms of the data submissions we used in the 2004 price review. These are 'PR04 Business plan information requirements[2] and the June Returns 2003 and 2004[3].

2.9 The remainder of this document provides an outline of the principles adopted with flowcharts to illustrate the logic. The flowcharts are cross referenced where appropriate.

[2] PR04 Business Plan Information Requirements, volumes 1 and 2 published January 2004.
[3] June Return Reporting Requirements, published December 2003.

2.10 Section 3 of this document explains the tariff basket model. Sections 4 to 18 explain the financial model. The flowchart numbering in this updated rulebook differs from previous versions as an additional flowchart has been inserted. The section numbering in the "forward look" model is consistent with this rulebook.


The Aquarius 3 system
F0
Data
Aquarius database
Historic company data
Expenditure projections
Macro economic assumptions
Revenue forecasts
Company assumptions
Tariff action plans
Customer base information
Revenue forecasts
Graphical User Interface (GUI)
Financial model
Data loaded via GUI
Excel calculations engine
Visual basic facilities
Tariff basket model
Data loaded via GUI
Excel calculations engine
Database functions
Store scenarios
Set target financial indicators
Ad hoc reporting
Maintenance

## 3 Tariff basket model

3.1 At the 1999 periodic review this model was represented by a set of linked Microsoft Excel 97 spreadsheets. For the 2004 periodic review, the spreadsheets were combined into one spreadsheet model which forms part of the Aquarius 3 financial model.

3.2 The primary purpose of the tariff basket model is to generate forecast revenue streams that are consistent with licence condition B for use in the financial modelling of price limits.

3.3 The principal outputs from the tariff basket model are:

- Forecast tariff basket revenue streams; and
- Forecast non-tariff basket revenue streams.

3.4 The data used in the tariff basket model is taken from the companies' tariff action plans which are provided in Part C of the PR04 business plan submissions. All inputs to the tariff basket model are collected in Tables C19 to C27 of the PR04 business plan and are entered in the Input worksheet of the tariff basket model.

3.5 The main functions of the tariff basket model are illustrated in flowchart F1. These functions:

- Reproduce the tariff action plan tables in the PR04 business plan;
- Replicate the arithmetic of licence condition B;
- Check that the household tariff differential constraint is satisfied for each year from the start of the review period;
- Check that the input tariffs are based on an assumption of K=0 for each year from the start of the review period;
- Produce tariff basket and non-tariff basket revenue streams for use by the financial model; and
- Run sensitivities on key assumptions in the tariff basket model.

3.6 The tariff action plan tables are created from the input data. When sensitivities are run, the assumptions are also reflected in the tariff action plans.

3.7 The tariff basket calculations replicate the arithmetic set out in licence condition B and perform the checks on the household differential and K=0 assumption for each year in the five year review period and the following five year period. Where the check criteria are not satisfied the model automatically recalculates the unmeasured rateable value (RV) poundage rates and the measured volumetric rates such that the constraints required are met. The values for the three years prior to the review period are based on the actual tariffs.

3.8 The algebra for the tariff basket calculations is set out in appendix A.

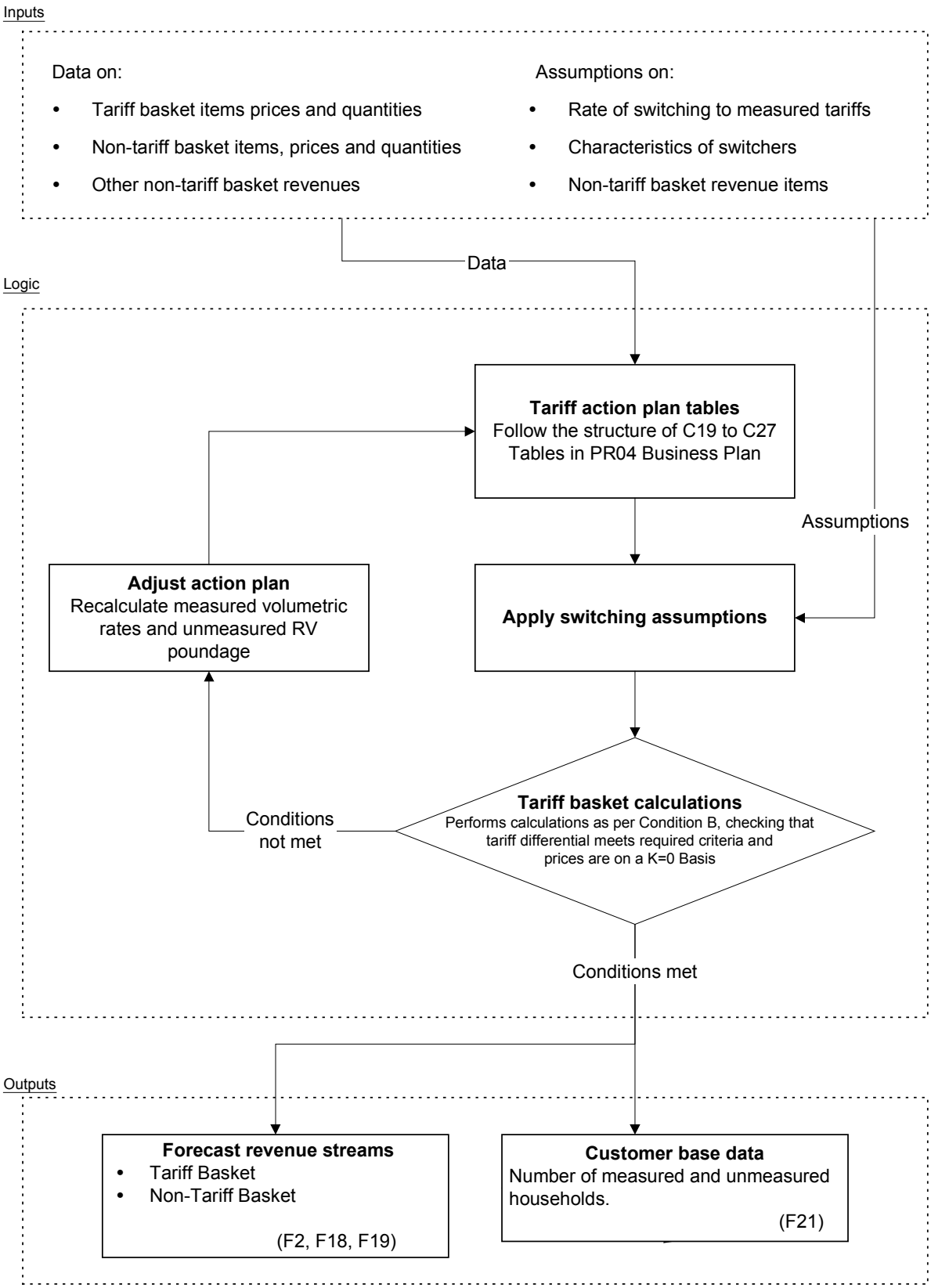
3.9 The tariff basket model allows the user to run sensitivities on key assumptions. This enables a user to vary the values for the following tariff basket and non-tariff basket items:

- Rate of switching
- RV of switchers
- Demand characteristic
- Demand reduction
- Large user revenues - water
- Large user unit price - water
- Water delivered to large users
- Measured non-household water delivered
- Revenues from special agreements - water
- Revenues from bulk supplies
- Large user revenues - sewerage
- Large user unit price - sewerage
- Sewage collected from large users
- Large user revenues – trade effluent
- Large user trade effluent volumes
- Large user trade effluent COD loads
- Large user trade effluent SS loads
- Measured non-household sewage collected
- Measured non-household trade effluent volumes
- Measured non-household trade effluent COD loads
- Measured non-household trade effluent SS loads
- Revenues from special agreements – sewerage
- Revenues from special agreements – trade effluent

3.10 The forecast revenue streams and a specified sub-group of household tariff items are saved as revenue assumptions and go forward into the financial model via the Aquarius 3 database.

3.11 For this release of Aquarius, the tariff basket model has been extended to calculate revenue streams over a 25 year period.

# Tariff basket model F1



## 4 Financial model overview

4.1 The regular financial model calculates K factors for the review period and a further five years. This "forward look" version calculates for a further 20 years. It produces financial statements covering a 28 year period (including the base year) for the given set of inputs (the regular model covers a period of 13 years).

4.2 These inputs can be categorised as base year position, investment/expenditure projections, capital investment assumptions from the previous final determination, revenue forecasts and financial assumptions. Appendix B provides full details of the financial model inputs.

Base year

4.3 The base year is 3 years before the first review period (this was the year ended 31 March 2003 for the 2004 price review). The financial statements for the base year are taken from data input to the model. Our source for this data is the June return, although we may modify the opening position. We notify companies of any adjustments we make to their June return data when establishing the base position.

Principles

4.4 The general principle of setting price limits is that charges to customers are sufficient to allow the company to operate its existing assets, fund new obligations and provide a reasonable return on equity and debt capital. The financial model calculates the costs of running the business (the revenue requirement) and the expected turnover (based on the revenue streams produced by the tariff basket model) in each year. The revenue requirement identifies the total amount of revenue that needs to be raised from customers in each year in order for the company to finance its functions. Section 5 explains the revenue requirement in more detail.

4.5 The financial model determines the year specific K factor which will match the tariff basket revenue stream with the revenue requirement (net of the non-tariff basket revenue streams). This produces an initial K factor for each year which ensures that the companies earn the required rate of return. The model allows the user to make adjustments to the opening balance sheet. It also provides a check to ensure that the resultant financial projection is financeable and suggests new K profiles to rectify unacceptable levels within each financial indicator. The user is required to enter the required K profile. When the K profile is revised, the financial statements are recalculated accordingly. The overall performance adjustment is applied to the revised K profile.

4.6 The K factors determined may include a weighted average charge increase (WACI) adjustment. The WACI adjustment is an input to the financial model. It does not affect the revenue or financial projections arising from the K including overall service performance adjustment.

4.7 Section 16 explains the initial K calculations and profiling of K factors in more detail.

4.8 The model also calculates indicative Ks for each of the water and sewerage services based on the service specific revenue requirement and tariff basket and non-tariff basket revenue streams.

4.9 Flowchart F2 sets out an overview of our approach to financial modelling.

Inputs

4.10 The majority of the inputs cover the review period, plus the 3 years leading up to it, starting from the base year. However a number of inputs cover a longer period. These are generally those inputs required to calculate the depreciation adjustment (see section 8). There are also some inputs to the financial model that precede the base year. In the "forward look" model, some inputs required to calculate the Infrastructure Renewals Charge (IRC) extend beyond the review period. These items are needed for the calculation of key components in the revenue requirement.

4.11 There are three broad categories of inputs:

- Final determination expectations for capital expenditure from the previous review;
- Historic data (reported actuals taken from the June return or provided in the business plan); and
- Projections (beyond base year);

Price base

4.12 The price base for each of the three broad categories of inputs are:

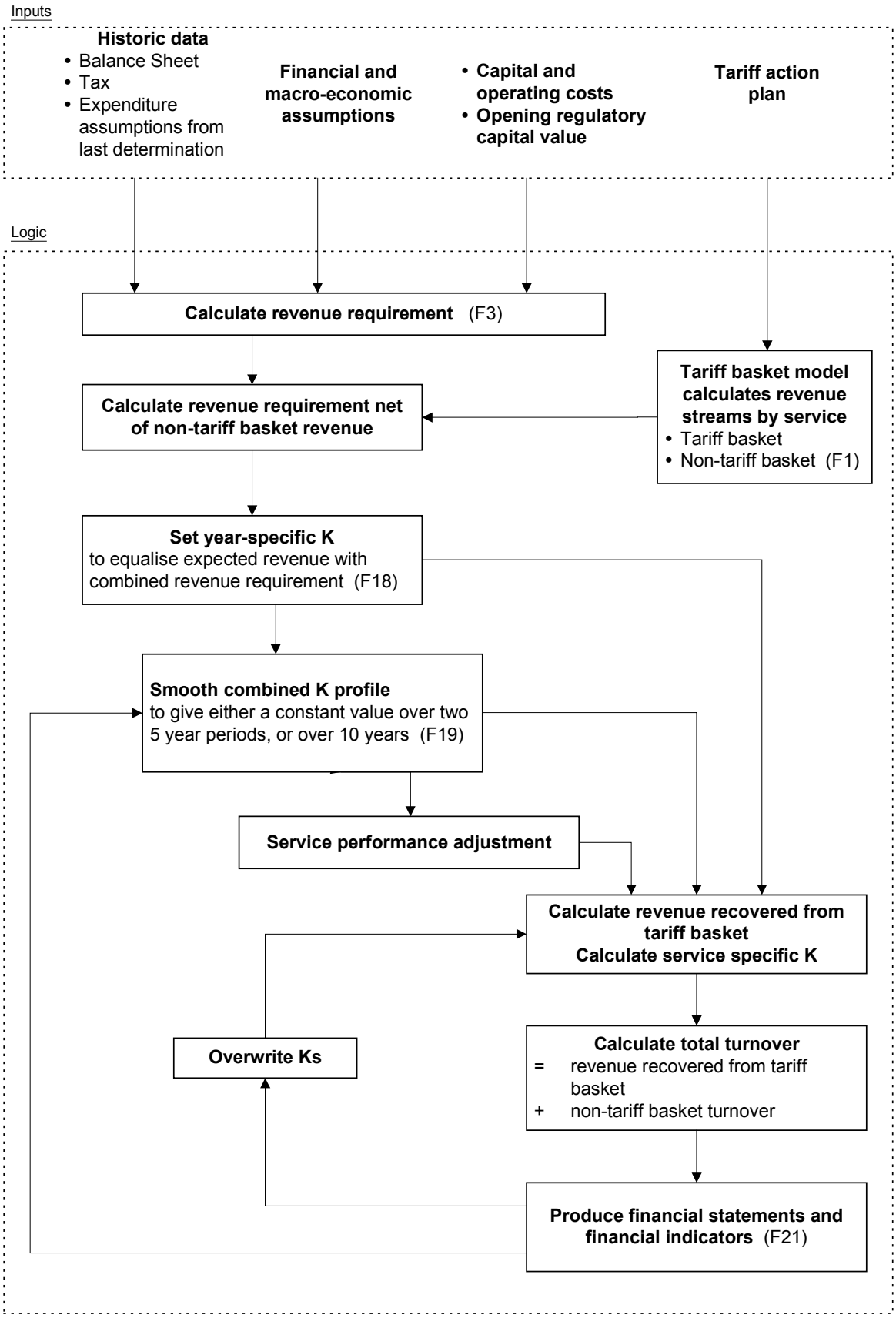
| **Type of input** | **Input price base** |
|---|---|
| Final determination expectation | Base year for previous review |
| Historic data | Out-turn prices |
| Projected data | Base year prices for current review |

4.13 The financial model calculates the revenue requirement in base year prices (taking account, where appropriate, of the movement in the construction output price index relative to the retail price index (RPI). See paragraph 4.14 below). The tariff basket and non-tariff basket revenue streams are in base year prices. The financial model calculates the cashflows, balance sheet and profit & loss account in out-turn prices using the input assumption on RPI.

4.14 We adjust capital investment to take account of the relative price effect (RPE) of changes in construction costs. The construction cost RPE is calculated in the model from the input data for RPI and COPI (Construction Output Price Index). Three companies have a clause in their licence that allows them to trigger an interim determination on the changes in the RPE. Consequently, for these companies there is no need to forecast construction cost RPE for the price setting period. The RPE forecast is applied only to those companies that do not have this clause in their licence. As part of our determinations in 2004, we

reviewed whether it was appropriate to extend this clause to all companies, but were not able to agree a uniform licence with companies at that time. We intend to return to this issue.

# Financial model overview F2



## 5 Revenue requirement

5.1 The revenue requirement represents the income a company requires in order for it to meet the cost of running its business and to fund its investment programme. It is calculated on an annual basis in real terms. The main components of the revenue requirement are operating costs, capital maintenance costs, a return on capital, taxation and the incentive allowance for operating and capital cost outperformance. This is shown in flowchart F3 and reflects the methodology of the 2004 review.

5.2 The revenue requirement is calculated at both the company level and separately for water and sewerage services.

5.3 Operating costs comprise the costs of operating the system as it stands in that year. This includes base service operating costs and net changes in operating costs associated with quality enhancements, maintaining the supply/demand balance and changes to levels of service.

5.4 Capital maintenance comprises the long-run cost of maintaining the asset systems, that is the infrastructure renewals charge (IRC) on below-ground assets and the current cost depreciation charge (CCD) on above-ground assets. The calculation of CCD is explained further in section 8 and IRC in section 9.

5.5 Return on capital is a post-tax return on the regulatory capital value (RCV). In broad terms, the RCV consists of the initial value established at privatisation plus subsequent capital expenditure net of depreciation and grants and contributions. The RCV is explained in more detail in section 10 and the cost of capital in section 11.

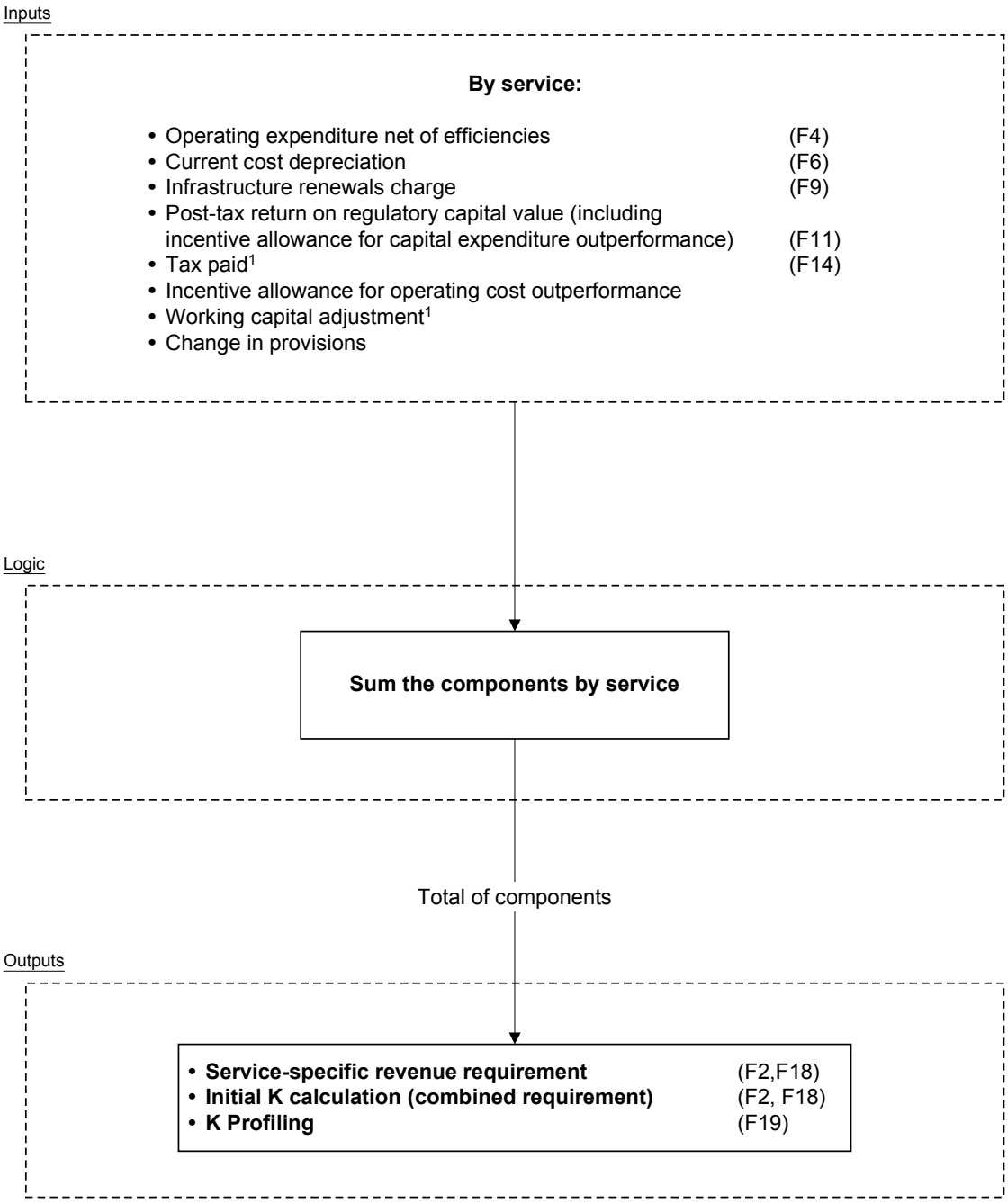
5.6 The price setting methodology used in all the previous reviews including the 2004 periodic review assumes that the return required by investors and lenders is a post-tax cost of capital. We model directly on a post tax basis and include the tax cost (reflecting the company's tax position) in the revenue requirement. The amount allowed for tax is not service specific. However for the purposes of calculating the service specific revenue requirement, it is split between the two services. The allocation is based on projected revenue streams net of historic cost depreciation, operating costs and IRC which are used as a proxy for service specific profit. In the "forward look" model, the tax requirement beyond 2010 is split based on the revenue requirement in the previous year. Sections 14 and 15 explain the tax calculations in more detail.

5.7 The incentive allowance allows companies to retain any operating or capital cost outperformance for five years after the year in which the cost savings were made. The service specific incentive allowance for operating outperformance is an input to the financial model. The incentive allowance for outperformance of capital expenditure is calculated as part of the RCV as set out in section 10. In 'Setting water and sewerage price limits to 2005-10 we said we will consult further on incentives. This consultation will deal with the framework for outperformance in the period 2005-10. Consequently any changes to the

calculations for the incentive allowance arising from this will not be needed until the 2009 periodic review.

5.8 The financial model calculates a target rate of return equal to the current cost operating profit, after deducting the incentive allowance. Current cost operating profit includes a working capital adjustment. This is also included in the revenue requirement. Like tax it is not service specific and is therefore apportioned in the same way as the allowance for tax.

# Revenue requirement F3




1. Tax paid and the working capital adjustment are not service-specific. However, for the purposes of calculating the service-specific revenue requirement, they are allocated pro rata to projected revenue streams (net of historic cost of depreciation, operating costs and infrastructure renewals charge)

## 6 Efficiencies

6.1 Projected expenditure for the Early Start programme is input to the financial model net of efficiency.

6.2 All other projected expenditure is input to the financial model gross of efficiencies. The model then applies the efficiency assumptions consistent with the PR04 business plan reporting requirements. There are two types of efficiencies which are applied to both the capital and operating expenditure projections:

- minimum efficiencies, which apply to the industry as a whole; and
- catch up efficiencies based on comparisons between companies.

6.3 The catch up efficiency is applied before the minimum efficiency. This is illustrated in flowchart F4.

6.4 The financial model has the flexibility to apply different efficiency assumptions to each of the following types of expenditure:

- Base operating expenditure
- Maintenance non-infrastructure expenditure
- Infrastructure renewals expenditure
- Quality enhancement operating expenditure, infrastructure capital expenditure and non-infrastructure capital expenditure
- Supply demand operating expenditure, infrastructure capital expenditure and non-infrastructure capital expenditure
- Enhanced levels of service operating expenditure, infrastructure capital expenditure and non-infrastructure capital expenditure

Catch up efficiencies

6.5 Catch up targets are set to reduce a proportion of the gap between a company and the most efficient company over the review period. The size of the efficiency gap is also an input. Catch up targets are included for base service expenditure. A catch up target is also set for quality operating expenditure on existing programmes.

6.6 The profile of catch up efficiencies for all types of expenditure is input. For base expenditure and quality expenditure on existing programmes, this should be consistent with achieving the catch up target by the end of the review period.

Minimum efficiencies

6.7 The minimum efficiency for operating expenditure applies directly to base operating expenditure. At the 2004 review we will assume that efficiency improvements on enhancement expenditure (quality enhancement, supply demand balance and enhanced service levels) can be achieved more rapidly than for base service. The financial model reflects this by applying a factor

(input to the model) to vary the minimum efficiency when applied to operating expenditure for each type of enhancement.

6.8 The minimum efficiency for capital expenditure is applied directly to infrastructure renewals expenditure and maintenance non-infrastructure.

6.9 Minimum efficiency inputs for base service expenditure can be entered from 2003-04 onwards but will only apply to enhancements from the start of the review period. For capital enhancement expenditure (as with operating expenditure for enhancement purposes) we will assume that efficiency improvements can be achieved more rapidly than for base service. Again the model reflects this by applying a factor (input to the model) to vary the minimum efficiency when applied to each type of capital enhancement expenditure.

End of period adjustments

6.10 Although this version of the model has been extended to calculate a revenue requirement and K factors for 25 years, it assumes that periodic reviews continue to be carried out every 5 years during this time.

6.11 At each review, “base service” expenditure would be the cost of maintaining and operating all existing assets up to and including those constructed in the previous 5 years.

6.12 Our approach at previous reviews has been to set lower efficiency targets for base service than enhancements. Accordingly, this version of the model transfers total enhancement opex after efficiency to base service at the end of each review period. This amount is deducted from enhancement expenditure in future years to avoid double-counting. “Re-based” expenditure attracts base service efficiency factors from the point at which it is transferred.

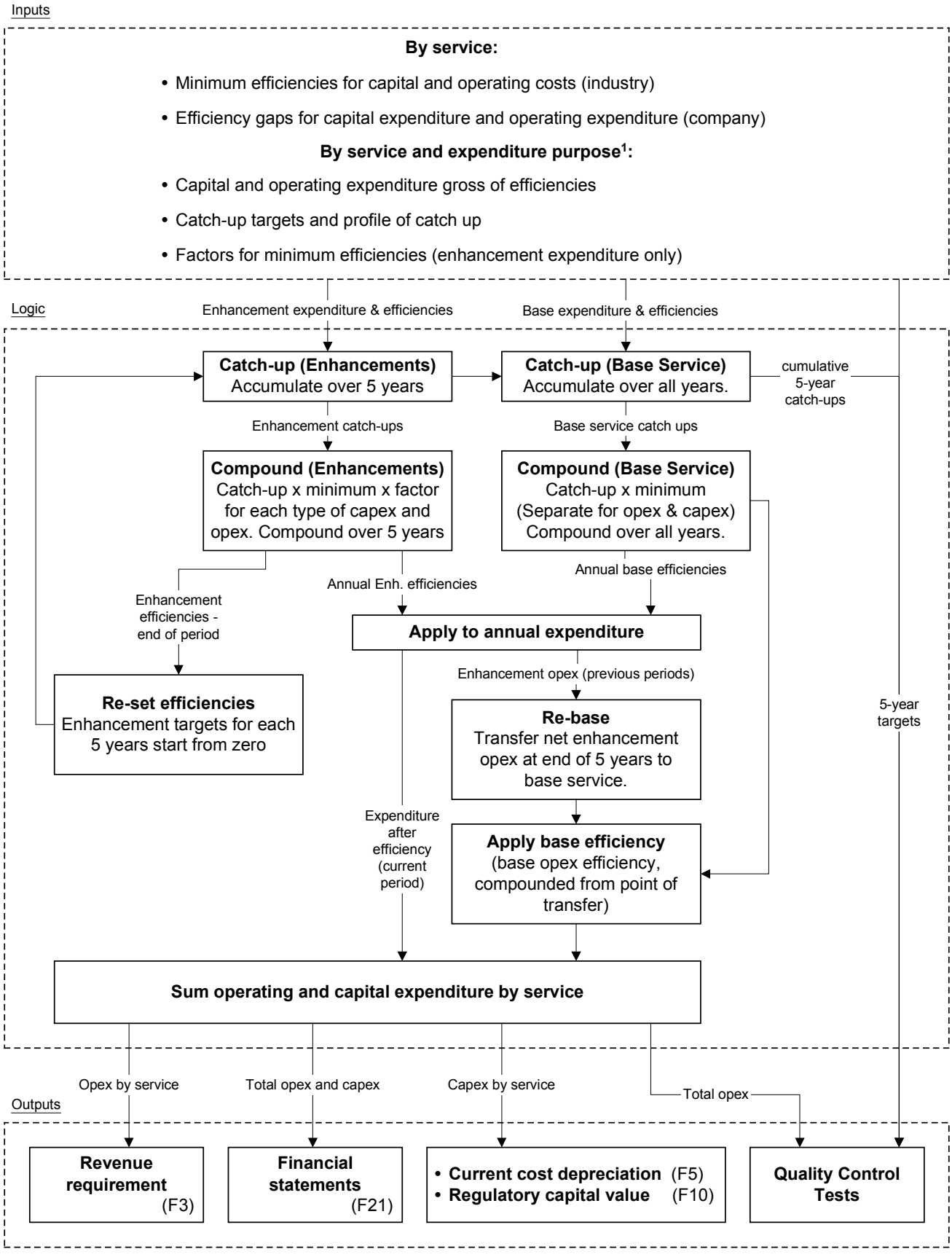
6.13 There is no automatic adjustment for capital expenditure at the end of each review. Enhancement capex relates to specific projects rather than continuous expenditure. A growing asset base will require additional maintenance, but this needs to be addressed through the capital maintenance inputs.

6.14 Efficiencies for all enhancement spending accumulate from zero at the start of each review period. Each programme will have different characteristics, and therefore we do not think it is appropriate to apply efficiencies assumed for previous reviews to these costs. However, since base service expenditure represents the continuation of existing programme, efficiencies achieved in one period would continue to the next. Therefore, base service efficiencies are compounded over the full period covered by the model.

Special cases

6.15 Two of the enhancement operating cost inputs (namely Quality Opex 1 and Metering opex) are subject to the overall base operating expenditure efficiency.

# Efficiency assumptions F4




1. Expenditure purposes for efficiency inputs are: base operating expenditure (opex); maintenance non-infrastructure expenditure (MNI); infrastructure renewals expenditure (IRE); enhanced service levels (ESL); supply demand balance (SDB); and quality enhancements.

## 7 Operating costs

7.1 The operating cost component of the revenue requirement reflects the ongoing cost of running the business plus the operating costs associated with new investment. It is simply the sum of the operating expenditure (net of efficiency) for the base service and additional enhancements.

7.2 Total operating costs are also required for the financial statements.

## 8 Current cost depreciation

8.1 The fixed assets of water companies are broadly divided into two categories - underground (or infrastructure) assets and surface (or non-infrastructure) assets. The underground assets are not depreciated but expenditure to maintain the serviceability to customers of the network is included in K factors via the infrastructure renewals charge (IRC). This is explained in section 9.

8.2 The revenue requirement includes an element for the replacement cost of depreciable assets spread over the economic life of the asset. This is the current cost depreciation charge (CCD).

8.3 CCD on existing assets ie. those at 31 March of the base year, is an input to the model. CCD on new investment is calculated on a straight line basis using five asset life categories. Similarly grants on above ground assets are written off over the life of the asset.

8.4 The depreciation calculations in the financial model use five asset life categories. These are:

- Very short - 0-5 years
- Short - 6-15 years
- Medium - 16-30 years
- Medium/long - 31-50 years
- Long - over 50 years

8.5 The proportions of capital investment in each asset life category are input separately for maintenance non-infrastructure, quality enhancement, supply demand balance and enhanced service levels expenditure. The apportionment of grants received between the asset life categories are also inputs to the model.

8.6 The model assumes that assets are purchased half way through the year and hence calculates half a year of CCD in the year in which capital expenditure is incurred. It also makes an adjustment to include the depreciation on those assets that are in the course of construction at 31 March of the base year and which are commissioned subsequent to this date. This is known as the work in progress (WIP) adjustment. The WIP adjustment is input separately for base service and enhancements.

8.7 The split of capital expenditure across the asset life categories also forms the basis of allocating capital expenditure to the various expenditure categories for tax purposes. This is explained in section 14. The apportionment of capital expenditure is shown in flowchart F5 and an overview of the CCD calculation is set out in flowchart F6.

8.8 The treatment of the grants and contributions and their amortisation in the financial model follow the principles of the CCD calculations.

Comparison of CCD and maintenance non-infrastructure (MNI) expenditure

8.9 As indicated in 'Setting water and sewerage price limits for 2005-10', if the service capability of a pool of non-infrastructure assets is in a steady state and the accounting life of the assets is equivalent to their service life, then in the long run the capital maintenance expenditure to renew and replace the asset base (maintenance non-infrastructure (MNI) expenditure) and the current cost depreciation charge for those assets should be comparable.

8.10 The time period over which the comparison is made for the 2004 review will be 28 years starting with 1992-93. CCD on assets existing at 31 March 1993 is an input to the model, as are MNI expenditure and the apportionments of this to the five asset life categories. Adjustments to CCD on base service assets or MNI expenditure to take account of any valid reasons for the difference between the two are also inputs to the model. These are taken into account when the model compares the 28 year period net present value (NPV) of the current cost depreciation charge with the NPV of capital maintenance expenditure over the 28 year period.

8.11 If comparability is not demonstrated then the model has the facility to make a downward adjustment to CCD so that the net present value over the comparison period falls within a specified percentage of base year turnover.

8.12 This approach is set out in flowchart F7.

8.13 The total CCD charge (including current cost depreciation adjustment on base service) is included in the revenue requirement and reflected in the calculation of the regulatory capital value (RCV).

8.14 To simplify and improve the calculation speed of the "forward look" model the depreciation adjustment calculations have been replaced with an input. The calculations will be reinstated for the next version of Aquarius, pending decisions on our approach to setting price limits for 2009.

Amortisation of grants

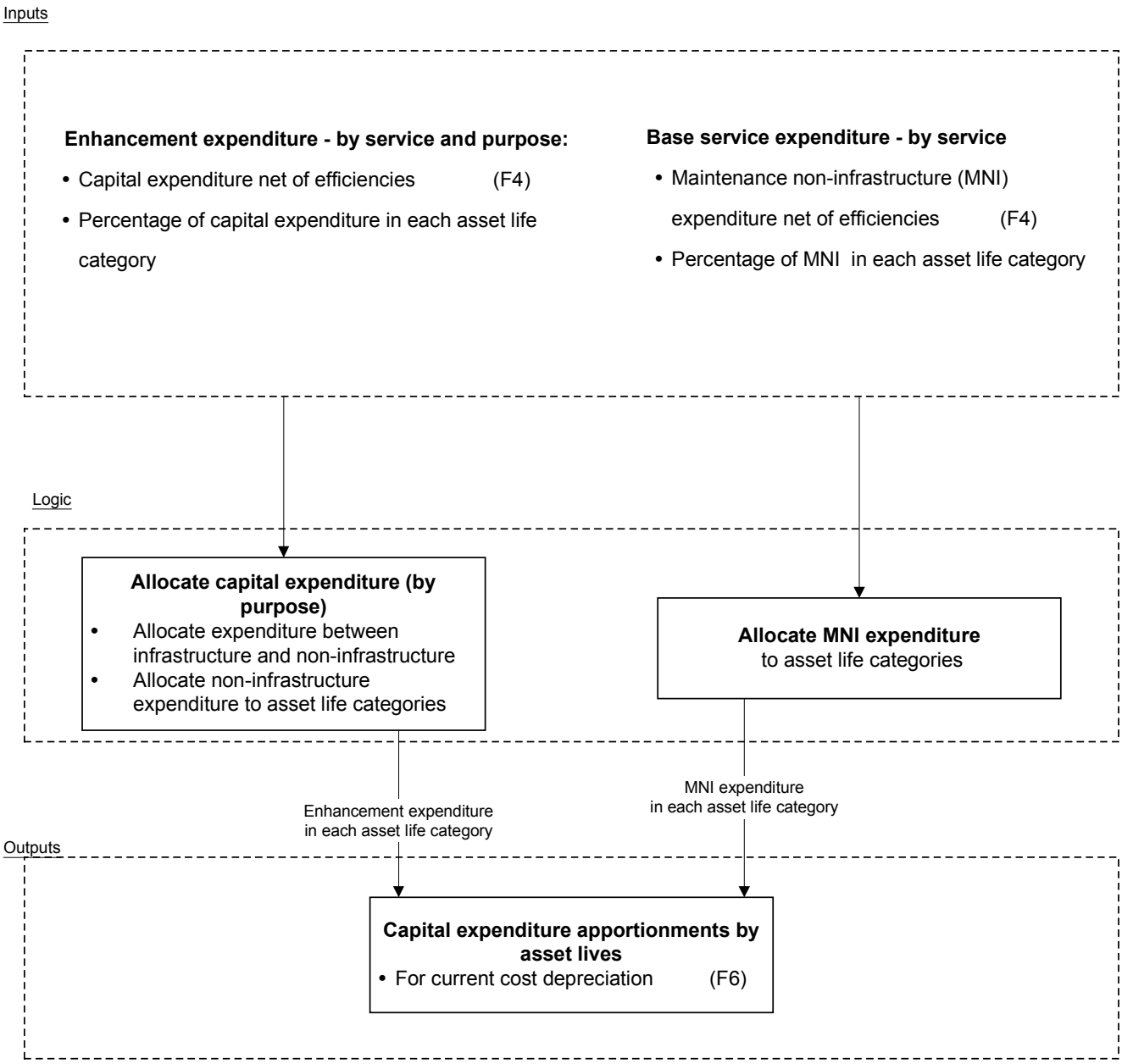
8.15 Capital grants and contributions attributable to enhancement infrastructure assets (but not those related to infrastructure renewals expenditure which is input net of grants), are held in perpetuity as a separate item in the balance sheet and are deducted from the RCV.

8.16 For non-infrastructure assets, grants are written off over the life of the assets concerned.

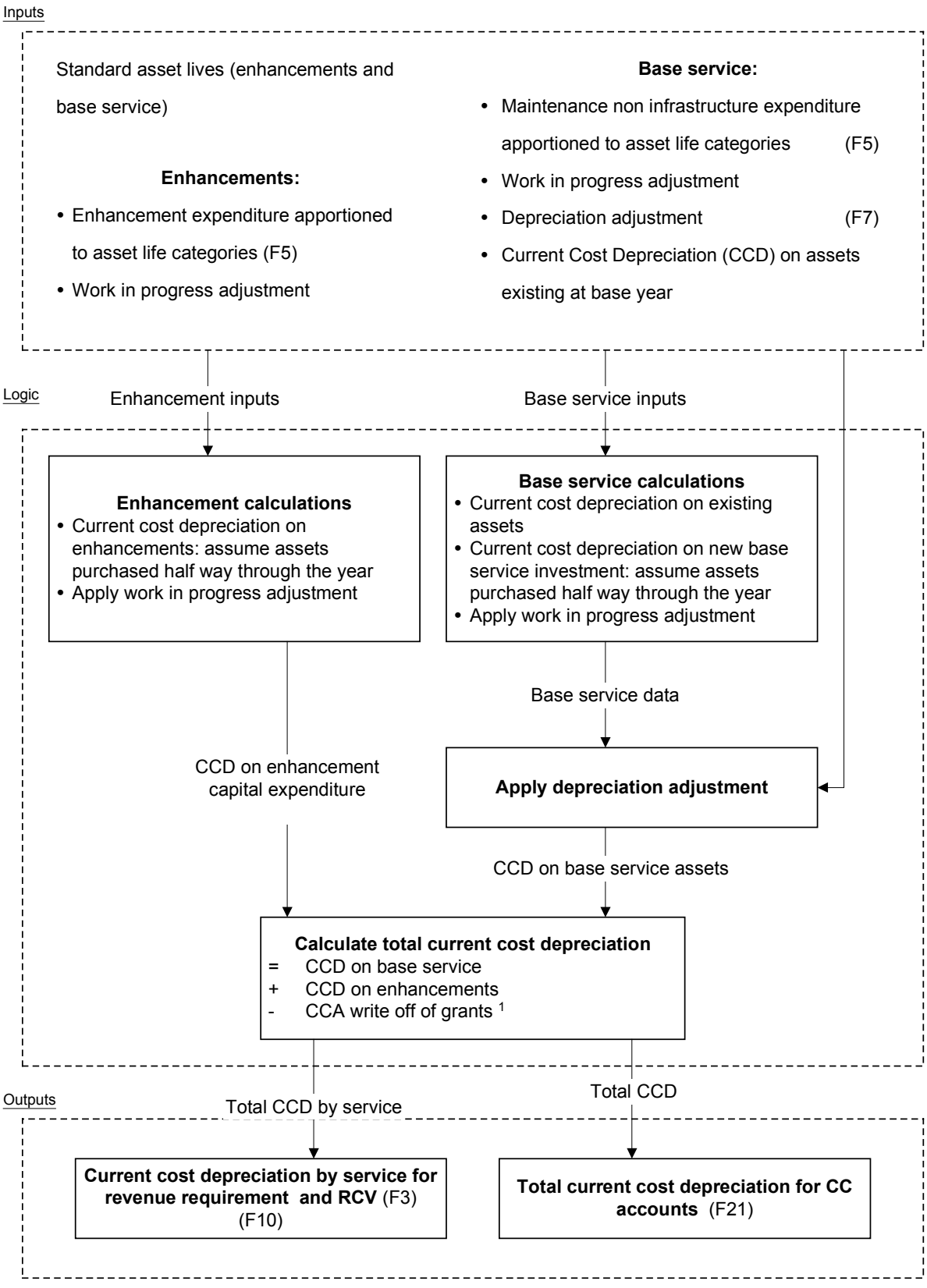
Historic cost depreciation (HCD)

8.17 The revenue requirement is driven by CCD. The financial statements and financial indicators are calculated in both historic cost and current cost accounting terms. Historic cost depreciation is calculated in a similar manner to CCD but no adjustment is made to the historic cost depreciation as a result of the comparison of CCD and MNI expenditure. The calculation of HCD is set out in flowchart F8.

# Capital expenditure apportionment F5



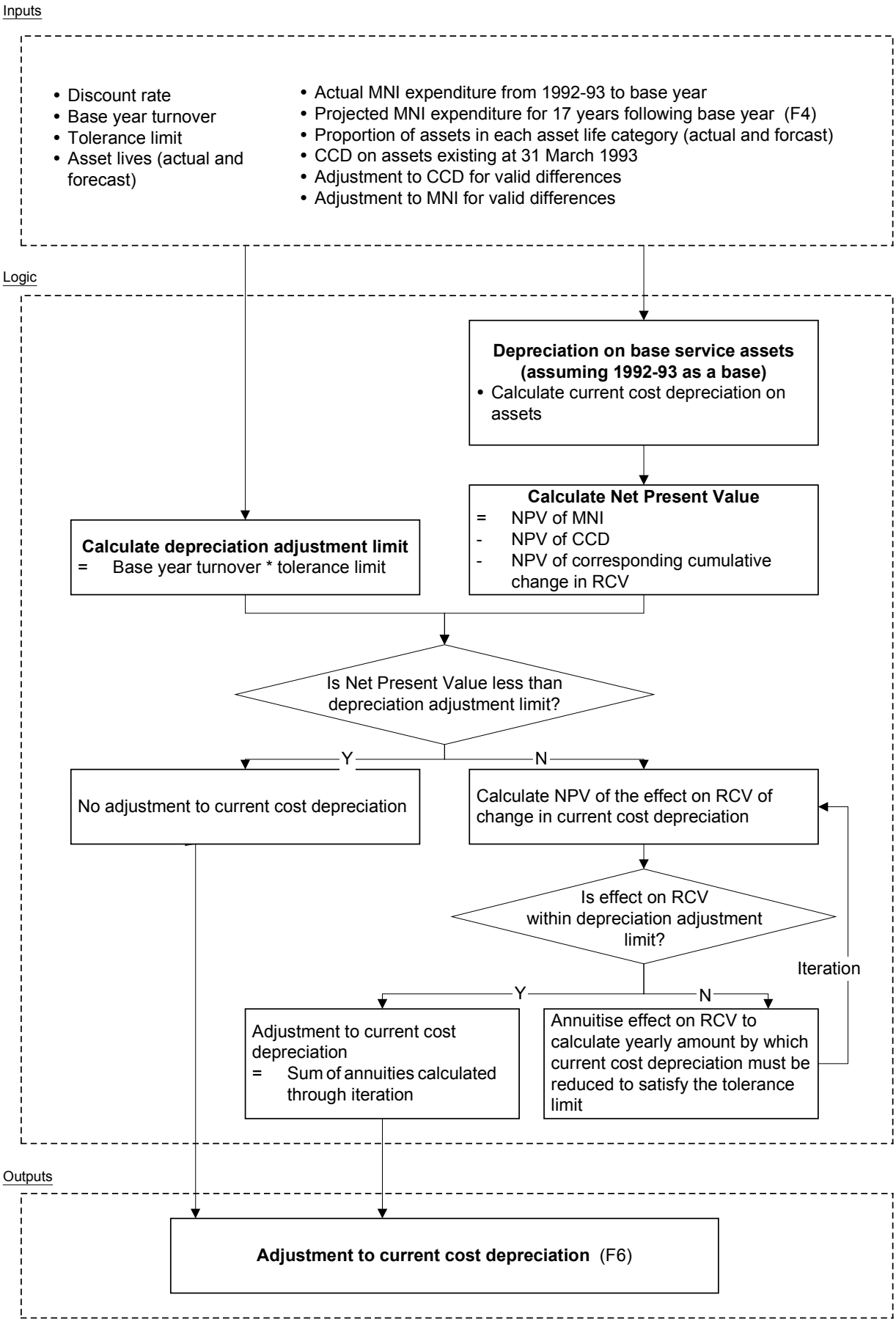
# Current cost depreciation F6



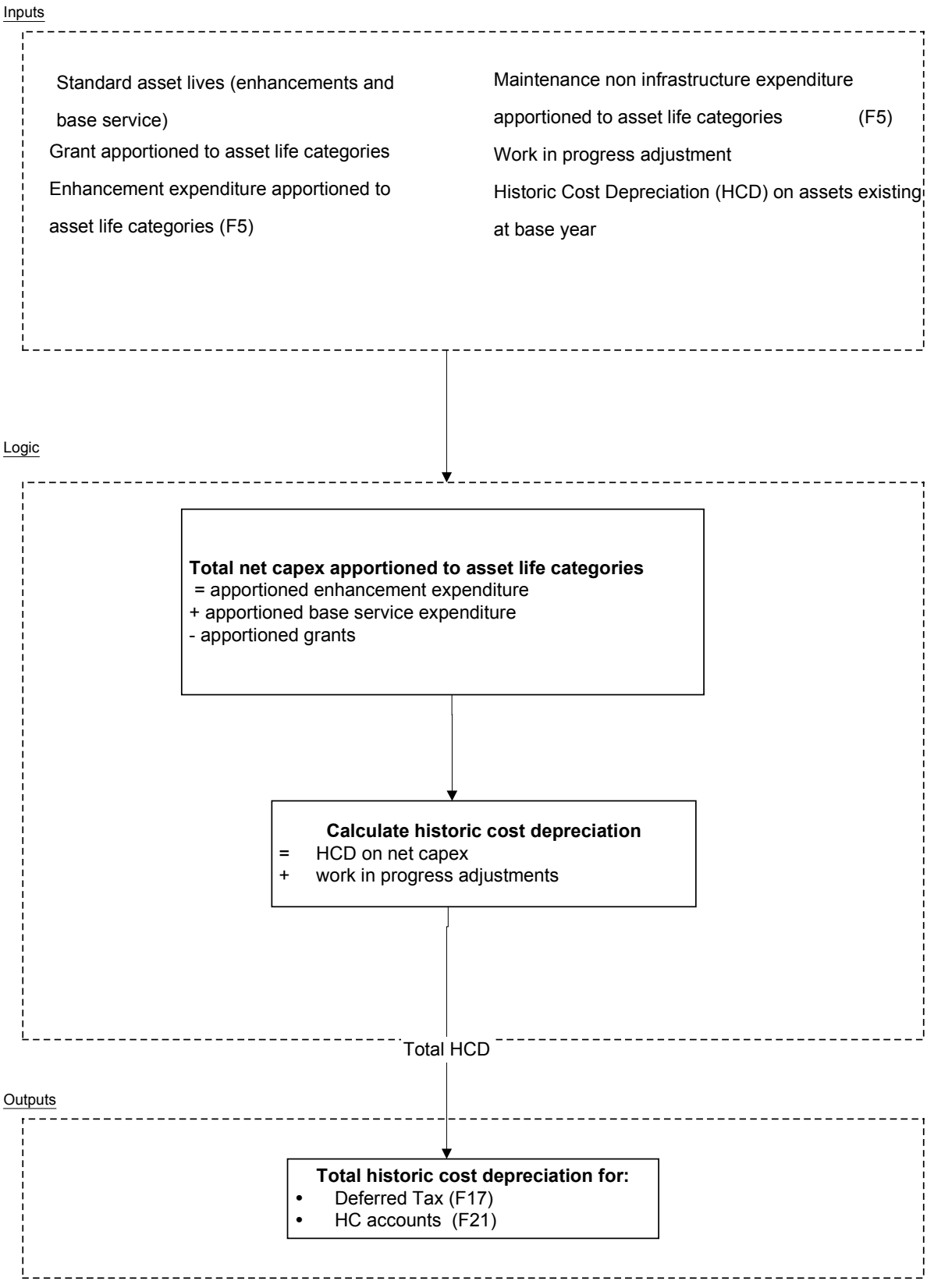

1 The write off of grants and contributions follows similar calculations to the depreciation of capital expenditure. Therefore the calculations are not set out in a seperate flowchart within the rule book.

# Depreciation adjustment F7

**(Base Service only)**



# Historic cost depreciation F8



## 9 Infrastructure renewals charge

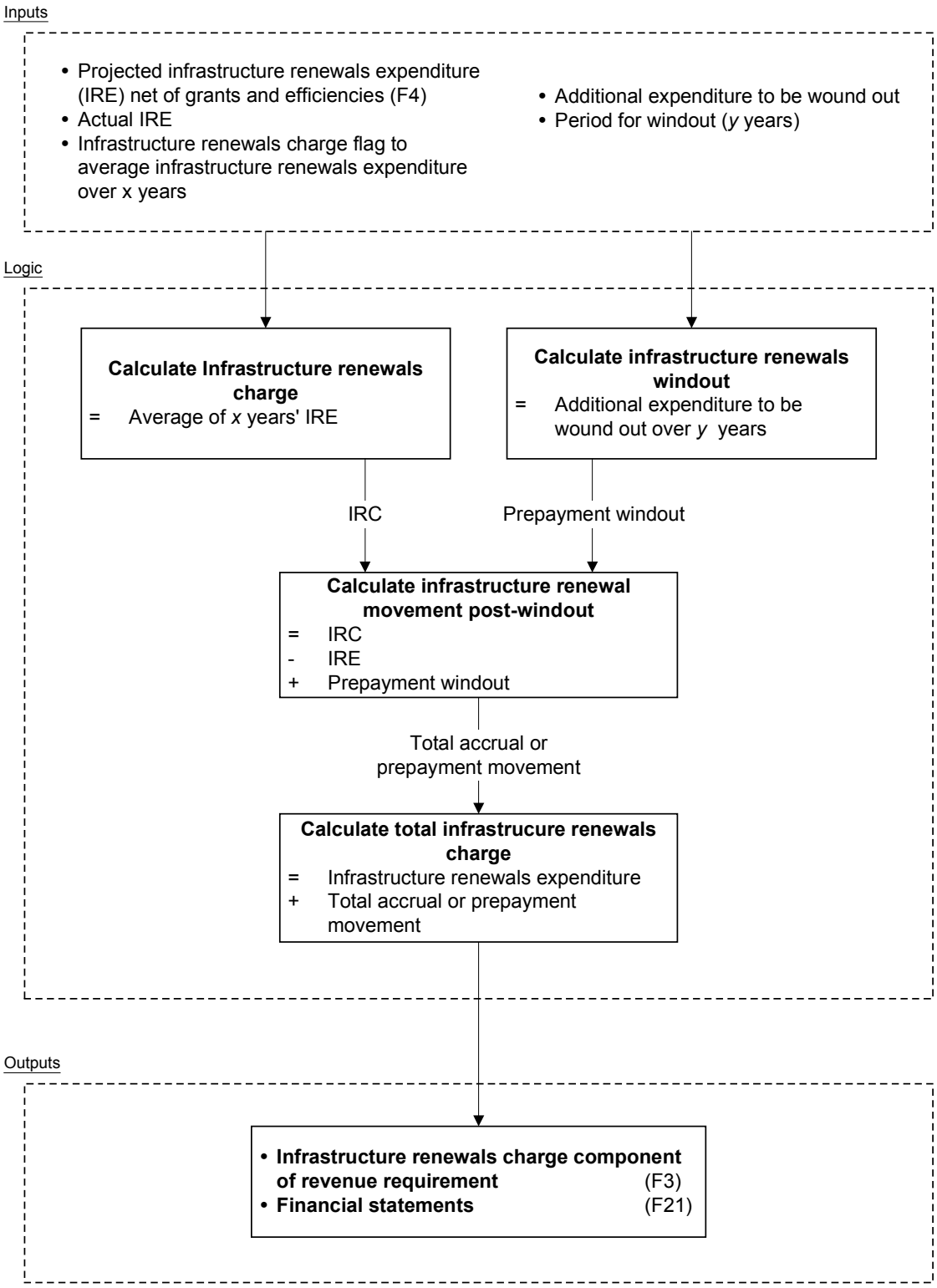
9.1 Infrastructure renewals accounting is used for underground assets rather than conventional depreciation. An infrastructure renewals charge (IRC) is made each year against profits. The IRC reflects the average of infrastructure renewals expenditure (IRE) over a period of time.

9.2 Where we accept a company's case that we should recognise IRE incurred over and above our assumption for the period 2000-05, we will do this through an increase in the IRC over a ten year period from 2005-06 to 2014-15. The amount of additional expenditure to be unwound and the period over which this will happen are inputs to the model.

9.3 This is set out in flowchart F9.

9.4 This version of Aquarius is very flexible, allowing a user to determine the period over which the expenditure will be averaged. The period can also be varied for different years so that, for example, the IRC for 2005-2010 might be based on expenditure from 2000-2015, while the IRC for 2010-2015 might be based on 2005-2020. There are also inputs allowing the IRC to be adjusted or overwritten.

# Infrastructure renewals charge F9



## 10 Regulatory capital value

10.1 The regulatory capital value (RCV) represents the capital base which is remunerated at (at least) the cost of capital. The cost of capital is explained in section 11.

10.2 The opening value of the RCV in the base year is an input to the financial model.

10.3 Capital expenditure to enhance and maintain the network is added to the RCV. Any capital grants or contributions towards the cost of the new assets are deducted. Current cost depreciation (based on the MEA value of the assets) is deducted from the RCV each year.

10.4 Infrastructure renewals expenditure (IRE) is not added to the RCV but the movement in the infrastructure renewals accrual/prepayment is added or deducted each year.

10.5 The RCV is adjusted for any disposal of land by the regulated business. When land is sold, the licence requires that the proceeds are split equally between shareholders and customers. The mechanism for doing this is through the RCV. The customers' share of any net proceeds is deducted from the opening RCV in calculating the input value.

10.6 As indicated in 'Setting water and sewerage price limits for 2005-10', companies retain the benefit of capital efficiencies for a five year period before they are transferred to customers. The RCV is the mechanism used to reflect past capital outperformance and transfer the benefit of this to customers through lower price limits. This implies a rolling adjustment to the RCV such that efficiencies achieved in year 1 are retained until year 6, those in year 2 until year 7 and so on. However, in the past this has resulted in a very uneven profile. In order to reflect a more even profile of outperformance but return the same overall value to customers, the outperformance for the five year price setting period is smoothed. The net present value of the unsmoothed outperformance adjustments for the five year period is calculated and annuitised to give the annual outperformance adjustment to the RCV. The annual outperformance adjustment is deducted from the RCV.

10.7 In broad terms the level of outperformance is assessed by comparing net actual capital expenditure with our projections from the last price review adjusted for expenditure logged up/down. Where actual expenditure over the five years of the last review period is greater than our projections plus agreed logging up/down the value of the capital expenditure is reduced before the outperformance is calculated.

10.8 The outperformance adjustment (before smoothing) is calculated by comparing the capital expenditure (excluding IRE and net of grants) actually incurred in a given year with that assumed in setting prices (plus any agreed logging up). This difference is then adjusted for depreciation using an average asset life for the industry. The difference between the movement in the infrastructure renewals accrual/prepayment actually reported in the year and that assumed in setting price limits is the final element of the calculation.

10.9 The model calculates in the outperformance adjustment for the five year price setting period only (i.e. 2005-10). The outperformance adjustments for 2003-04 and 2004-05 are those calculated at the 1999 final determination. These are inputs to the model.

10.10 The overall approach to RCV is set out in flowchart F10.

10.11 The "forward look" model includes a facility to model the potential impact of future outperformance. A trigger input rolls forward the year in which forecast and actual expenditure are compared. Instructions for modelling future outperformance are included as an appendix to the Aquarius 3 user manual.

# Regulatory capital value F10

Inputs

**By service:**

Projections from previous determination and actual :
- Capital expenditure, excluding IRE
- Capital grants
- Movement in infrastructure renewals prepayment / (accrual)

Forecast values for the above (F4/F9)
CCD projections (F6)
Capital expenditure logged up / (logged down)
Value of discretionary expenditure agreed

Opening value in base year
Rolling period (years)
Weighted average asset life
Outperformance adjustment for base year +2 and base year +2 as determined at previous FD

Logic

**Ceiling on investment:**
Is actual capital expenditure over 5 years > total allowed in previous FD + agreed logging up/(down)?

Y

**Reduce capital expenditure by service**
Reduced value
= Final determination
+ Logging up/(down)
+ Agreed discretionary expenditure

N

Capped capital expenditure

**Calculate out-performance**
Difference between actual / capped -
- Capital expenditure net of grants and excluding infrastructure renewals expenditure;
- Movement in IR prepayment/(accrual), and
- Net values for same items projected at previous FD

**Roll in net new capital expenditure**
Cumulative projected capital expenditure net of grants
Infrastructure renewals prepayment (accrual)
Less projected current cost depreciation

**Depreciation adjustment:**
Projected depreciation less value of out-performance / weighted average asset life

**Smoothed adjustment to RCV**
- Calculates total outperformance for each year in price setting period
- NPV of 5 years' worth of outperformance
- Annuitised value given annual outperformance adjustment

Outputs

**Closing regulatory capital value**
Opening value in base year adjusted for net new capital expenditure and out-performance of previous assumption

(F21)

**Inputs to rate of return calculation**
- Opening value in base year adjusted for out-performance less depreciation on existig assets
- Rolled up capex for regulatory capital value net of depreciation

(F11)

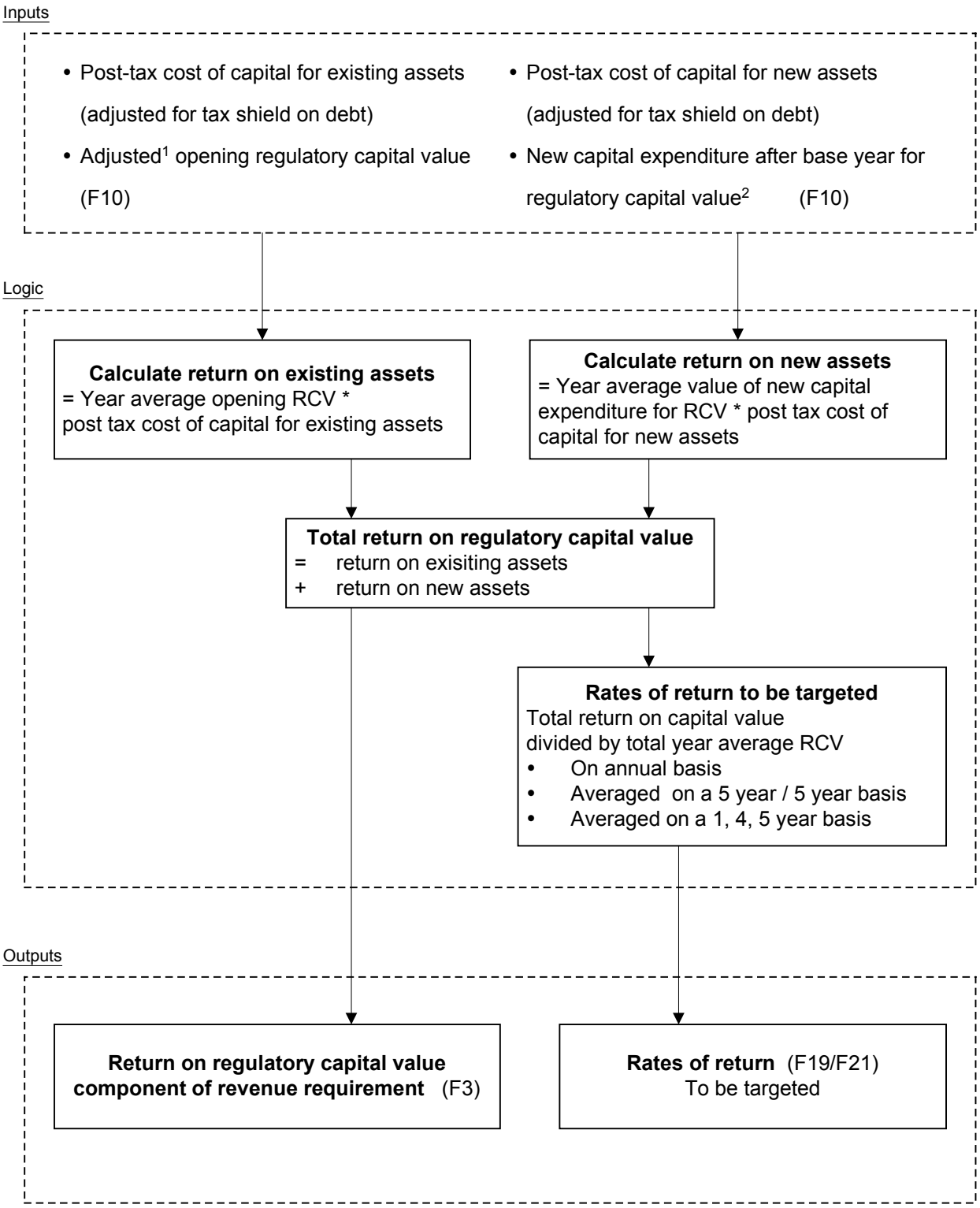
## 11 Cost of capital

11.1 The rate of return to be earned on the RCV is determined by reference to the post-tax cost of capital.

11.2 Interest payable on debt is deducted when calculating the taxable profit (the 'tax shield') and hence the tax costs included in the revenue requirement are lower. In order to avoid double counting of this tax shield, the post-tax cost of capital input to the financial model is the weighted average of the pre-tax cost of debt and the post-tax cost of equity.

11.3 The post-tax cost of capital is an input to the model which has the flexibility to apply different values for the cost of capital for existing assets and for new assets. This is shown in flowchart F11.

# Return on capital F11




1. Net of CCD on existing assets and adjusted for outperformance as described in F10.
2. Net of grants, and current cost depreciation, adjusted for movement in infrastructure renewals prepayment/(accrual) as described in F10.

## 12 Dividends

12.1 Aquarius accommodates two main types of dividend policies: annual growth from a given starting point ("the growth method"), or the distribution of a proportion of profits available for the year ("the distribution method"). Any other policy can be modelled by entering values for "Opening Ordinary Dividends" in all years rather than treating this as a starting point.

12.2 The policy applied by the model depends on the way that input values are populated. When the inputs required for one method are not populated, the model checks the inputs required for the next method. This is set out in flowchart F12. The general order of priority is as follows:

- Input values for "Opening Ordinary Dividends";
- Growth method – previous year's dividends multiplied by inflation plus real growth (input);
- Distribution method – distributable profit multiplied by percentage distributed (input).

12.3 To establish a starting point for the growth method, the model can calculate a "recommended dividend" for the year prior to the review period. This is calculated as a percentage yield (input) on the implied equity portion of the Regulatory Capital Value (the RCV less net debt). If a dividend adjustment is made as part of the K Solving process (see section 16), the recommended dividend will be substituted for the input dividend in this year only.

12.4 The model can calculate interim dividends as a proportion of the ordinary dividend for the full year (input), or an input value can be entered. As with opening ordinary dividends, input values take priority over calculations.

12.5 There are two checks on dividend payments:

- no dividends will be paid if the share inputs are not populated;
- the model will not allow the dividend to exceed the total funds available for distribution.

If either of these events prevents the payment of a modelled dividend, the model generates a quality control error.

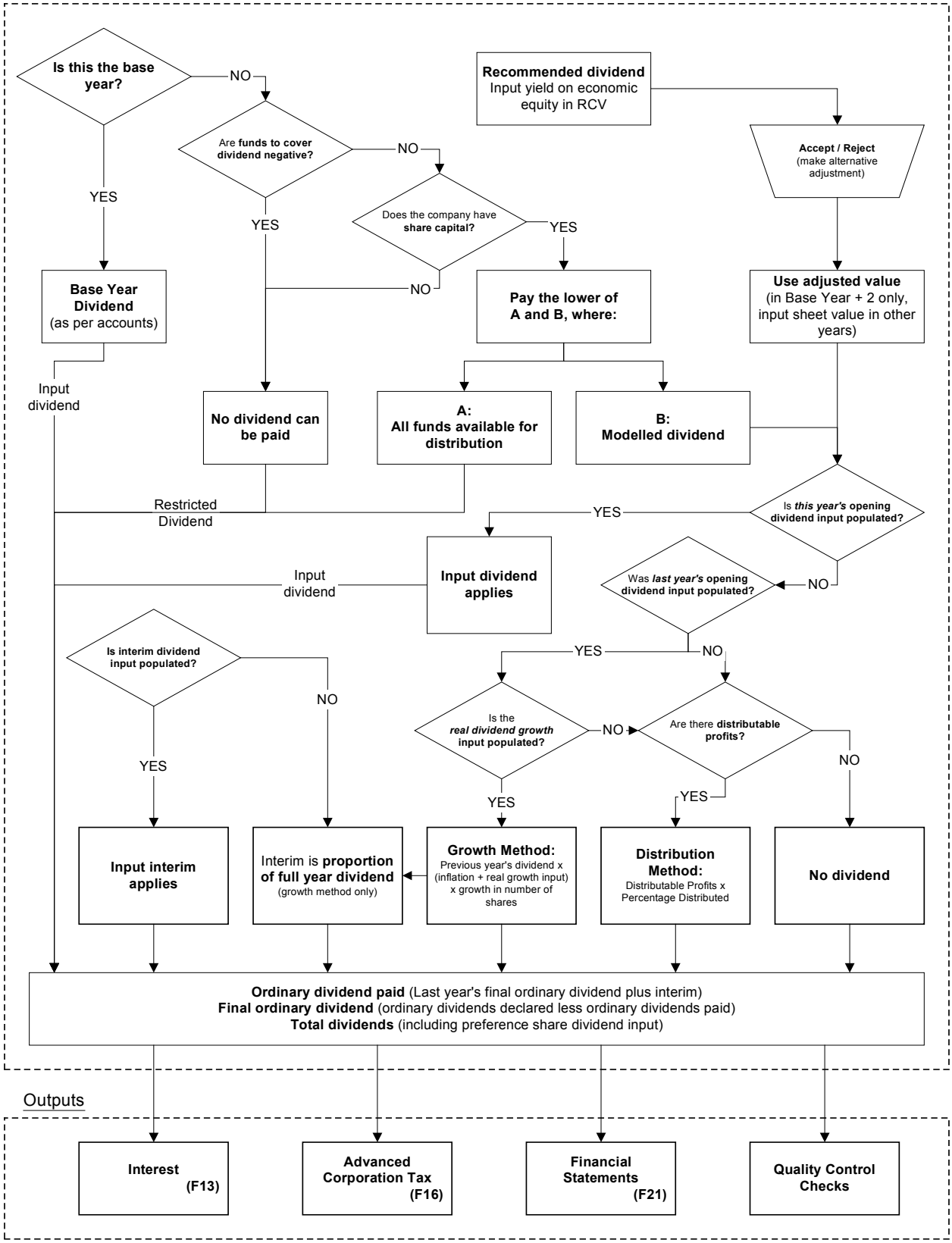
12.6 Preference share dividends are an additional input, and are deducted from the profits available for distribution to ordinary shareholders.

12.7 There are further input options allowing the payment of special dividends, a percentage of ordinary dividends to be paid as scrip shares and other share issues. There is an appendix in the Aquarius 3 user manual setting out a procedure that could be adopted to model a rights issue.

# Dividends

**F12**

Logic




Outputs

## 13 Interest

13.1 Interest received is calculated on the average cash balance for the year plus any interest receivable that has been input to the model.

13.2 Interest paid is made up of a number of elements:

- Interest on overdraft
- Interest on fixed rate loans
- Interest on floating rate debt
- Finance lease interest;
- Debenture loan interest; and
- Interest on index linked loans.

13.3 Interest on floating rate debt, finance lease interest, debenture loan interest, interest on index linked loans and the charge to the profit and loss account for the indexation to the principal of the index linked loans are all inputs to the model. Interest on fixed rate debt and overdraft are calculated by the model.

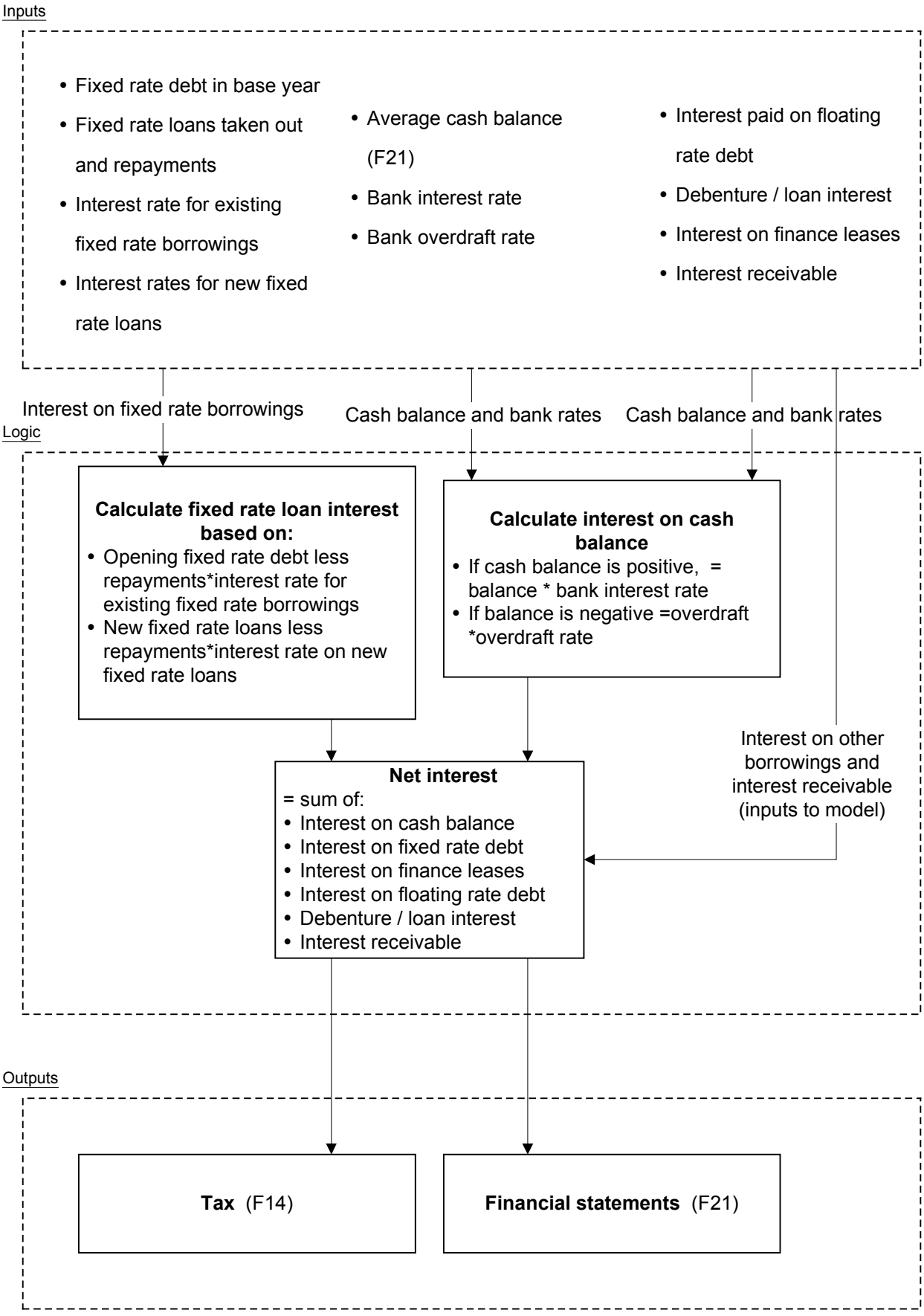
13.4 The amount of opening fixed rate debt, new fixed rate loans taken out or repaid and the rate at which interest is charged on these loans are inputs to the model. These inputs will depend upon a detailed assessment of the debt in companies' balance sheets in the base year to ensure customers do not bear inefficient financing costs.

13.5 New floating rate debt, debentures or finance leases taken out or repaid are also inputs to the model. If there are no new loans from other sources input to the model, it assumes that all borrowings are taken out at the variable overdraft rate through the overdraft calculations.

13.6 The cash balance and interest on any overdraft arising are calculated on a quarterly basis to prevent circularity in the tax calculations.

13.7 The interest on all borrowings will impact on the financial statements and the company's tax position. As we explained in Setting water and sewerage price limits for 2005–10, where necessary, we will adjust companies' opening balance sheets to ensure the level of gearing is consistent with our view of the weighted average cost of capital. Our assumptions about the level of interest reflected in the cashflow and the financial statements will also reflect this view. However, the amount of interest taken into account in the tax calculations will reflect the company's actual balance sheet for the base year. The model includes a switch to enable us to adjust the amount of interest which flows through the tax calculation to reflect either our view of efficient capital structure or the actual balance sheet.

# Interest F13



## 14 Tax

14.1 Tax calculations can become circular in financial modelling. Incorporating tax within the revenue requirement is an additional complication. To address this some calculations for tax and cash flow are calculated on a quarterly basis. This involves some assumptions about the timing of payments and the utilisation of tax allowances such as loss relief.

14.2 The allowed tax element is included in the revenue requirement (see paragraph 11.2). The model reflects the current tax regime as at April 2003. It assumes that the regulated business is a free-standing company, for example, dividends paid to the group are assumed to be paid to the ultimate shareholders.

14.3 The tax position in the base year is input to the model. The tax calculations performed in the model will reflect the individual circumstances of the company. (This includes the gearing and interest position). This is shown in flowchart F14.

14.4 The impact of tax calculations on the balance sheet, profit & loss account and cash flow statement can be summarised as follows:

- The mainstream corporation tax liability (or asset), less any advance corporation tax (ACT) offset (from any surplus ACT carried forward after 6 April 1999) is included in the balance sheet along with any ACT debtor and deferred tax liability;
- The tax charge in the profit & loss account includes movements in ACT debtors and deferred tax liabilities;
- The tax entry in the cash flow is mainstream corporation tax paid.

14.5 The corporation tax calculation in the financial model has been designed to replicate the corporation tax computations which a regulated business would be expected to prepare but are not designed to cater for every conceivable eventuality. The corporation tax calculations in the model also contain a number of necessary assumptions and simplifications. Key assumptions which the model makes in calculating tax are as follows:

- Mainstream corporate tax is payable calculated on a quarterly basis. Payment is made two quarters in arrears.
- When a company has an overall tax loss but a taxable profit in the previous year, it may elect to carry the loss back and set it against the profile of the previous year. The financial model assumes that this election will always be made.
- It is possible that a company may have a trading loss but a taxable profit for tax purposes (for example if it has a chargeable gain). The model does not deal with this situation.

Capital and other allowances

14.6 The model reflects the prevailing capital allowance regime as set out in flowchart F15. There are capital allowance categories for:

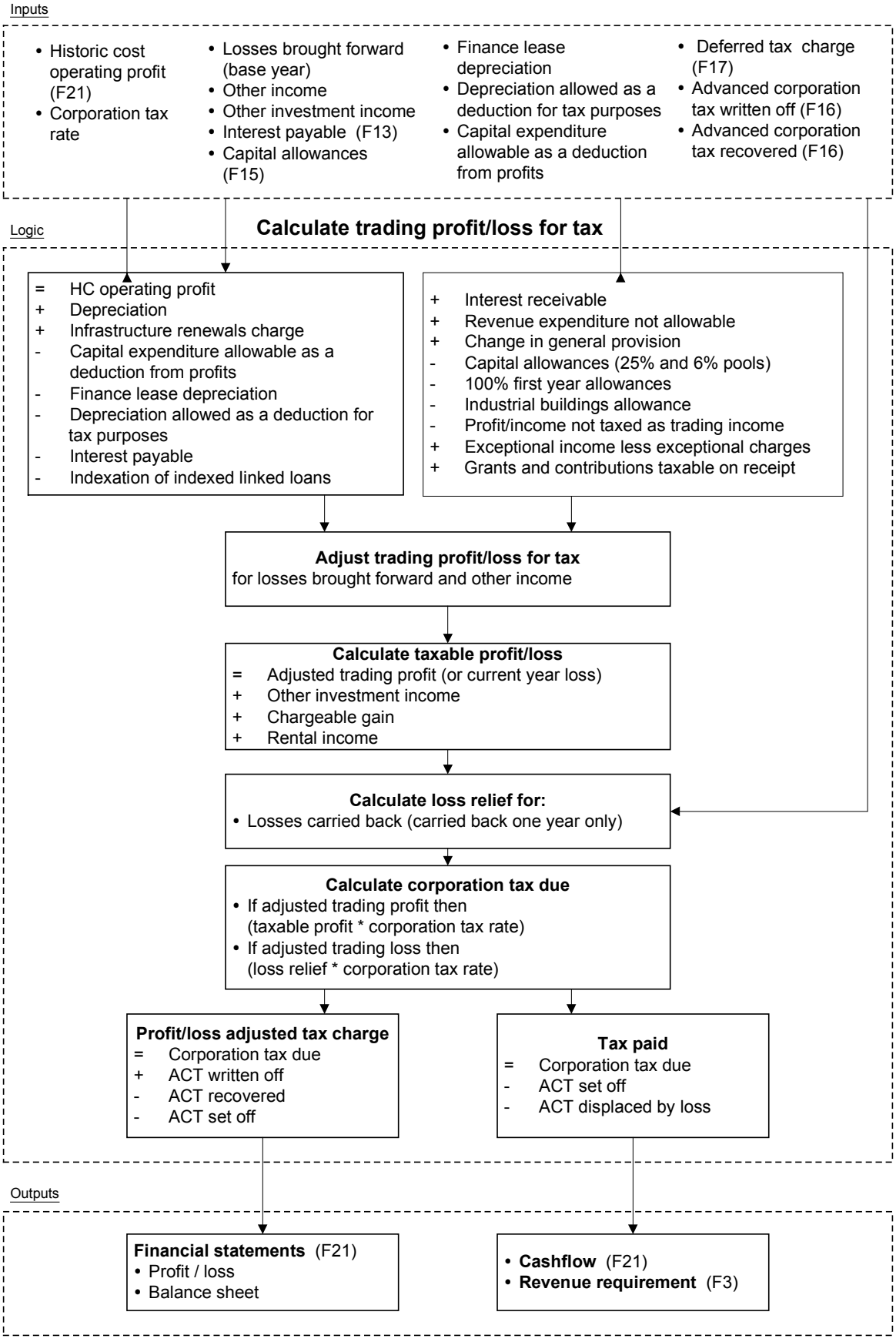
- Writing down allowances at 25% pa reducing balance;
- Writing down allowance at 6% pa reducing balance (for long life assets).
- Industrial Buildings Allowances (IBA) at the prevailing rate are included.
- Assets qualifying for 100% first year allowances.

14.7 Capital expenditure is classified for tax purposes into one of the following categories:

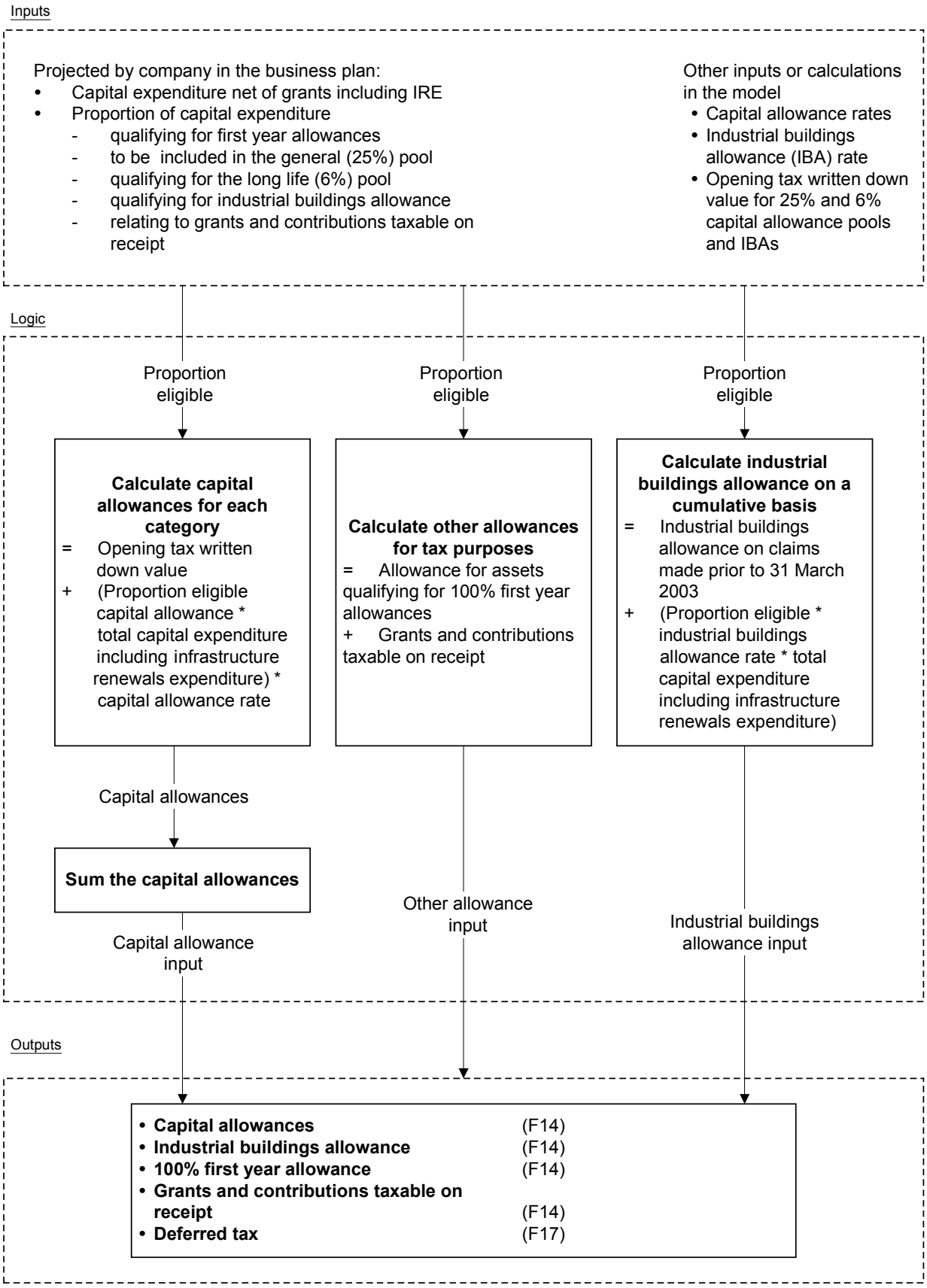
- Qualifying for capital allowances at either 100% per annum, 25% per annum or 6% per annum for long life assets (as set out in 14.6 above).
- Depreciation on expenditure under finance leases is allowed in accordance with the prevailing guidance from the Inland Revenue. Finance leases are assumed to have been entered into after 4 November 1991;
- For some capital expenditure, no tax relief is available;
- Expenditure qualifying for industrial buildings allowances;
- Capital expenditure incurred which is allowed against trading profit in the year in which it is incurred.
- Capital expenditure upon which the depreciation charged in the historic cost accounts is allowed. (This is split between infrastructure and non-infrastructure assets).
- Grants and capital contributions which are taxable on receipt.

14.8 The proportions of capital investment attracting each allowance are inputs to the financial model. These are multiplied by the total capital expenditure (including IRE) to determine the value of qualifying investment for each type of allowance. Capital allowances and industrial buildings allowances are calculated in the model. Allowances for depreciation on expenditure under finance leases, capital expenditure allowed against trading profits and depreciation which is allowed as a deduction are inputs to the model. The inputs to the financial model should reflect the appropriate tax treatment for each company.

# Taxation F14



# Capital allowances F15



14.9 The inputs to and calculations in the model give it the flexibility to reflect:

- The current tax regime;
- The changes set out in the Inland Revenue document - Tax Bulletin 53, which will be introduced in April 2005; and
- Possible changes in tax deductions resulting from changes in accounting standards (consulted on by the Accounting Standard's Board in Financial reporting exposure draft 29: Property, plant and equipment (FRED 29)).

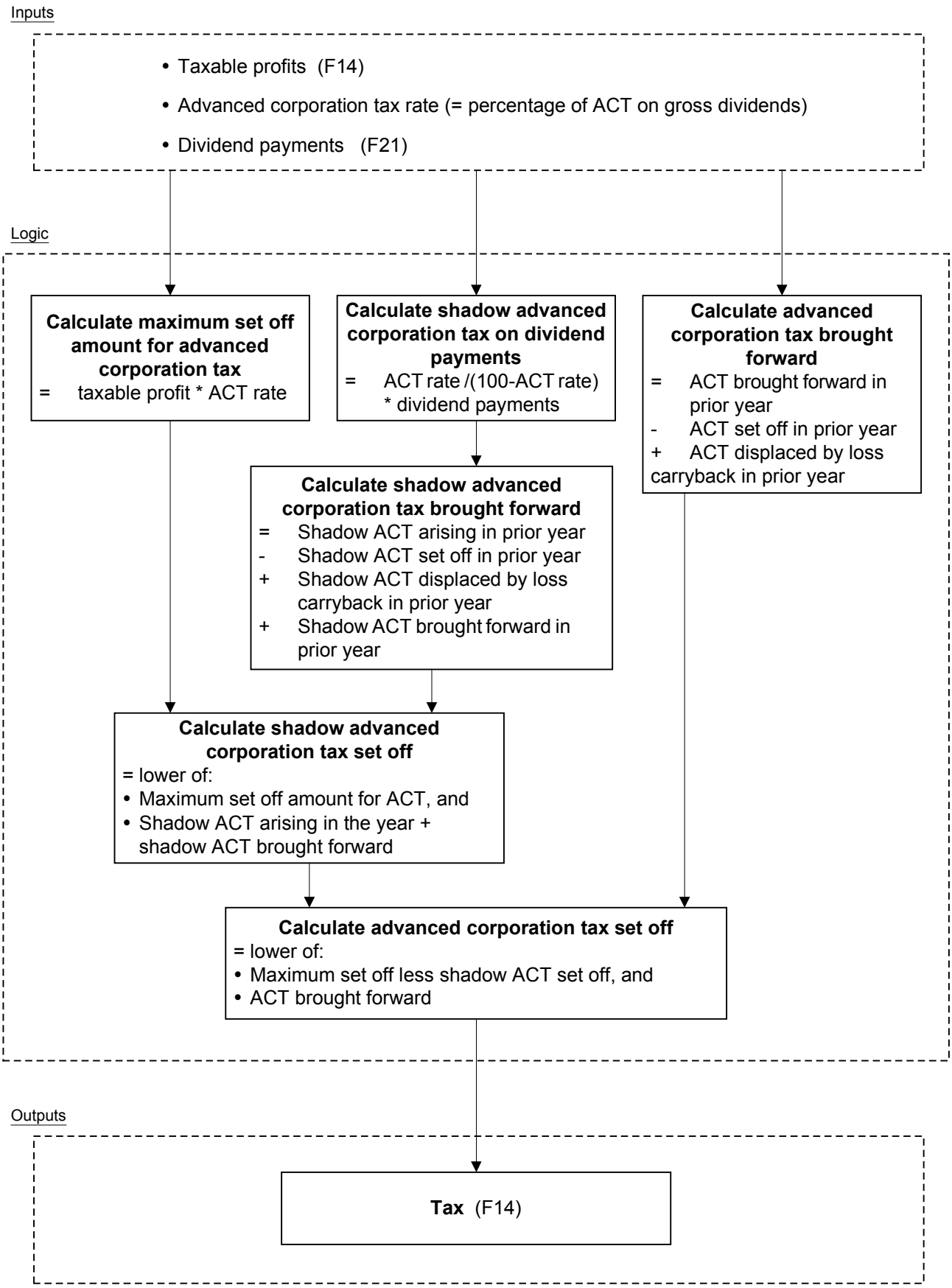
This flexibility is achieved by amending the inputs to the model as appropriate.

ACT

14.10 The model reflects the abolition of ACT from April 1999 and the concept of shadow ACT. This is shown in flowchart F16.

14.11 Shadow ACT is modelled in accordance with the Inland Revenue regulations on the assumption that the water companies are not members of a group. The model calculates the ACT capacity (maximum ACT offset) and reduces it by the shadow ACT (including brought forward surplus shadow ACT). Any excess shadow ACT is carried forward to reduce the ACT capacity in the next period. However, if any capacity remains in a period, surplus ACT is recovered and used to reduce the tax payments.

# Advance corporation tax F16



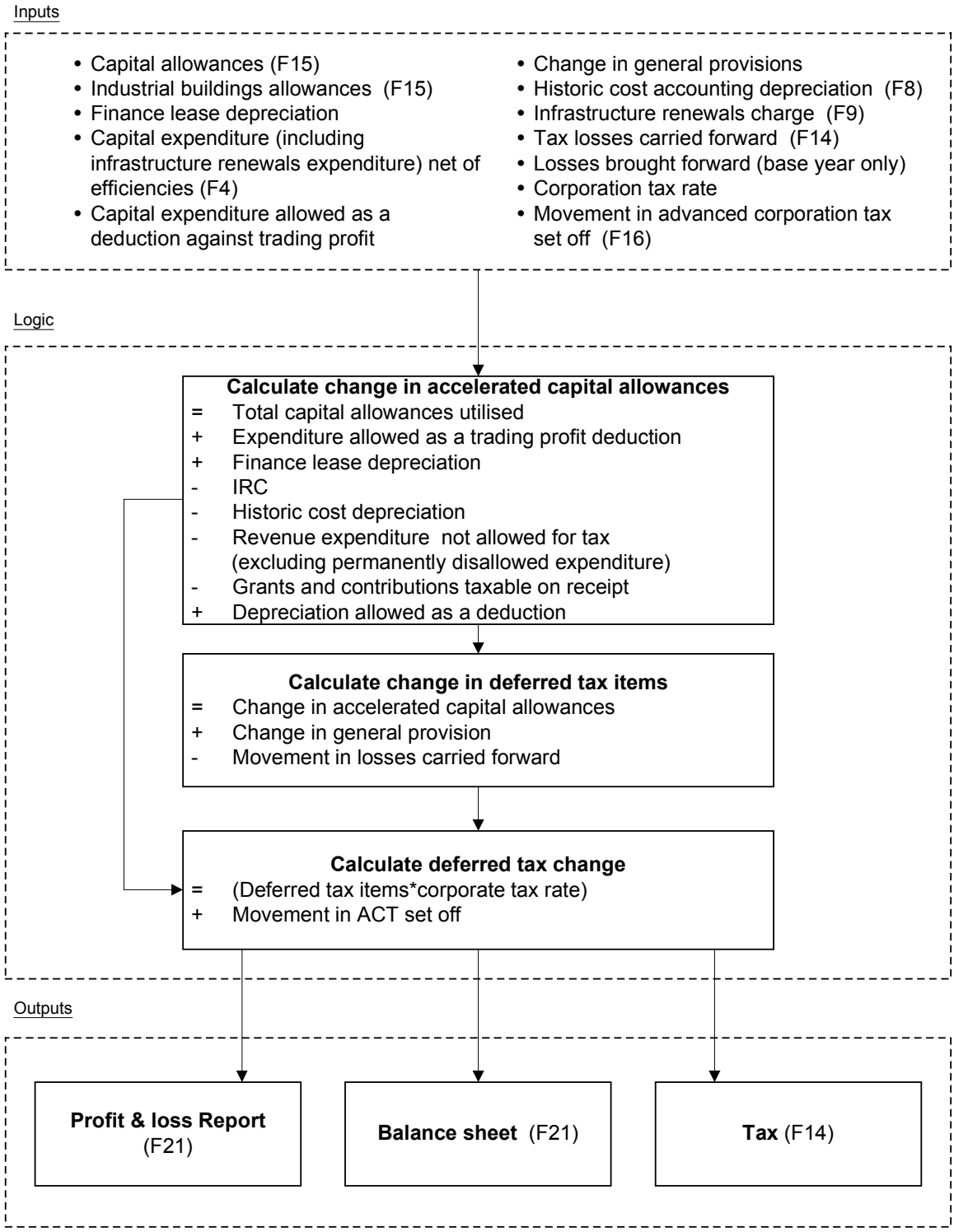
## 15 Deferred tax

15.1 The deferred tax treatment reflects the requirements of current accounting standards (FRS 19), but assumes no discounting.

15.2 The financial model calculates the change in accelerated capital allowances (ACAs). The model includes infrastructure assets in the accelerated capital allowances calculation. The change in general provisions is also included. Tax losses set off and ACT set off are deducted from the amount provided. The change in the deferred tax provision is reflected in the profit and loss account in the tax charge.

15.3 Surplus ACT which has been written off may be set against a deferred tax liability on the basis that if there is a future liability there is future ACT capacity. Shadow ACT will interfere with this presumption and the model only recognises ACT against a deferred tax liability to the extent that surplus shadow ACT could not use up the capacity.

# Deferred tax F17



## 16 K factors and K factor profiling

Initial K calculation

16.1 The K factors are calculated for each year of the review period and a further five years.

16.2 The financial model derives the K factors. These factors relate the changes in the forecast tariff basket revenues to the associated change in the revenue requirement adjusted for non-tariff basket revenue for each year. The model assumes that the forecast tariff basket revenue is equal to the revenue requirement (adjusted for non-tariff basket revenues) in the last year of the previous quinquennium. This produces the initial K profile as shown in flowchart F18.

16.3 The initial K profile gives a rate of return equal to the return to be targeted (the annual blended cost of capital). The financial model allows checks to be performed at this point. These are:

- Check that gearing is at the optimum level over the period; and
- Specify the profile of the blended annual average cost of capital for use in the return on capital element of the revenue requirement when solving K.

16.4 The optimum gearing level is an input to the model. If gearing is outside the optimum range, the model will suggest an adjustment to the opening balance sheet that has been input to the model. The user is required to accept the suggestion or specify their own adjustment which can be none.

16.5 The gearing adjustment is an optional step in solving K. If it is used, then the opening position as input and the outcome of the adjustment made is recorded.

16.6 The gearing adjustment can be used to gear up or gear down the balance sheet. It adjusts the cash and reserves in the opening balance sheet inputs by increasing them when gearing down or decreasing them when gearing up.

16.7 The financial statements are automatically recalculated when the gearing adjustment is applied and when the profile of the average cost of capital is changed. These then form the starting position for the K solving calculations.

Solving K

16.8 The financial projections are checked to ensure that key financial indicators meet the required minimum/maximum levels (inputs to the model). From version 6 onwards, the targets may be specified on an annual basis. Where financial indicators arising from the initial K profile do not satisfy these targets, the model will find the lowest value of K that will achieve the cost of capital and all financial indicator criteria. The K values are solved using a Newton Raphson algorithm. The user has the choice of accepting or rejecting the solutions suggested by the model.

16.9 There is an optional facility in the financial model to smooth the K profile. This will solve a constant K value for each year that maintains the present value of the revenue arising from the entered K profile from the checks on the financial indicators. If this profile is amended manually, the model can find a constant K for the remaining years that have not been adjusted.

16.10 The staged process for adjusting the initial K profile is shown in flowchart F19.

16.11 The model will allow a manual overwrite of the K profile to any profile requested by the user. For any K profile, the financial model will apply the overall service performance adjustment (input to the model) and calculate indicative water and sewerage Ks. For a water company the indicative water K will be the same as the overall K.

16.12 Each time the K profile is adjusted the model recalculates the financial statements.

Average household bills

16.13 In addition to the financial statements and financial indicators, the financial model calculates average household bills (in real terms) for a given K profile. This is based on the customer characteristics in each year.

16.14 The average bill calculated in the financial model will differ slightly from that calculated in the tariff basket model, because it does not reflect the full complexity of changes in customer characteristics. The tariff basket model produces more accurate average bill projections, and is also capable of calculating:

- Standard unmeasured bill based on the average household rateable value in the base year; and
- Standard measured bill based on the average measured household water delivered in the base year; and

WACI adjustment

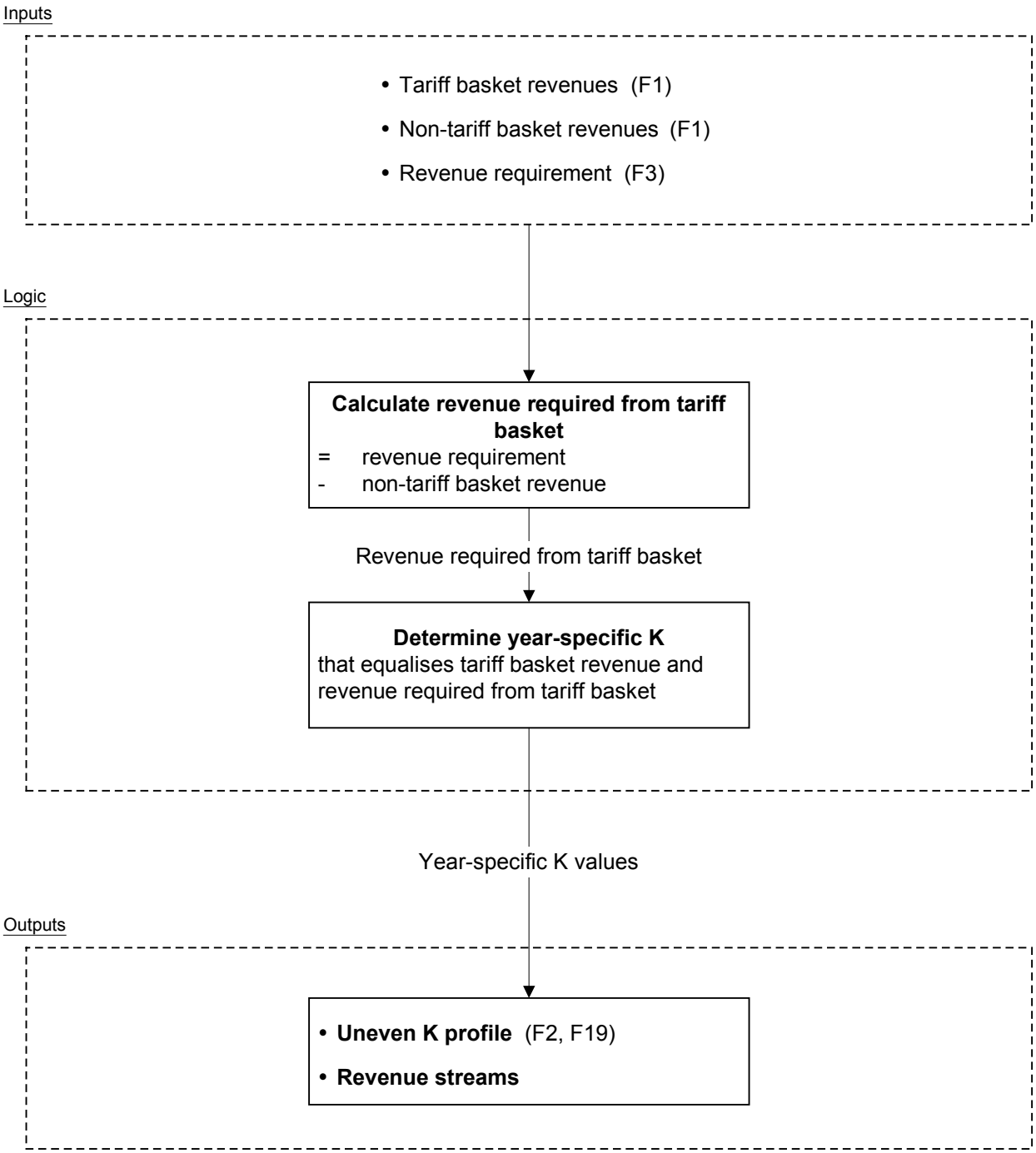
16.15 The determined K factors may include a weighted average charge increase (WACI) adjustment. The WACI adjustment is an input to the financial model. It does not affect the revenue or financial projections arising from the K including overall service performance adjustment.

16.16 The WACI adjustment compensates for situations where the tariff basket model run with K equal to the solved K from the financial model does not produce the same revenue stream as calculated in the financial model.

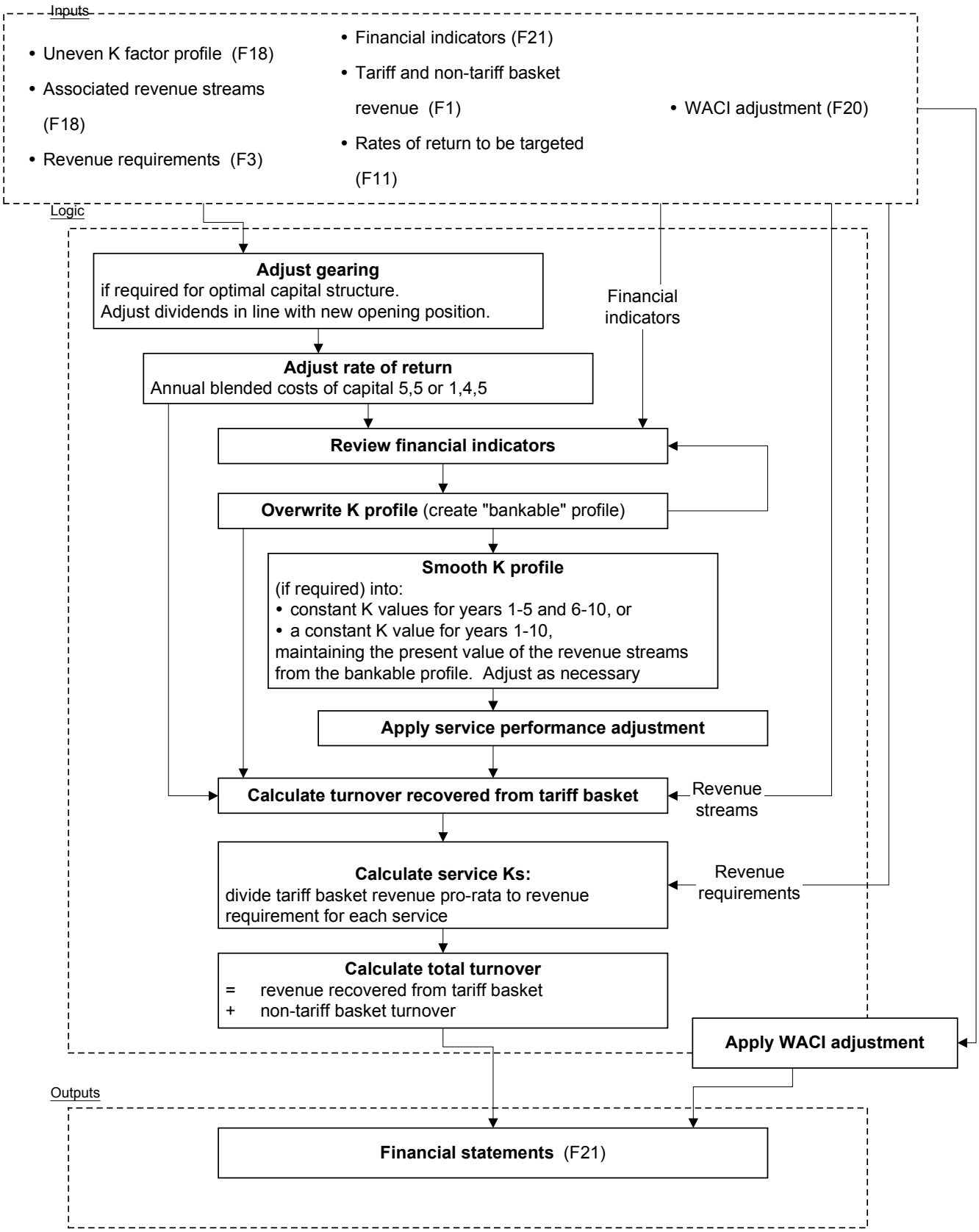
16.17 The financial model assumes tariff basket revenue streams on K=0 basis are scaled by K. For a company with high meter switching and high Ks, it may not be possible to achieve this level of revenue through the tariff basket. Applying K to K=0 revenue streams assumes that all charges will increase by K. However, if a company's customer base is changing, the revenue that it can recover will differ slightly depending on how the company chooses to change charges in its principal statement, due to the timing lags in the tariff basket formula. The size of the discrepancy will be proportional to the value of K.

16.18 We will use the tariff basket model to find the K that will allow companies to accrue the revenue projected by the financial model where the expected revenue is equal to K=0 revenues scaled by the modelled K including overall performance adjustment. The difference between the modelled K and the K found using the tariff basket model is the "WACI adjustment". The WACI adjustment is input to the financial model to feed into the reported K factors. This procedure is illustrated in flow chart F20.

# Initial K calculation F18

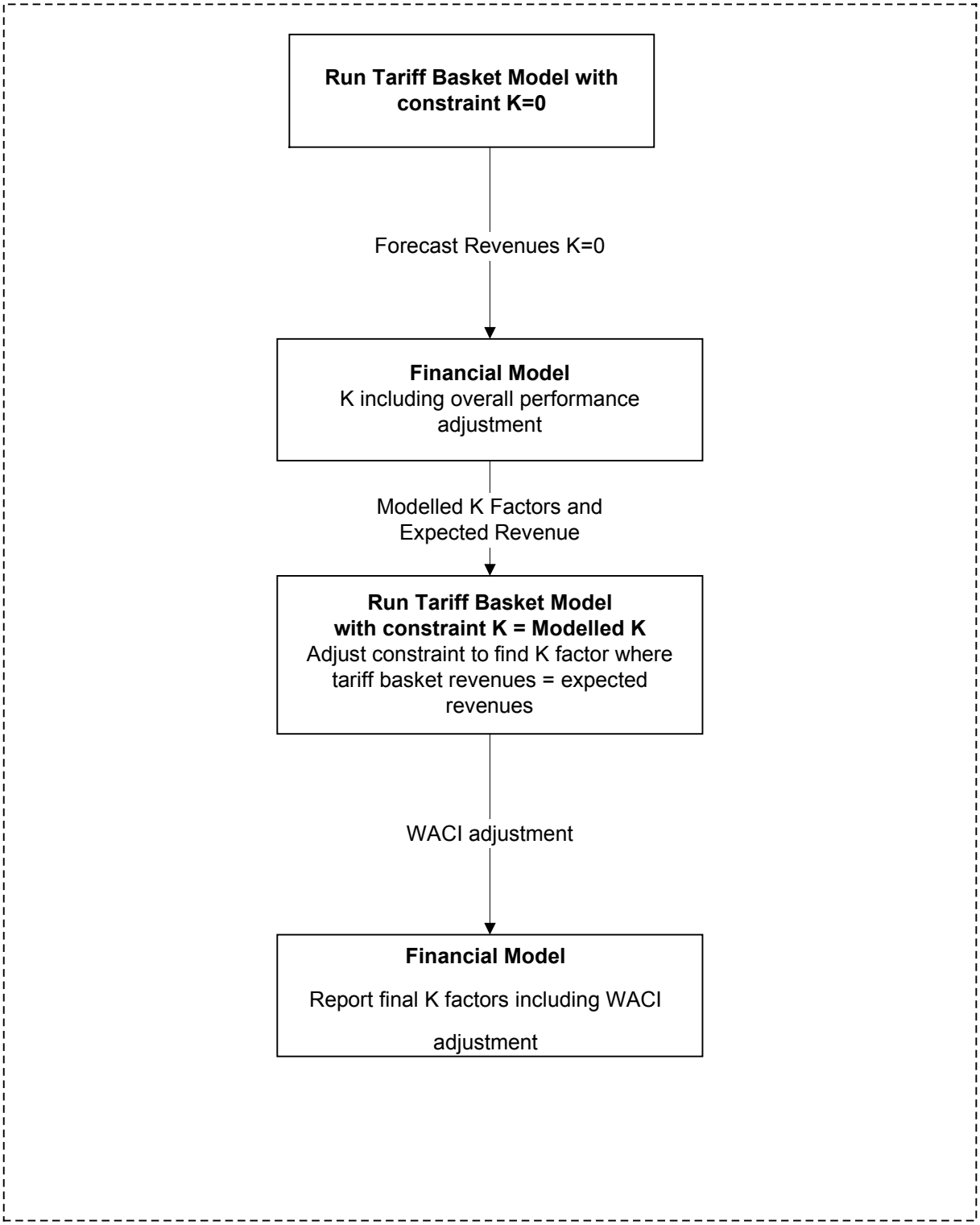


# K factor profiling F19



# WACI adjustment F20

Logic



## 17 Financial statements & financial indicators

17.1 For a given K profile the model calculates the tariff basket turnover and adds the non-tariff basket turnover to determine total turnover. This, in conjunction with the cost components of the revenue requirement, is then used to construct the cashflow, profit & loss and balance sheet for each year. These are then used to calculate relevant financial indicators. This is illustrated in flowchart F21.

Accounts

17.2 Historic Cost (HC) and Current Cost (CC) accounts are produced following the accounting policies set out in the regulatory accounting guidelines (RAGs).

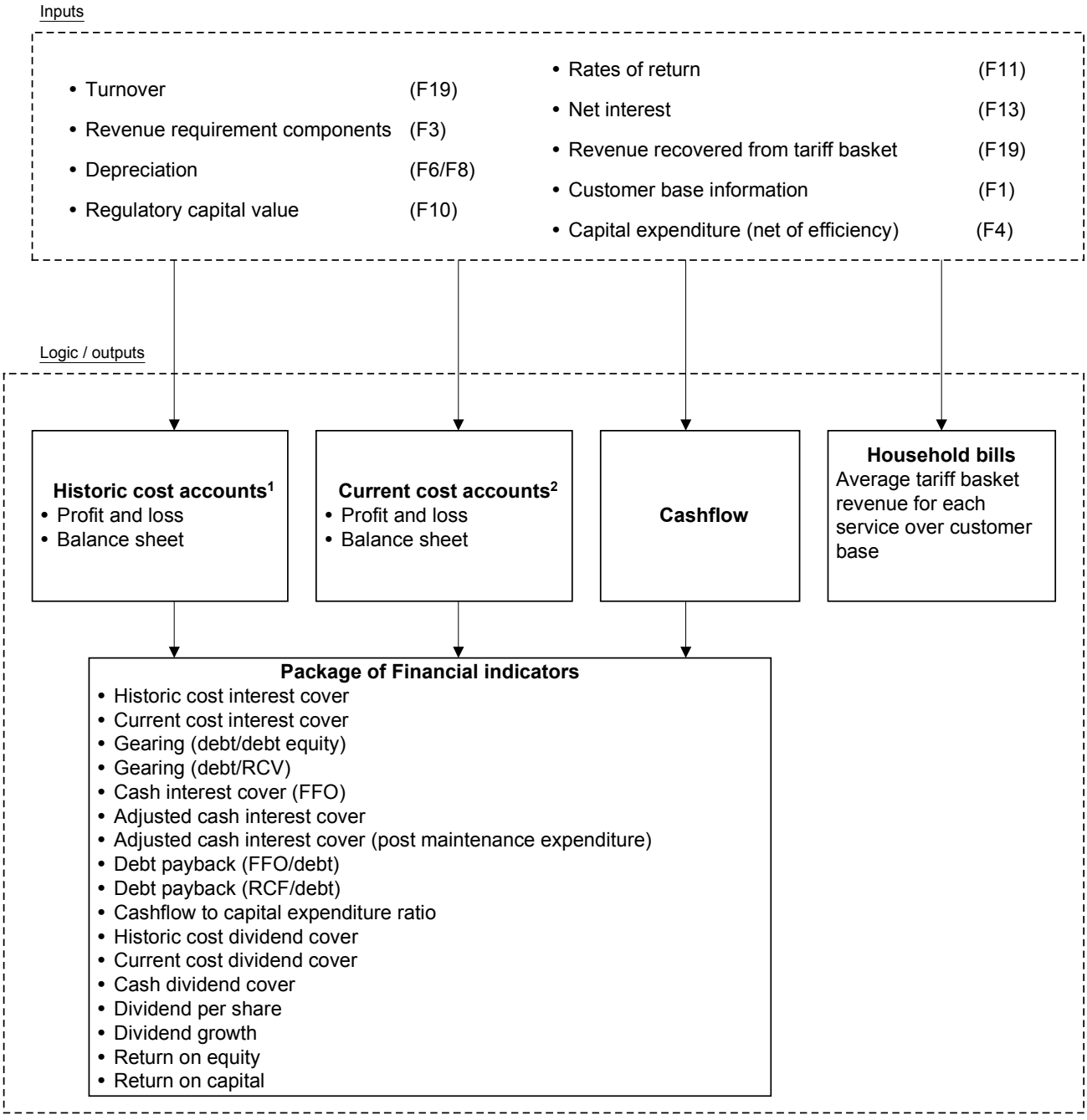
Financial indicators

17.3 We recognise that finance providers and commentators use past and future performance, as set out in accounting and cashflow statements, to assess company performance. As stated in 'Setting water and sewerage price limits for 2005-10' we will use a package of financial indicators to assess the financeability of K profiles.

17.4 The financial model calculates a number of financial indicators. Eight of these are available to be used in the K solving process (explained in section 16) and are:

- Cash interest cover (FFO);
- Ratio of debt to RCV;
- CCA dividend cover;
- Adjusted cast interest cover;
- Adjusted cast interest cover (post maintenance expenditure);
- HCA interest cover;
- Debt payback (FFO/debt); and
- Debt payback (RCF/debt).

# Financial statements and financial indicators F21




1. Historic cost accounts constructed in accordance with UK Generally Accepted Accounting Principles (GAAP)
2. Current cost accounts constructed in accordance with Regulatory Accounting Guidelines (RAGs)
3. "Standard" customers in base year are unmeasured customers with average rateable value and measured customers with average consumption

## 18 Cashflows

18.1 The cash flow statement is the key financial statement linking the profit and loss account with the balance sheet. The size of the capital programme in the water industry places great emphasis on understanding cash flows. The cashflow statement in the financial model follows the conventional format.

18.2 Operating profit is adjusted for non cash items such as depreciation to calculate the net cashflow from operating activities. Other cashflow items such as interest paid or received, taxation, purchase or sale of fixed assets and dividends are then added or subtracted from the net operating cashflow. Any issue or repayment of loans, or issue of shares is then taken into account. The net result being the increase or decrease in cash for the period.

18.3 The following assumptions are made regarding the timing of cashflows.

- IRE is treated as an investing activity rather than part of operating cashflow (IRC is adjusted in arriving at net operating cashflow);
- Interest is paid or received in the year it is incurred;
- Interim dividends are paid in the year to which they relate;
- Final dividends are paid in the following year;
- Corporation tax reflects the new quarterly payment requirements;
- Capital expenditure is paid in the year it is incurred;
- The level of stocks are assumed to be immaterial and not change from period to period.

# APPENDICES

## Tariff Basket Model

In order for Ofwat to set price limits, companies provide revenue forecasts based on average prices only increasing by inflation as measured by the retail price index (RPI). The tariff basket formula calculates the weighted average charges increase. Companies must also ensure that they do not exceed the measured/unmeasured household differential.

The tariff basket model allows Ofwat to alter assumptions while keeping the weighted average charge increase and the measured/unmeasured differential constant.

The tariff basket model combines the tariff basket formula and the measured/unmeasured household differential calculation to produce two simultaneous equations involving the household average rateable value charge and the household volumetric charge.

If assumptions are revised the model changes the household average rateable value charge and the household volumetric charge in order to keep the weighted average charge increase and the measured/unmeasured differential constant.

What follows is a detailed explanation of how the tariff basket formula and the measured/unmeasured differential are combined.

The tariff basket formula is:

$$\gamma^{u}_{t-2}\left(\frac{A_t}{A_{t-1}}\right)+\left(1-\gamma^{u}_{t-2}\right)\left(\frac{B_t}{B_{t-1}}\right)$$

where:

| | | |
|---|---|---|
| $\gamma^{u}_{t-2}$ | = | t-2 unmeasured share of tariff basket revenue |
| $A$ | = | average unmeasured revenue divided by occupied properties |
| $B$ | = | measured basket weighting year revenue |

$A_t$ can be written as:

$$A_t=\frac{\left(\begin{array}{l}\left(f_t^{uhh}\cdot N_{t-1}^{uhh}+\alpha_t^{uhh}\cdot RV_{t-1}^{uhh}+SUN_t^{uhh}\cdot N_{t-1}^{SUNuhh}\right)\\+\left(f_t^{unhh}\cdot N_{t-1}^{unhh}+\alpha_t^{unhh}\cdot RV_{t-1}^{unhh}+SUN_t^{unhh}\cdot N_{t-1}^{SUNunhh}\right)\end{array}\right)}{N_{t-1}^{uhh}+N_{t-1}^{unhh}}$$

(see companies licence condition B)

where:

f =average fixed charge
N =number of properties
$\alpha$ =average rateable value charge
RV =total rateable value
SUN =average sundry charge (any other charge)

superscripts refer to

uhh =unmeasured households
unhh =unmeasured non-households
SUNuhh =unmeasured households charged a sundry charge
SUNunhh =unmeasured non-households charged a sundry charge

and subscripts refer to

t = charging year (ie the year that the charges are made)
t-1 = prior year (ie the year before the charging year)

If we introduce new terms:

$$\phi_{t-1}^{uhh} = \frac{N_{t-1}^{uhh}}{N_{t-1}^{uhh} + N_{t-1}^{unhh}} \quad \text{and} \quad \phi_{t-1}^{unhh} = \frac{N_{t-1}^{unhh}}{N_{t-1}^{uhh} + N_{t-1}^{unhh}}$$

$$\overline{RV}^{uhh}_{t-1} = \frac{RV_{t-1}^{uhh}}{N_{t-1}^{uhh}} \quad \text{and} \quad \overline{RV}^{unhh}_{t-1} = \frac{RV_{t-1}^{unhh}}{N_{t-1}^{unhh}}$$

then we can write $A_t$ as:

$$A_t = \phi_{t-1}^{uhh} \cdot \left[ f_t^{uhh} + \alpha_t \cdot \overline{RV}^{uhh}_{t-1} + \frac{SUN_t^{uhh} \cdot N_{t-1}^{sun \cdot hh}}{N_{t-1}^{uhh}} \right] + \phi_{t-1}^{unhh} \cdot \left[ f_t^{unhh} + \alpha_t^{unhh} \cdot \overline{RV}^{unhh}_{t-1} + \frac{SUN_t^{unhh} \cdot N_{t-1}^{SUN-unhh}}{N_{t-1}^{unhh}} \right]$$

By introducing further terms :

$$\overline{SUN}^{uhh}_{t-1} = \frac{SUN_t^{uhh} \cdot N_{t-1}^{SUNuhh}}{N_{t-1}^{uhh}} \quad \text{and} \quad \overline{SUN}^{unhh}_{t-1} = \frac{SUN_t^{unhh} \cdot N_{t-1}^{SUNunhh}}{N_{t-1}^{unhh}}$$

and making the assumption that $\alpha_t^{unhh}$ is directly proportional to $\alpha_t^{uhh}$ so that we can introduce a constant $\upsilon$ which is equal to:

$$\upsilon = \frac{\alpha_{t(original)}^{unhh}}{\alpha_{t(original)}^{uhh}}$$

(These are values given by the companies and are therefore constants)

we can write $A_t$ as:

$$\begin{aligned} A_t = \alpha_t^{uhh} & \left[ \phi_{t-1}^{uhh} \cdot \overline{RV}_{t-1}^{uhh} + \phi_{t-1}^{unhh} \cdot \upsilon \cdot \overline{RV}_{t-1}^{unhh} \right] \\ & + \phi_{t-1}^{uhh} \left[ f_t^{uhh} + \overline{SUN}_{t-1}^{uhh} \right] \\ & + \phi_{t-1}^{unhh} \left[ f_t^{unhh} + \overline{SUN}_{t-1}^{unhh} \right] \end{aligned}$$

The formula for the measured/unmeasured differential ($D_t$) is :

$$D_t = \left( s_t^{mhh} + \beta_t^{mhh} \cdot \overline{V}_{t-2}^{uhh} \right) - \left( f_t^{uhh} + \alpha_t^{uhh} \overline{RV}_{t-2}^{uhh} + \overline{SUN}_{t-2}^{uhh} \right)$$

where

$s_t^{mhh}$ =average measured household standing charge for year t

$\beta_t^{mhh}$ =average measured household volumetric charge for year t

$\overline{V}_{t-2}^{uhh}$ =average volume of water delivered per unmeasured household in year t-2

$\overline{RV}_{t-2}^{uhh}$ = average rateable value per unmeasured household in year t-2

and $\overline{SUN}_{t-2}^{uhh} = \frac{SUN_t^{uhh} \cdot N_{t-2}^{sun-uhh}}{N_{t-2}^{uhh}}$.

We can rearrange this to make $\alpha_t$ the subject

$$\alpha_t^{uhh} = \beta_t^{mhh} \cdot \left( \frac{\overline{V}_{t-2}^{uhh}}{\overline{RV}_{t-2}^{uhh}} \right) + \left( \frac{s_t^{mhh} - f_t^{uhh} - \overline{SUN}_{t-2}^{uhh} - D_t}{\overline{RV}_{t-2}^{uhh}} \right)$$

If we then substitute this expression of $\alpha_t^{uhh}$ in the earlier formula of $A_t$ we get:

$$A_t = \left[ \beta_t \cdot \left( \frac{\overline{V}^{uhh}_{t-2}}{\overline{RV}^{uhh}_{t-2}} \right) + \left( \frac{s_t^{mhh} - f_t^{uhh} - \overline{SUN}^{uhh}_{t-2} - D_t}{\overline{RV}^{uhh}_{t-2}} \right) \right] \cdot \left[ \phi_{t-1}^{uhh} \cdot \overline{RV}^{uhh}_{t-1} + \phi_{t-1}^{unhh} \cdot \upsilon \cdot \overline{RV}^{unhh}_{t-1} \right]$$
$$+ \phi_{t-1}^{uhh} \left[ f_t^{uhh} + \overline{SUN}^{uhh}_{t-1} \right]$$
$$+ \phi_{t-1}^{unhh} \left[ f_t^{uhh} + \overline{SUN}^{unhh}_{t-1} \right]$$

Introducing five new symbols we can present this in a different way:

$$A_t = \beta_t^{mhh} \cdot \chi_1 \cdot \chi_2 + \chi_3 \cdot \chi_2 + \chi_4 + \chi_5$$

where the five symbols are:

$$\chi_1 = \frac{\overline{V}^{uhh}_{t-2}}{\overline{RV}^{uhh}_{t-2}}$$
$$\chi_2 = \phi_{t-1}^{uhh} \cdot \overline{RV}^{uhh}_{t-1} + \phi_{t-1}^{unhh} \cdot \upsilon \cdot \overline{RV}^{unhh}_{t-1}$$
$$\chi_3 = \left( \frac{s_t^{mhh} - f_t^{uhh} - \overline{SUN}^{uhh}_{t-2} - D_t}{\overline{RV}^{uhh}_{t-2}} \right)$$
$$\chi_4 = \phi_{t-1}^{uhh} \cdot \left( f_t^{uhh} + \overline{SUN}^{uhh}_{t-1} \right)$$
$$\chi_5 = \phi_{t-1}^{unhh} \cdot \left( f_t^{unhh} + \overline{SUN}^{unhh}_{t-1} \right)$$

This is an expression for $A_t$, now we need one for $B_t$. $B_t$ can be written as:

$$B_t = \left( s_t^{mhh} \cdot N_{t-2}^{mhh} + \beta_t^{mhh} \cdot V_{t-2}^{mhh} + SUN_t^{mhh} \cdot N_{t-2}^{SUNmhh} \right)$$
$$+ \left( s_t^{mnhh} \cdot N_{t-2}^{mnhh} + \beta_t^{mnhh} V_{t-2}^{mnhh} + SUN_t^{mnhh} \cdot N_{t-2}^{SUNmnhh} \right)$$

(see companies' licence condition B)

where

| | |
|---|---|
| s | =average fixed/standing charge |
| N | =number of properties |
| β | =average volumetric charge |
| V | =total water billed |
| SUN | =average sundry charge (sundry charge is any other charge) |

superscripts refer to

| | |
|---|---|
| mhh | =measured households |
| mnhh | =measured non-households |
| SUNmhh | =measured households charged a sundry charge |
| SUNmnhh | =measured non-households charged a sundry charge |

and subscripts refer to

t = charging year (ie the year that the charges are made)
t-2 = weighting year (ie the year two years before the charging year)

If we introduce a new term

$$\Gamma_t^m = \left(s_t^{mhh} \cdot N_{t-2}^{mhh} + SUN_t^{mhh} \cdot N_{t-2}^{SUNmhh}\right) + \left(s_t^{mnhh} \cdot N_{t-2}^{mnhh} + SUN_t^{mnhh} \cdot N_{t-2}^{SUNmnhh}\right)$$

and make the assumption that $\beta_t^{mnhh}$ is directly proportional to $\beta_t^{mhh}$ so that we can introduce a constant $\varsigma$ which is equal to:

$$\varsigma = \frac{\beta_{t(original)}^{mnhh}}{\beta_{t(original)}^{mhh}}$$ (These are values given by the companies and are therefore constants)

then we can express $B_t$ more concisely as:

$$B_t = \Gamma_t^m + \beta_t^{mhh}\left(V_{t-2}^{mhh} + \varsigma V_{t-2}^{mnhh}\right)$$

As a reminder the tariff basket formula is:

$$\gamma_{t-2}^u\left(\frac{A_t}{A_{t-1}}\right) + \left(1-\gamma_{t-2}^u\right)\left(\frac{B_t}{B_{t-1}}\right)$$

If we replace $A_t$ and $B_t$ in the tariff basket with the formulas we have derived and set the formula equal to inflation we get,

$$(1+\text{RPI}) = \gamma_{t-2}^u\left(\frac{\beta_t^{mhh} \cdot \chi_1 \cdot \chi_2 + \chi_3 \cdot \chi_2 + \chi_4 + \chi_5}{A_{t-1}}\right) + \left(1-\gamma_{t-2}^u\right)\left(\frac{\Gamma_t^m + \beta_t^{mhh}\left(V_{t-2}^{mhh} + \varsigma V_{t-2}^{mnhh}\right)}{B_{t-1}}\right)$$

where RPI is the annual increase in the retail price index at the November before year t.

This can be rearranged to:

$$(1+RPI)A_{t-1}B_{t-1} - A_{t-1}\left(1-\gamma_{t-2}^u\right)\left(\Gamma_t^m\right) - B_{t-1}\gamma_{t-2}^u\left(\chi_3 \cdot \chi_2 + \chi_4 + \chi_5\right) = \beta_t^{mhh}\left\{B_{t-1}\gamma_{t-2}^u\left(\chi_1 \cdot \chi_2\right) + A_{t-1}\left(1-\gamma_{t-2}^u\right)\left(V_{t-2}^{mhh} + \varsigma V_{t-2}^{mnhh}\right)\right\}$$

which can be rearranged as:

$$\beta_t^{mhh} = \frac{\left[(1+RPI)A_{t-1}B_{t-1}\right] - \left[A_{t-1}\left(1-\gamma_{t-2}^u\right)\left(\Gamma_t^m\right)\right] - \left[B_{t-1}\gamma_{t-2}^u\left(\chi_3 \cdot \chi_2 + \chi_4 + \chi_5\right)\right]}{\left[B_{t-1}\gamma_{t-2}^u\left(\chi_1 \cdot \chi_2\right)\right] + \left[A_{t-1}\left(1-\gamma_{t-2}^u\right)\left(V_{t-2}^{mhh} + \varsigma V_{t-2}^{mnhh}\right)\right]}$$

Introducing five new symbols we can present this in a different way:

$$\beta_t^{mhh} = \frac{\Lambda_1 - \Lambda_2 - \Lambda_3}{\Lambda_4 + \Lambda_5}$$

where the five symbols are:

$$\Lambda_1 = (1 + RPI) A_{t-1} B_{t-1}$$
$$\Lambda_2 = A_{t-1}\left(1 - \gamma_{t-2}^{u}\right)\left(\Gamma_t^{m}\right)$$
$$\Lambda_3 = B_{t-1}\gamma_{t-2}^{u}\left(\chi_3 \cdot \chi_2 + \chi_4 + \chi_5\right)$$
$$\Lambda_4 = B_{t-1}\gamma_{t-2}^{u}\left(\chi_1 \cdot \chi_2\right)$$
$$\Lambda_5 = A_{t-1}\left(1 - \gamma_{t-2}^{u}\right)\left(V_{t-2}^{mhh} + \varsigma V_{t-2}^{mnhh}\right)$$

This will solve $\beta_t^{mhh}$ and then we can solve $\alpha_t^{uhh}$ by using the rearranged differential formula from above:

$$\alpha_t^{uhh} = \frac{s_t^{mhh} + \beta_t^{mhh} \cdot \overline{V}_{t-2}^{uhh} - f_t^{uhh} - \overline{SUN}_{t-2}^{uhh} - D_t}{\overline{RV}_{t-2}^{uhh}}$$

***Modification for the sewerage service***

Only simple changes need to be made to the calculations for the water service to make them suitable for the sewerage service, and they are changes to what symbols represent, rather than to the algebra.

In order to accommodate the slight difference in the methodology for the measured/unmeasured differential between water and sewerage services the following change is needed:

$\overline{V}_{t-2}^{uhh}$ = average volume per unmeasured household in year t-2 less the average unmeasured supply pipe leakage per unmeasured customer year t-2, plus the average measured supply pipe leakage per externally metered household, with the result adjusted for the company's measured household non-return to sewer allowance.

To incorporate the trade effluent basket weighting year revenue is redefined as:

$$B_t = \left(s_t^{mhh} \cdot N_{t-2}^{mhh} + \beta_t^{mhh} \cdot V_{t-2}^{mhh} + SUN_t^{mhh} \cdot N_{t-2}^{SUNmhh}\right)$$
$$+ \left(s_t^{mnhh} \cdot N_{t-2}^{mnhh} + \beta_t^{mnhh} V_{t-2}^{mnhh} + SUN_t^{mnhh} \cdot N_{t-2}^{SUNmnhh}\right)$$
$$+ Trade\_Effluent\_weighting\_year\_revenue$$

This makes a further redefinition necessary.

$$\Gamma_t^m = \left(s_t^{mhh} \cdot N_{t-2}^{mhh} + SUN_t^{mhh} \cdot N_{t-2}^{SUNmhh}\right) + \left(s_t^{mnhh} \cdot N_{t-2}^{mnhh} + SUN_t^{mnhh} \cdot N_{t-2}^{SUNmnhh}\right) + Trade\_Effluent\_weighting\_year\_revenue$$

***Modification for the special case where there is no RV charge***

The normal algebra needs to be changed if a water company does not charge by RV. At the present time this does not apply to any water company.

If a water company does not charge at least one household property by RV, then $\overline{RV}_t^{uhh} = 0$ and the formulas used in the normal case become invalid.

In this case the tariff basket model treats the unmeasured household fixed charge as a variable instead of the unmeasured household rateable value charge.

To solve this problem the model calculates charges for unmeasured customers as if **all** unmeasured revenue is recovered by fixed charges. In this case $A_t$ is:

$$A_t = \frac{\left(\left(f_t^{uhh} \cdot N_{t-1}^{uhh}\right) + \left(f_t^{unhh} \cdot N_{t-1}^{unhh}\right)\right)}{N_{t-1}^{uhh} + N_{t-1}^{unhh}}$$

The model further calculates charges as if unmeasured household fixed charges and non-households fixed charges are equal, so:

$$A_t = \frac{\left(f_t^{uhh} \cdot \left(N_{t-1}^{uhh} + N_{t-1}^{unhh}\right)\right)}{N_{t-1}^{uhh} + N_{t-1}^{unhh}} = f_t^{uhh}$$

The formula for the measured/unmeasured differential ($D_t$) would be :

$$D_t = \left(s_t^{mhh} + \beta_t^{mhh} \cdot \overline{V}_{t-2}^{uhh}\right) - f_t^{uhh}$$

Rearranging to make $f_t^{uhh}$ the subject we get:

$$f_t^{uhh} = \left(s_t^{mhh} + \beta_t^{mhh} \cdot \overline{V}_{t-2}^{uhh}\right) - D_t = A_t$$

Writing this in a similar way to the normal case we get:

$$A_t = \beta_t^{mhh} \cdot \widetilde{\chi}_1 + \widetilde{\chi}_3$$

where the two symbols are:

$$\widetilde{\chi}_1 = \overline{V}_{t-2}^{uhh}$$

$$\widetilde{\chi}_3 = s_t^{mhh} - D_t$$

This is therefore the expression for $A_t$ presented in a similar way to the normal case. The expression for $B_t$ only changes due to this changed expression:

$$\beta_t^{mhh} = \frac{\widetilde{\Lambda}_1 - \widetilde{\Lambda}_2 - \widetilde{\Lambda}_3}{\widetilde{\Lambda}_4 + \widetilde{\Lambda}_5}$$

where the five symbols are:

$$\widetilde{\Lambda}_1 = (1 + RPI) A_{t-1} B_{t-1}$$
$$\widetilde{\Lambda}_2 = A_{t-1} \left(1 - \gamma_{t-2}^{u}\right) \left(\Gamma_t^{m}\right)$$
$$\widetilde{\Lambda}_3 = B_{t-1} \gamma_{t-2}^{u} \left(\widetilde{\chi}_3\right)$$
$$\widetilde{\Lambda}_4 = B_{t-1} \gamma_{t-2}^{u} \left(\widetilde{\chi}_1\right)$$
$$\widetilde{\Lambda}_5 = A_{t-1} \left(1 - \gamma_{t-2}^{u}\right) \left(V_{t-2}^{mhh} + \varsigma V_{t-2}^{mnhh}\right)$$

Therefore we can solve $\beta_t^{mhh}$

We solve $f_t^{uhh}$ by using the rearrangement of the differential calculation as above:

$$f_t^{uhh} = \left(s_t^{mhh} + \beta_t^{mhh} \cdot \overline{V}_{t-2}^{uhh}\right) - D_t = f_t^{unhh}$$

Please note that in the tariff basket model this final calculation is carried out on a different worksheet to all other calculations presented above.

# Financial model inputs

## Glossary of terms and definitions

**Appointed business**: The business providing water (and sewerage) services. Typically the appointed business is carried out in a subsidiary company known as the Appointed Company which acts under an Instrument of Appointment (or Licence).

**Base service:** The current level of service provided to customer. In the context of base service assets this refers to the assets which provide the base level of service.

**Bulk supplies**: Supplies of treated or untreated water traded between individual water companies. These supplies are often traded under long-term contracts and on non-standard terms. Ofwat has power to determine the terms of such supplies if so requested.

**Capital base**: See Regulatory Capital Value.

**Capital maintenance**: Planned work carried out by companies to replace and repair water and sewerage assets to provide continuing services to customers.

**Capital programmes**: Planned construction work being carried out by companies to build new assets such as sewage treatment works and water mains.

**Cost of capital**: The minimum return that providers of capital require to induce them to invest in or lend to a business, given its risks (see weighted average cost of capital).

**Current cost accounting**: A method of accounting originally designed to deal with the problem of showing the effect of inflation on business profits. Instead of showing assets at their historic cost (ie their original purchase price), less depreciation where appropriate, the assets are shown at their current cost (replacement cost) at the time of producing the accounts. This method of accounting is used in tandem with Historic Cost Accounting (HCA) in the water industry because of the extensive nature of capital assets and the fact that historic costs do not reflect the asset's true worth.

**Depreciation**: Depreciation is a measure of the consumption, use or wearing out of an asset over the period of its useful economic life.

**Dividend cover**: The number of times a company's dividends to ordinary shareholders could be paid out of net profits after tax in the same period.

**Enhancement expenditure:** Expenditure to enhance and grow the asset base.

**Enhanced service levels**: Permanent, identifiable and measurable improvements in service levels that are above the most recently established company-wide base levels of service and which are additional to improvements resulting from expenditure in other purpose categories.

**Equity finance**: The risk-sharing part of a company's capital. Usually referred to as ordinary share capital.

**Financial indicators**: Financial ratios used to measure the financial performance of a company. These involve for example service, interest cover and divided cover.

**Gearing:** A company's net debt expressed as a percentage of its total capital (ie the ratio of net debt to net debt plus equity expressed as a percentage). Another measure of gearing used in the water industry is net debt/RCV.

**Historic cost accounting**: The traditional form of accounting, in which assets are shown in balance sheets at their costs to the organisation (historic cost), less any appropriate depreciation.

**Indexation**: The policy of connecting prices, costs, wages, taxes etc to rises in the general price level, retail prices or other measures of prices (inflation).

**Infrastructure assets**: Mainly underground assets, such as water mains and sewers and also dams and reservoirs that last for a long time. A distinction is drawn between infrastructure and non-infrastructure assets because of the way in which the assets are managed, operated and maintained by the companies.

**Infrastructure charges**: Paid by developers and customers in new properties for either a first time connection of premises for domestic purposes to a public water supply or a public sewer.

**Infrastructure renewals charge**: An annual accounting provision for expenditure on the renewal of infrastructure (ie mainly underground) assets charged to the profit and loss account.

**Infrastructure renewals expenditures:** Expenditure to replace and renew underground (or infrastructure assets)

**Interest cover**: The number of times a company's profits before interest and tax cover interest due on all its borrowings.

**Large users**: In general terms, large users are industrial and commercial customers using significant annual amounts of water (eg greater than 25-50 megalitres a year). Under the Competition and Service (Utilities) Act 1992

large Users are defined as those customers using 250 megalitres or more a year.

**Levels of service**: Specific measures of services to customers.

**Licence**: The water (and sewerage) companies operate under licences granted by the Secretaries of State for the Environment and Wales, or by the Director, to provide water and sewerage services in England and Wales. The licences impose conditions on the companies which the Director is required to enforce.

**Maintenance non-infrastructure, expenditure:** Capital expenditure to replace and renew non-infrastructure assets.

**Net present value**: The economic value of a project, at today's prices, calculated by netting off its discounted cash flow from revenues and costs over its full life.

**Newton Raphson algorithm:** The Newton Raphson algorithm is used to iterate to a value x such that f(x) =0, and is particularly useful in solving functions that where it is impossible (or very difficult) to do so algebraically but finding the inverse of the function.. The algorithm is:

$X_{n+1} = X_n - f(X_n)/f'(X_n)$

Where f'(x) is the gradient of the function f at X. Within Aquarius 3 it will not be possible to define the gradient of f(x) mathematically, so it will be calculated empirically by changing the value of X slightly. The algorithm is considered to have converged once the f(X) is within the prescribed tolerance or 0.

**Non-infrastructure assets**: Mainly surface assets such as water and sewerage treatment works, pumping stations and company laboratories, depots and workshops.

**Overall service performance adjustment:** An adjustment made to companies price limits because they provide a level of service which is significantly higher or lower than other companies.

**Quality enhancements**: A generic term for work programmes implemented by the companies to improve the quality of drinking water or the environment such as treating wastewater discharges to a higher standard. These enhancements are required to fulfil new legislation or national initiatives approved by Ministers.

**Quinquennium**: A period of five years.

**Rate of return**: The annual income and capital growth from an investment, expressed as a percentage of the original investment.

**Regulatory accounts**: Financial statements about the Appointed Business which are required by the Director to enable him to carry out his duties.

**Regulatory capital value**: The capital base used in setting price limits. The value of the Appointed Business which earns a return on investment. It represents the initial market value (200 day average), including debt, plus subsequent net new capital expenditure as assumed at the time of initial price setting and including new obligations imposed since 1989. The capital value is calculated using Ofwat's methodology (ie after current cost depreciation and infrastructure renewals accrual).

**Requisition charges**: The charge to a developer and property owner or local authority for requisitioning from the company a new water main or public sewer to be extended to the existing system and to connect into it.

**Review period**: The five years for which the K factors are to be determined.

**Rights issue:** A method by which companies which are quoted on the Stock Exchange raise new equity capital, in exchange for new shares issued by way of rights to its existing shareholders.

**Special dividends**: Dividends paid by the company which are not part of the usual dividend stream arising in the usual course of business.

**Supplementary investment**: Investment carried out by companies to provide enhanced levels of service but which has not already been allowed for in price limits.

**Supply/demand balance**: The balance between the amount of a company's available water resource and the demand for water by customers. Any imbalance between supply and demand can commonly be met via demand management strategies such as selective metering and leakage control.

**Tariff basket**: The basket of charges to which the annual regulatory price limits apply comprising: charges for unmeasured water supply; charges for measured supply; charges for unmeasured sewerage services; charges for measured sewerage services and charges for reception, treatment and disposal of trade effluent.

**Weighted average cost of capital (WACC)**: For a company, the average of its cost of debt and cost of equity capital (see Cost of capital), weighted according to the balance of debt and equity which finances the company's assets.