WATER SERVICES REGULATION AUTHORITY
WATER INDUSTRY ACT 1991, SECTION 12

BRISTOL WATER PLC

Notice of Reference: Determination of Price Controls for the period from 1 April 2015

4 March 2015

1. (a) Bristol Water plc ("the Company") holds an Appointment as a water undertaker for the purposes of Chapter I of Part II of the Water Industry Act 1991 ("the Appointment");

1. (b) on 12 December 2014, the Water Services Regulation Authority ("Ofwat") gave notice to the Company of a determination under Condition B of the Appointment of the Price Controls for the period from 1 April 2015 ("the Disputed Determination"). The terms of the Disputed Determination are set out in Schedule 1 hereto;

1. (c) the Company has required Ofwat to refer the Disputed Determination to the Competition and Markets Authority ("CMA"). The terms of the Company's notice are set out in Schedule 2 hereto.

2. Ofwat, as required by section 12(3)(a) of the Water Industry Act 1991 and the Appointment, refers the Disputed Determination to the CMA.

3. The CMA shall report on and determine the Disputed Determination within a period of six months beginning with the date of this reference.

Signed for and on behalf of the
Water Services Regulation Authority

Keith Mason
Senior Director of Finance and Networks

Schedule 1: Final determination letter

Luis Garcia
Chief Executive
Bristol Water plc
PO Box 218
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Bristol
BS99 7AU

12 December 2014

Dear Luis

Final determination of price controls

I enclose the formal notification of the determination by the Water Services Regulation Authority (Ofwat) of Price Controls for Retail Activities and for Wholesale Activities. This sets out:

- the designation of Retail Activities;
- the Price Controls in respect of Retail Activities;
- the Price Control in respect of Wholesale Activities; and
- (in the attached annex) the Notified Item and Land sales assumptions.

We will publish information about the annual regulatory reporting and assurance requirements early in 2015.

This final determination letter has been published on our website. We are also publishing the outcomes and associated performance commitments for the company to deliver, together with information on our general approach and the reasons for our decisions.

A key feature of our price review has been clarity about the outcomes that you will deliver and the performance commitments that you have set out. So while not part of the detail set out in the enclosed notification, the set of outcomes, performance commitments and outcome delivery incentives (as detailed in Annex 4 to the published appendix that is specific to your company) should be seen as an essential part of both the price review package and what you need to deliver for your customers.

You must notify us of your menu choice by 16 January 2015 (see IN 14/15, '2014 price review – timetable for setting charges for 2015-16 and making menu choices' (September 2014)).

You have two months from today to decide whether to ask us to refer the determination to the Competition and Markets Authority. If you wish to refer the determination you must let us know in writing no later than 12 February 2015.

Yours sincerely

Cathryn Ross
Chief Executive

Notification by the Water Services Regulation Authority of its determination of Price Controls for Retail Activities and for Wholesale Activities for Bristol Water plc ("the Determination")

Introduction

This is the Determination by the Water Services Regulation Authority ("Ofwat") as to the Price Controls for Retail Activities and for Wholesale Activities. It is made by Ofwat in accordance with Part III of Condition B (Charges) of your Appointment as a water undertaker, having had regard to all the circumstances which are relevant in the light of the principles which apply by virtue of Part I of the Water Industry Act 1991, including, without limitation:

- any change in circumstance which has occurred since the last Periodic Review or which is to occur; and
- the guidance issued by the Secretary of State for Environment, Food and Rural Affairs under section 2A of the Water Industry Act 1991.

The Price Controls will apply to the Charging Year starting on 1 April 2015 and subsequent Charging Years.

You must levy charges in a way best calculated to comply with the Price Controls.

Unless the contrary intention appears, words and expressions used in this document shall have the same meaning as in the Conditions of the Appointment.

Designation of Retail Activities

For the purposes of the Determination, Ofwat confirms the designation under sub-paragraph 8.9 of Condition B of (in summary) the following activities and costs as Retail Activities:

Customer services including:

- billing;
- payment handling;
- remittance and cash handling;
- charitable trust donations;
- vulnerable customer schemes; and
- network and non-network customer enquiries and complaints.

Debt management and doubtful debts.

Meter reading.

Other operating costs including:

- decision and administration of disconnections and reconnections;
- demand-side water efficiency initiatives;
- customer-side leaks;
- attributable other direct costs;

- attributable general and support expenditure; and
- attributable other business activities.

Developer services:

- providing developer information; and
- administration for new connections.

Attributable Business Rates (referred to as Local authority rates in Regulatory Accounting Guideline (RAG) 4.04).

These are, with one change, the retail activities summarised in Table 1 of ‘Setting price controls for 2015-20 – final methodology and expectations for companies’ business plans’ (July 2013) and defined in more detail in section A5.4 of Appendix 5 (Guidance on business plan tables) to that document. The one change is that our definition of Retail Activities was subsequently updated to exclude all scientific services (see IN 13/10, ‘Change to company business plan guidance for the 2014 price review – costs of scientific services’ (September 2013)).

All activities undertaken as part of the Appointed Business that are not designated as Retail Activities are Wholesale Activities.

This designation is treated for the purposes of sub-paragraph 15.1 (References to the Competition and Markets Authority) of Condition B as part of the Determination.

Price Control for Wholesale Activities

In respect of the Appointed Business’s Wholesale Activities, except those activities for which there are Excluded Charges, for the five consecutive Charging Years starting on 1 April 2015 there shall be one single Price Control.

Such Price Control shall consist of, in each Charging Year:

- the percentage change (expressed, in the case of an increase, as a positive number, in the case of a decrease, as a negative number, and, in the case of no change, as zero) in the Retail Prices Index between the published for the month of November in the Prior Year and that published for the immediately preceding November; and
- a number, “**K**”, which may be a positive number or a negative number or zero

which together shall be expressed as a percentage, and which shall limit the change in the revenue allowed to the Appointed Business in each Charging Year in respect of the Wholesale Activities concerned.

For the purpose of this Price Control, the revenue in respect of the Wholesale Activities concerned includes capital contributions such as cash receipts from connection and infrastructure charges (including requisitions and self lay).

For each Charging Year starting on or after 1 April 2016 the revenue allowed to the Appointed Business in respect of the Wholesale Activities concerned will be the product of the following formula:

$$R_t = R_{t-1} \times (1 + (RPI + K_t)/100)$$

Where:

R_t = Revenue allowed to the Appointed Business in Charging Year t;
R_{t-1} = Revenue allowed to the Appointed Business in the Prior Year;
$RPI + K_t$ = a number which is the sum of:

(i) the percentage change (expressed, in the case of an increase, as a positive number, in the case of a decrease, as a negative number, and, in the case of no change, as zero) in the Retail Prices Index between that published for the month of November in the Prior Year and that published for the immediately preceding November; and

(ii) a number, "K_t" for Charging Year t, which may be a positive number or a negative number or zero.

For the Charging Year starting on 1 April 2015 the revenue allowed to the Appointed Business in respect of the Wholesale Activities concerned is the product of the same formula except that R_{t-1} = the relevant revenue allowance (as set out below). This is because (as the form of Price Controls has since changed) at the last Periodic Review no revenue allowance in respect of Wholesale Activities was set for the Charging Year that started on 1 April 2014.

The starting point for the calculation of the change in the revenue allowed to the Appointed Business in the Charging Year starting on 1 April 2015 (the wholesale water revenue allowance) is £100.247 million. The "K" numbers for each Charging Year are set out in Table 1.

Table 1 Water services "K" numbers

Charging Year beginning 1 April	K
2015	0.0
2016	-6.33
2017	0.72
2018	-0.16
2019	0.06

Note:

There is no Table 2 in this Determination. This is a deliberate omission that ensures consistency in Table numbers between water undertakers and water and sewerage undertakers.

Price Controls for Retail Activities

In respect of the Appointed Business's Retail Activities, Ofwat has decided that there shall be:

- one single Price Control in respect of the Appointed Business's Household Retail Activities; and
- one single Price Control in respect of the Appointed Business's Non-household Retail Activities.

For the purposes of the Determination:

- "**households**" has the same meaning as:
  (i) the regulatory reporting definition of that term set out in section A5.4 of Appendix 5 (Guidance on business plan tables) to 'Setting price controls for 2015-20 – final methodology and expectations for companies' business plans' (July 2013); or (if different)
  (ii) such definition as may be included in Regulatory Accounting Guidelines issued under paragraph 5 of Condition F (Accounts and accounting information) of the Appointment;
- "**Household Retail Activities**" means Retail Activities relating to the supply of water to households;
- "**Non-household Retail Activities**" means Retail Activities relating to the supply of water to premises other than households;
- "**metered**" means that all or some of the charges for a supply of water are based on measured quantities of volume; and
- "**unmetered**" means that none of the charges for a supply of water are based on measured quantities of volume.

Price Control for Household Retail Activities

The Price Control for Household Retail Activities:

- shall consist of a limit on the total revenue allowed to the Appointed Business in each Charging Year in respect of the Retail Activities concerned; and
- is set for a period of five consecutive Charging Years starting on 1 April 2015.

The total revenue allowed to the Appointed Business in each Charging Year in respect of the Retail Activities concerned (Household retail allowed revenue) shall be the relevant amount set out in Table 3 as modified in accordance with the following formula:

$$\text{Revenue modification for charging year y} = \sum_{c=1}^{2} (\text{actual customer numbers}_{y,c} - \text{forecast customer numbers}_{y,c}).\text{modifcation factor}_{y,c}$$

Where:

y = Charging Year;
c = customer type (unmetered water only, metered water only);
"**customer numbers**" means the average number of individual households supplied or served by the Appointed Business in a Charging Year; and "**forecast customer numbers**" and "**modification factors**" are set out in Tables 4 and 5.

Table 3 Household retail allowed revenue

Charging Year beginning 1 April	£million
2015	10.434
2016	10.875
2017	11.371
2018	11.856
2019	12.484

Note:

There is no Table 2 in this Determination. This is a deliberate omission that ensures consistency in Table numbers between water undertakers and water and sewerage undertakers.

Table 4 Household retail allowed revenue modification factors by class of customer (£/customer)

	Revenue modification per:	2015-16	2016-17	2017-18	2018-19	2019-20
1	Unmetered water only customer	17.81	18.40	19.14	19.91	20.69
2	Metered water only customer	25.56	25.63	25.88	26.17	26.94

Table 5 Forecast customer numbers for household retail allowed revenue (thousands)

	Number of customers	2015-16	2016-17	2017-18	2018-19	2019-20
1	Unmetered water only	245.697	226.342	208.302	191.497	175.847
2	Metered water only	237.002	261.797	285.272	307.437	328.367

Price Control for Non-household Retail Activities

The Price Control for Non-household Retail Activities:

- consists of limits on the average revenue allowed to the Appointed Business in each Charging Year in respect of the Retail Activities concerned for specific customer types;
- is set for a period of two consecutive Charging Years starting on 1 April 2015;
- does not impose any limit on the revenue allowed to the Appointed Business in respect of the Retail Activities concerned where a customer freely chooses to pay different charges to those that they would otherwise be liable for; and
- does not impose any limit on any revenue in respect of Retail Activities from Excluded Charges, charges (including charges for developer services) that are not Standard Charges or any miscellaneous charges that are not directly related to the supply of water.

The total revenue allowed to the Appointed Business in each Charging Year in respect of the Retail Activities concerned for a specific customer type shall not exceed R calculated in accordance with the following formula:

$$R = [((rc \times cn) + w) / (1 - m)] - w$$

Where:

rc = the allowed average retail cost component for a given customer type (in pounds) as set out in Table 6;
cn = the customer numbers for a given customer type;
w = the wholesale revenue for a given customer type; and
m = the allowed net margin for a given customer type (expressed as a percentage) as set out in Table 6.

For the purposes of the Price Control for Non-household Retail Activities:

- a "**customer type**" is a class of customers described in Table 6 by reference to the type of charge (known as a default tariff), fixed by or in accordance with a charges scheme under section 143 of the Water Industry Act 1991 or agreements with the persons to be charged, that is payable by them for any water supply provided by the Appointee;

- "**customer numbers**" means the average number of individual premises supplied or served by the Appointed Business in a Charging Year; and
- "**wholesale revenue**" means the revenue that the Appointee recovers in a Charging Year in respect of Wholesale Activities relating to the supply of water to premises other than households (assuming for these purposes that the Appointee offered itself no more favourable terms in relation to payment than would be offered to any other person in respect of Wholesale Activities).

Table 6 Non-household customer types, allowed average retail cost components and allowed net margins

Customer type	Term (units)	2015-16	2016-17	2017-18	2018-19	2019-20
Band A - 250Ml+	r_c (£)	1,885.72	1,825.36	1,731.02	1,736.03	1,740.96
	m (%)	2.0%	2.0%	2.1%	2.2%	2.2%
Band B - 100-250Ml	r_c (£)	992.90	966.33	924.79	927.00	929.17
	m (%)	1.9%	1.9%	2.0%	2.1%	2.1%
Band C - 50-100 Ml	r_c (£)	749.59	745.23	738.41	738.78	739.13
	m (%)	1.9%	1.9%	2.0%	2.1%	2.1%
Band D - 15-50 Ml	r_c (£)	484.16	489.15	496.94	496.53	496.12
	m (%)	2.0%	2.1%	2.1%	2.1%	2.2%
Band E 5-15Ml	r_c (£)	201.57	196.21	187.83	188.27	188.71
	m (%)	2.1%	2.1%	2.1%	2.2%	2.2%
Band F - 1-5Ml	r_c (£)	49.13	46.53	42.48	42.69	42.91
	m (%)	1.7%	1.8%	1.8%	1.8%	1.8%
Band G - 0-1Ml	r_c (£)	23.62	23.95	24.46	24.43	24.41
	m (%)	4.2%	4.0%	3.8%	3.7%	3.7%
Band U	r_c (£)	7.12	7.34	7.67	7.65	7.64
	m (%)	2.9%	4.7%	4.3%	4.2%	4.1%

Demonstrating Compliance

In September 2014 Ofwat published a consultation on proposals for an integrated annual regulatory report that would be one of the ways in which the Appointee would demonstrate compliance with the Price Controls. We will publish information about the annual regulatory reporting and assurance requirements that will apply to the Appointee early in 2015.

Annex: Notified Item and Land Sales

Notified Item: Water Business Rates

For the purposes of the Determination Ofwat gives notice that it has not allowed in full for the effect from 1 April 2017 on the Appointed Business of the coming into force on 1 April 2017 of a new central non-domestic rating list in relation to water supply hereditaments to the extent that the effect could not have been avoided by prudent management action.

This Notified Item is a two-way Notified Item: that is, Ofwat may instigate an interim determination or, if the Appointee instigates an interim determination, Ofwat may take into account any effect on the Appointed Business whether favourable or unfavourable for the Appointee.

The costs or savings attributable to this Notified Item shall for each relevant Charging Year comprise the product of the following formula for the Appointee:

(Water Business Rate Sharing Rate – Menu Cost Sharing Rate) X (Applicable Water Business Rate Cost$_t$ – (Water Business Rate Cost Allowance$_t$ X Menu Choice Expenditure Factor))

For the purposes of this Notified Item:

Words and expressions used in this Notified Item have the same meaning as in the Conditions of the Appointment unless the contrary intention appears.

"**Water Business Rates**" means the rateable value determined under the Local Government Finance Act 1988 of water supply hereditaments used wholly or mainly for the purposes of a water undertaker or for ancillary purposes as shown in the central rating list;

"**central rating list**" shall be construed in accordance with section 52(1) of the Local Government Finance Act 1988;

"**water supply hereditaments**" means the hereditaments described:

- in relation to England, in regulation 15(1) of the Central Rating List (England) Regulations 2005 (SI 2005/551); and
- in relation to Wales, in regulation 15(1) of the Central Rating List (Wales) Regulations 2005 (SI 2005/422);

"**Applicable Water Business Rate Costs$_t$**" means, to the extent that they could not have been avoided by prudent management action, the amount(s) payable in respect of Water Business Rates (such amount(s) payable being a function of rateable value multiplied by uniform business rate (UBR) (rate in the pound) less transitional relief) in Charging Year t minus any contributions towards Water Business Rates received, or likely to be received, by the Appointed Business in that year;

"**Menu Choice**" means the Appointee's menu choice on the menu set out in Table A3.7 of 'Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues'. All references to the menu for the purposes of this Notified Item refer to that table;

"**Menu Choice Expenditure Factor**" means the allowed expenditure under the Appointee's Menu Choice divided by what would have been the allowed expenditure if the Appointee's Menu Choice had been 100;

"**Menu Cost Sharing Rate**" means the cost sharing rate set out in the menu that follows from the Appointee's Menu Choice;

"**Water Business Rate Sharing Rate**" = 75%;

"**prudent management action**" shall be assessed by reference to the circumstances which were known or which ought reasonably to have been known to the Appointee at the relevant time; and

"**Water Business Rate Cost Allowance$_t$**" means the figure for the relevant Charging Year set out in Table 7 (the "**Water Business Rate Constant$_t$**") multiplied by the Inflation Factor and for these purposes:

- "**Inflation Factor**" = RPI_{t-1} / RPI_{2013};
- "**RPI_{t-1}**" means the Retail Prices Index published, or likely to be published, for November in Charging Year t-1; and
- "**RPI_{2013}**" means the Retail Prices Index for November 2013.

Table 7 Water Business Rate Constant$_t$

Charging Year beginning 1 April	£million
2017	4.731
2018	4.731
2019	4.731

Land sales

For the purposes of the Determination Ofwat gives notice that for each of the five consecutive Charging Years starting on or after 1 April 2015:

- the value attributable to Relevant Disposals of Land allowed for in making this determination is zero; and
- variations in value received or expected to be received from Relevant Disposals of Land shall constitute a Relevant Change of Circumstance.

Schedule 2: Letter to Ofwat referring Final Determination for Bristol Water plc

Cathryn Ross
OFWAT
Centre City Tower
7 Hill Street
Birmingham
B5 4UA

12 February 2015

By Fax, email and Post

Dear Cathryn,

Final Determination for Bristol Water plc

Following on from our discussion on 5 February 2015 and your letter dated 11 February 2015, on behalf of my Board, I confirm that we formally dispute your wholesale water price control as set out in the Final Price Control Determination Notice dated 12 December 2014, and that we accept the price controls for Retail Household and Retail Non-Household for the period 2015-2020. We understand that the scope of the referral to the CMA is a matter for Ofwat to determine in accordance with the relevant provisions of the WIA '91 and our Instrument of Appointment. We also understand that Ofwat considers that these three price controls form part of a single determination.

Accordingly, and on the basis of the rejection of the wholesale price control, we require Ofwat to refer the disputed determination for Bristol Water plc published by Ofwat on 12 December 2014 to the Competition & Markets Authority ("CMA") for determination in accordance with Section 12 of the Water Industry Act 1991 (as amended) ("WIA'91") and paragraph B 15 of our Instrument of Appointment.

As we have discussed we will continue to work with you and the rest of the industry on the Ofwat forward work programme and on implementing the reforms for retail Competition in parallel with the CMA process.

I would appreciate your confirmation that you have received this letter and that it fully meets your notification requirements.

Yours sincerely

Luis García
Chief Executive

Ofwat's duties under section 2 of the Water Industry Act 1991

1. This appendix sets out Ofwat's duties as presented to us by Ofwat.

2. Ofwat's general duties are set out in Part I of the WIA 91 and in particular, section 2, as amended (in relation to relevant undertakers whose area is wholly or mainly in England).

3. In the remainder of this appendix we set out the relevant elements of section 2 of the WIA 91 as annotated by Ofwat.

General duties with respect to the water industry

(1) This section shall have effect for imposing duties on the Secretary of State and on [the Authority] as to when and how they should exercise and perform the following powers and duties, that is to say—

(a) in the case of the Secretary of State, the powers and duties conferred or imposed on him by virtue of the provisions of this Act relating to the regulation of relevant undertakers and of licensed water suppliers; and

(b) in the case of [the Authority], the powers and duties conferred or imposed on [it] by virtue of any of those provisions, by the provisions relating to the financial conditions of requisitions or by the provisions relating to the movement of certain pipes.

(2A) The Secretary of State or, as the case may be, the Authority shall exercise and perform the powers and duties mentioned in subsection (1) above in the manner which he or it considers is best calculated—

(a) to further the consumer objective;

(b) to secure that the functions of a water undertaker and of a sewerage undertaker are properly carried out as respects every area of England and Wales;

(c) to secure that companies holding appointments under Chapter 1 of Part 2 of this Act as relevant undertakers are able (in particular, by securing reasonable returns on their capital) to finance the proper carrying out of those functions;

(d) to secure that the activities authorised by the licence of a licensed water supplier and any statutory functions imposed on it in consequence of the licence are properly carried out; and

(e) to further the resilience objective.

(2B) The consumer objective mentioned in subsection (2A)(a) above is to protect the interests of consumers, wherever appropriate by promoting effective competition between persons engaged in, or in commercial activities connected with, the provision of water and sewerage services.

(2C) For the purposes of subsection (2A)(a) above the Secretary of State or, as the case may be, the Authority shall have regard to the interests of—

(a) individuals who are disabled or chronically sick;

(b) individuals of pensionable age;

(c) individuals with low incomes;

(d) individuals residing in rural areas; and

(e) customers, of companies holding an appointment under Chapter 1 of Part 2 of this Act, whose premises are not eligible to be supplied by a licensed water supplier,

but that is not to be taken as implying that regard may not be had to the interests of other descriptions of consumer.

(2D) For the purposes of subsection (2C) above, premises are not eligible to be supplied by a licensed water supplier if—

(a) they are household premises (as defined in section 17C below); or

(b) the total quantity of water estimated to be supplied to the premises annually for the purposes of subsection (2) of section 17D below is less than the quantity specified in that subsection.

(2DA) The resilience objective mentioned in subsection (2A)(e) is—

(a) to secure the long-term resilience of water undertakers' supply systems and sewerage undertakers' sewerage systems as regards environmental pressures, population growth and changes in consumer behaviour, and

(b) to secure that undertakers take steps for the purpose of enabling them to meet, in the long term, the need for the supply of water and the provision of sewerage services to consumers, including by promoting—

(i) appropriate long-term planning and investment by relevant undertakers, and

(ii) the taking by them of a range of measures to manage water resources in sustainable ways, and to increase efficiency in the use of water and reduce demand for water so as to reduce pressure on water resources.

(2DB) For the purposes of subsection (2DA)—

(a) the reference to water undertakers' supply systems is to be construed in accordance with section 17B;

(b) the reference to sewerage undertakers' sewerage systems is a reference to the systems comprising—

(i) the systems of public sewers, the facilities for emptying public sewers and the sewage disposal works and other facilities for dealing effectually with the contents of public sewers that undertakers are required to provide by section 94, and

(ii) the lateral drains that undertakers are required to maintain by section 94.

(2E) The Secretary of State and the Authority may, in exercising any of the powers and performing any of the duties mentioned in subsection (1) above, have regard to—

(a) any interests of consumers in relation to electricity conveyed by distribution systems (within the meaning of the Electricity Act 1989);

(b) any interests of consumers in relation to gas conveyed through pipes (within the meaning of the Gas Act 1986);

(c) any interests of consumers in relation to communications services and electronic communications apparatus (within the meaning of the Communications Act 2003), which are affected by the exercise of that power or the performance of that duty.

(3) Subject to subsection (2A) above, the Secretary of State or, as the case may be, the Authority shall exercise and perform the powers and duties mentioned in subsection (1) above in the manner which he or it considers is best calculated—

(a) to promote economy and efficiency on the part of companies holding an appointment under Chapter 1 of Part 2 of this Act in the carrying out of the functions of a relevant undertaker;

(b) to secure that no undue preference is shown, and that there is no undue discrimination in the fixing by such companies of water and drainage charges;

(ba) to secure that no undue preference (including for itself) is shown, and that there is no undue discrimination, in the doing by such a company of—

(i) such things as relate to the provision of services by itself or another such company, or

(ii) such things as relate to the provision of services by a water supply licensee or a sewerage licensee;[1]

(c) to secure that consumers are protected as respects benefits that could be secured for them by the application in a particular manner of any of the proceeds of any disposal (whenever made) of any of such a company's protected land or of an interest or right in or over any of that land;

(d) to ensure that consumers are also protected as respects any activities of such a company which are not attributable to the exercise of functions of a relevant undertaker, or as respects any activities of any person appearing to the Secretary of State or (as the case may be) the Authority to be connected with the company, and in particular by ensuring—

(i) that any transactions are carried out at arm's length;

(ii) that the company, in relation to the exercise of its functions as a relevant undertaker, maintains and presents accounts in a suitable form and manner;

(iii) …

(e) to contribute to the achievement of sustainable development.

(4) In exercising any of the powers or performing any of the duties mentioned in subsection (1) above in accordance with the preceding provisions of this

[1] Paragraph (ba) of subsection (3) was inserted into section 2 of the WIA91 with effect from 1 January 2015 in relation to relevant undertakers whose area is wholly or mainly in England and therefore did not apply when Ofwat made the disputed determination.

section, the Secretary of State and the Authority shall have regard to the principles of best regulatory practice (including the principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed).

(5) In this section the references to water and drainage charges are references to—

(a) any charges in respect of any services provided in the course of the carrying out of the functions of a relevant undertaker; and

(b) amounts of any other description which such an undertaker is authorised by or under any enactment to require any of its customers or potential customers to pay.

(5A) In this section—

“consumers” includes both existing and future consumers; and

“the interests of consumers” means the interests of consumers in relation to—

(a) the supply of water by means of a water undertaker’s supply system to premises either by water undertakers or by licensed water suppliers acting in their capacity as such; and

(b) the provision of sewerage services by sewerage undertakers.

(6) For the purposes of this section—

(a) subject to subsection (6A) below, the reference in subsection (1) above to the provisions of this Act relating to the regulation of relevant undertakers and of licensed water suppliers is a reference to the provisions contained in Part 2 of this Act (except section 27A, and Schedule 3A), or in any of sections 37A to 38, 39, 39B, 39C, 66B, 66D, 66F to 66H, 66K, 66L, 95, 96, 153, 181, 182, 192A, 192B, 195, 195A and 201 to 203 below;

(b) the reference in that subsection to the provisions relating to the financial conditions of requisitions is a reference to the provisions contained in sections 42, 43, 43A, 48, 51C, 99, 100 and 100A below; and

(c) the reference in that subsection to the provisions relating to the movement of certain pipes is a reference to the provisions of section 185 below.

(6A) Subsections (2A) to (4) above and section 2A below do not apply in relation to anything done by [the Authority] in the exercise of functions assigned to [it] by section 31(3) below ("Competition Act functions").

(6B) [The Authority] may nevertheless, when exercising any Competition Act function, have regard to any matter in respect of which a duty is imposed by any of subsections (2A) to (4) above and section 2A below, if it is a matter to which [the CMA] could have regard when exercising that function.

(7) The duties imposed by subsections (2A) to (4) above and section 2A below do not affect the obligation of the Authority or, as the case may be, the Secretary of State to perform or comply with any other duty or requirement (whether arising under this Act or another enactment, by virtue of any [EU] obligation or otherwise)."

Retail price controls

Introduction

1. This appendix concerns the retail price controls that Ofwat determined for Bristol Water. It is structured as follows:

   (a) Ofwat's determination of retail price controls.

   (b) Submissions on the retail price controls.

   (c) Our assessment of whether to redetermine the retail price controls.

Ofwat's determination of retail price controls

2. This section introduces the four different price controls set by Ofwat across water and wastewater activities and then summarises the two retail price controls.

Separate price controls for wholesale and retail

3. For all price control periods running up to 31 March 2015, Ofwat set a single price control for each water company.

4. Following formal changes to each company's Licence (conditions of appointment), Ofwat's price controls from 1 April 2015 comprise four separate price controls (three for water-only companies). These cover:

   (a) wholesale water activities;

   (b) wholesale wastewater activities (not relevant to Bristol Water);

   (c) retail supply to households; and

   (d) retail supply to non-households.

5. The allocation of activities between wholesale and retail is specified in the Licence, or otherwise determined by Ofwat.

6. The development of these separate price controls reflects, in part, a number of legislative and regulatory changes in the water industry in England which are intended to support the development of competition, particularly for the supply of retail water and wastewater services to non-household customers.

7. Ofwat summarised the benefits of setting separate price controls for wholesale and retail as follows in its final determinations:[1]

> This creates important benefits – it provides greater transparency, and therefore understanding, of costs. It also provides more effective incentives and supports the development of effective competition in the relevant markets where appropriate, in line with the provisions of the Water Act 2014.

8. Bristol Water agreed with the rationale for separate price controls:[2]

> We understand why Ofwat has introduced separate controls for retail household, retail non-household, and wholesale, and consider that it will help to improve incentives and performance within each of these parts of the business.

9. The operation and determination of Ofwat's two sets of retail price controls is quite different to that for wholesale controls. We provide an overview of the retail price controls below.

Retail services to household customers

10. Ofwat described the form of the household retail control as a 'total revenue control with annual revenue adjustment factors to reflect differences between actual and forecast customer numbers and meter penetration.'[3] It is a five-year price control from 1 April 2015.

11. Ofwat made an assessment of the appropriate allowance for total household retail revenue by combining three main elements:

    (a) Its assessment of the average (retail) cost to serve (ACTS) per customer, which included what Ofwat referred to as an 'efficiency challenge'.

    (b) The projected customer numbers in the company's revised business plan.

    (c) An allowance for a net (profit) margin for retail supply to household.

12. The average (retail) cost to serve was based on benchmarking analysis across the water companies in Ofwat's sample. The margin was 1% of forecast wholesale and retail costs.

[1] Ofwat (December 2014), *Final price control determination notice: policy chapter A1 – introduction*, p3.
[2] Bristol Water SoC, paragraph 398.
[3] Ofwat (March 2015), *Referral of Bristol Water's determination of price controls for the period from 1 April 2015 – introduction for the Competition and Markets Authority*, p49.

13. Ofwat reported that its final determinations for Bristol Water's household retail price control were based on an allowance for the relevant retail revenue of £57 million.[4]

14. Bristol Water suggested that Ofwat's final determinations for the household retail price control could best be compared with its own proposals by looking at proposed retail revenues excluding the retail margin. This comparison excludes differences caused by inconsistent assumptions on wholesale revenues, which affect the retail margin. On this basis, the allowance from Ofwat's final determinations was £52.7 million which is 1% less than Bristol Water's proposal of £53.1 million.[5]

15. Ofwat said the following on outcomes and performance commitments related to the household retail control:[6]

> Bristol Water has committed to delivering outcomes which reflect its customers' views. Our assessment of the specific PCs [performance commitments] proposed by each company for household retail focused on a company-specific assessment to ensure that the performance proposed by each company was challenging, appropriately incentivised and supported by customer engagement.
>
> We did not intervene in any of the PCs and incentives types proposed by Bristol Water. We considered that the company put forward a set of effective incentives that would allow for customers protection [sic] against under-delivery.

Retail services to non-household customers

16. Ofwat's price controls for retail services to non-household customers are actually a series of separate average revenue controls that apply to different types of customers or services.

17. Ofwat said that companies must offer 'default tariffs' for the relevant customer type which comply with these average retail revenue controls. The control for each customer type in each year is given by the formula below:[7]

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[4] Ofwat (March 2015), *Referral of Bristol Water's determination of price controls for the period from 1 April 2015 – introduction for the Competition and Markets Authority*, p19.
[5] Bristol Water SoC, Table 145.
[6] Ofwat submission, page 32.
[7] Ofwat (December 2014), *Final price control determination notice: policy chapter A6 – non-household retail costs and revenues*, p11.

$$R = [(r_c \times c_n) + w)] / (1 - m)$$

Where:

R = the estimated total allowed revenue for a given customer type

r_c = the allowed average retail cost for a given customer type

c_n = the forecast customer numbers for a given customer type

w = the forecast wholesale revenue for a given customer type

m = the allowed net margin for a given customer type

18. The elements of this formula that were set by Ofwat in its final determinations were the allowance (£ per customer) to cover the retail costs (c_n) and the profit margin (m).

19. As an example, Ofwat specified that the 2015/16 control for retail supply to 'band D' non-household customers, who consume between 15 and 50 megalitres of water per year, should be calculated using a cost per customer (r_c) of £484.16 and a margin (m) of 2%.[8]

20. Under this formula, the level of the maximum retail revenue in each year will depend on the applicable wholesale charges for the customer type. Ofwat said that under the controls 'allowed revenue is dynamically pegged to underlying wholesale revenues in order to avoid insufficient margins occurring due to changes in the wholesale charges'.[9]

21. Ofwat reported that its final determinations for Bristol Water's non-household retail price control were based on (or indicative of) an allowance for the relevant retail revenue of £7.8 million (in total if expressed over a five-year period).[10]

22. Bristol Water suggested that Ofwat's final determinations for the non-household retail price controls could best be compared with its own proposals by looking at proposed retail revenues excluding the retail margin. This comparison excludes differences caused by inconsistent assumptions on wholesale revenues, which affect the retail margin. On this basis, the

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[8] Ofwat, *Final price control determination notice: company-specific appendix – Bristol Water*, p47.
[9] Ofwat (March 2015), *Referral of Bristol Water's determination of price controls for the period from 1 April 2015 – introduction for the Competition and Markets Authority*, p55.
[10] Ofwat (March 2015), *Referral of Bristol Water's determination of price controls for the period from 1 April 2015 – introduction for the Competition and Markets Authority*, p19.

allowance from Ofwat's final determinations was £4.7 million which is 35% less than Bristol Water's proposal of £7.2 million.[11]

Submissions to the inquiry on the retail price controls

23. We summarise relevant aspects of submissions from the following parties:

(a) Bristol Water

(b) Ofwat

(c) CCWater

(d) Wessex Water

Bristol Water

24. In its SoC, Bristol Water said:[12]

> Whilst there are some differences in view between Ofwat and ourselves in relation to the two retail price controls, on balance we consider that the PR14 process for retail has been challenging but reasonable. Accordingly, our Board accepted both retail price controls.

25. Similarly, Bristol Water explained that:[13]

> The Board of Bristol Water accepted Ofwat's FD14 on the Retail Household price control. This decision was made because, in the round, FD14 was assessed to provide an appropriate level of costs to cover retail activities.

26. Nonetheless, Bristol Water recognised that the CMA's determination may consider retail and its SoC accordingly covers retail as well as wholesale price control matters:[14]

> We understand, however, that the redetermination means that all aspects of FD14 may be reviewed, and not just areas where there is disagreement between the parties. We have, therefore, provided full oversight of all elements of FD14.

[11] Bristol Water SoC, Table 157.
[12] Bristol Water SoC, paragraph 4.
[13] Bristol Water SoC, paragraph 2056.
[14] Bristol Water SoC, paragraph 4.

27. Bristol Water identified some specific issues on the calculation of the household retail price control:[15]

> Allowed costs for Bristol Water are set with reference to the industry average cost to serve, whereby companies are allowed the lower of their own costs or the industry average. Bristol Water is below the industry average for both metered and unmetered cost to serve, but Ofwat's methodology has resulted in a reduction being applied to Bristol Water's allowed metered costs that Bristol Water considers to be incorrectly applied, reducing allowed revenue by £1.8 million. This balances against a calculative approach to price basing by Ofwat which, if corrected, would reduce Bristol Water's revenue by £1.3 million.

28. On the non-household retail price control, Bristol Water said the following:[16]

> The Board of Bristol Water accepted Ofwat's FD14 on the Retail Non-Household price control. This decision was made because, whilst Bristol Water remains concerned that the level of costs allowed for the set-up of the competitive market is inappropriate and that Ofwat has not allowed inflationary increases to non-household retail costs, the amount of difference between the Business Plan and revenues allowed in Ofwat's FD14 was not considered to be sufficiently material to warrant rejection of the Retail Non-Household price control.

29. Bristol Water's position is that it has accepted the non-household retail price control and it has not argued for us to review this price control. However, Bristol Water identified some issues that would be relevant in the event that we were to examine the non-household retail control. In particular, Bristol Water said that if we were to choose to redetermine the retail non-household price control, it would like us to:[17]

(a) set a net profit margin equal to or greater than that set by Ofwat;

(b) make an allowance for the forecast costs associated with arrangements to establish competitive retail markets (Bristol Water would like an uncertainty mechanism to allow pass-through of these uncertain costs to customers); and

[15] Bristol Water SoC, paragraph 2057.
[16] Bristol Water SoC, paragraph 2151.
[17] Bristol Water SoC, paragraph 2244.

(c) take account of input cost pressures on operating costs.

30. In its reply to Ofwat's response to its SoC, Bristol Water said that, for both the household and non-household retail price controls, 'it agreed with Ofwat's position that if the CMA is satisfied that this does not deserve further scrutiny it does not intend to pursue the discussion further'.[18]

Ofwat

31. Ofwat's reference to the CMA includes the retail price controls:

> In its letter requesting a reference, Bristol Water indicated that it is content with the retail price controls in the final determination. However, the entire disputed determination (including the wholesale water, household retail and non-household retail price controls and the designation of retail activities) has been referred to the Competition and Markets Authority (CMA).[19]

32. Although the household retail price control forms part of the reference it made to the CMA, Ofwat did not consider that we should make any changes to the household retail price controls that Ofwat developed for Bristol Water:[20]

> We consider that, as Bristol Water's Board has accepted the final determination for household retail, and we have not identified any further material issues, it would be appropriate not to make further interventions in the household retail control.

33. On the non-household retail price control, Ofwat said the following:

> Bristol Water's Board has accepted the final determination on non-household retail. In light of this, and in line with our view that there are no significant issues with the Final determination position, we do not consider it appropriate to make further interventions in this area.
>
> [Any] request from Bristol to increase the allowed revenue in this area should be seen as unnecessary, as the company's Board clearly does not consider it to be required in order for them to meet their legal duties and sufficiently serve their customers/other stakeholders.[21]

[18] Bristol Water reply, paragraph 37.
[19] Ofwat response, paragraph 11.
[20] Ofwat response, paragraph 126.
[21] Ofwat response, paragraph 131.

34. Ofwat's response to Bristol Water's SoC, and its further submissions, responded to a number of specific points that Bristol Water had made about Ofwat's calculation of the retail price controls.

CCWater

35. In its submission to the inquiry, CCWater said the following on the retail price controls:[22]

> We supported the approach that Bristol Water took towards its retail performance commitments and the retail revenue allowance set in the Final Determination. We note that Bristol Water does not dispute the Ofwat decisions relating to the company's retail business.
>
> We have no issues about the retail element of the Determination as the areas of dispute between Ofwat and Bristol Water concern the costs, performance commitments, investment and financing of the company's wholesale business.

Wessex Water

36. Wessex Water made a submission that included comments on the retail price controls. Wessex Water's submission explains as follows:[23]

> Bristol Water's board has accepted the retail household price control – nevertheless because the CMA is required to make a determination on the whole price control Bristol Water has expressed concern about the methodology that underpins the efficiency challenge Ofwat has applied in this element of the price control. In their Statement of Case Bristol Water has referenced the Wessex Water retail household determination as primary evidence of the lack of robustness in Ofwat's efficiency challenge. The evidence we provide in this document clarifies and contextualises the reasons for the apparent inconsistencies.

37. Wessex Water did not seek to argue that the CMA should review Bristol Water's retail price controls. Instead, Wessex Water made points on specific aspects of Ofwat's determination of retail price controls (eg cost allocation

[22] CCWater submission, paragraphs 2.12 & 3.1.
[23] Wessex Water submission, paragraph 7.

rules and the treatment of metering costs) that may be relevant if we were to choose to review the retail price controls for Bristol Water.

Assessment of whether to redetermine the retail price controls

38. Bristol Water rejected Ofwat's proposed wholesale price controls and sought a determination of the wholesale price control from the CMA. It accepted Ofwat's proposed retail price controls.

39. We consider that the reference from Ofwat to the CMA enables us to review and, if necessary, re-determine the retail price controls. However, the reference does not require that we review every aspect of Ofwat's final determinations for Bristol Water. In this context, we made an assessment of whether to review the retail price controls as part of our determination.

40. We considered the following:

(a) Whether the retail price controls are sufficiently separable from the wholesale price controls to enable us to make a reasonable determination of the wholesale price control without adjusting Ofwat's proposed retail price controls.

(b) Whether any of the submissions to the inquiry identified grounds for us to redetermine the retail price controls for Bristol Water.

(c) Whether a review of retail price controls would represent a priority area for our inquiry and a proportionate regulatory approach.

41. We discuss each of these in turn below.

Are the wholesale and retail price controls separable?

42. Bristol Water's Licence specifies separate price controls for wholesale and retail activities. Paragraph 8.3 of Condition B provides the basis for the retail price control and paragraph 8.4 provides the basis for the wholesale price control.

43. We did not identify any aspect of Condition B that would prevent us from reaching a different view to Ofwat on the wholesale price control determination while at the same time adopting Ofwat's proposals (accepted by Bristol Water) for retail price controls.

44. This does not mean that the wholesale and retail price controls are completely independent of one another. For example, Ofwat's approach to the allowance for the cost of capital for the wholesale price control involved calculations to

deduct forecast profits from retail activities (under its proposed retail price controls). Bristol Water has disputed Ofwat's calculations of these deductions. We have considered this issue as part of our determination of the cost of capital for the wholesale price control.

45. We found that it was feasible to set a reasonable wholesale price control for Bristol Water whilst taking as given the retail price controls that Bristol Water accepted.

46. There is one possible qualification to consider. Because Ofwat's retail price controls involve a retail margin on wholesale and retail costs, the calculation of allowed retail revenues used by Ofwat was dependent on the assumed level of wholesale revenues. Bristol Water said that the allowed retail revenues should be recalculated following our determination of the wholesale price control.

47. We could recalculate Ofwat's household retail price control for Bristol Water to take account of any difference in forecast wholesale revenues arising directly from differences between our wholesale price control determination and Ofwat's wholesale price control determination. We considered that we should make an adjustment to the household retail price control on this basis if the difference was significant. This adjustment would not involve any change to the household retail price control beyond addressing a potential inconsistency, arising as a result of our determination, in the wholesale revenue forecast that Ofwat used to calculate the household retail control. However, we found that, on the basis of our provisional findings for the wholesale control, the difference was not significant and no adjustment was necessary.

48. No similar adjustment needs to be considered for the non-household retail controls as these controls are in the form of formulae that adjust the maximum allowed revenue according to factors including the level of wholesale revenues.

49. Overall, we found that our determination of the wholesale price control for Bristol Water does not require that we reopen the retail price controls.

Do any of the submissions identify grounds for us to redetermine retail controls?

50. We have summarised above relevant submissions that we have received on the retail price controls. We did not identify any grounds, from these submissions, for redetermining the retail price controls.

51. Neither Ofwat nor Bristol Water argued that we ought to redetermine the retail price controls that Bristol Water had accepted.

52. To the extent that Bristol Water made submissions on particular aspects of the retail controls, it provided these in case we chose to review the retail price controls. Bristol Water has not sought to advocate that we should review the retail price controls. It accepted the retail price controls. As set out above, Bristol Water said that Ofwat's process for the retail price controls was 'challenging but reasonable'. Bristol Water agreed with Ofwat's position that if we were satisfied that the household and non-household retail price controls did not deserve further scrutiny, it did not intend to pursue these further as a matter for our inquiry.

Priorities for the inquiry and proportionality

53. It is possible that a detailed investigation of the retail price controls accepted by Bristol Water may indicate that these should be adjusted or refined in some way to protect the interests of consumers. However, we did not consider this possibility sufficient to carry out a detailed review of the retail price controls.

54. We considered that we should concentrate on the wholesale price controls and that it would not be proportionate for us to review the retail price controls. Our assessment reflects a number of factors, taken together.

55. First, the retail price controls set by Ofwat are complicated and reflect substantial work developed over several years. It would take considerable time and resource for us to review these retail controls – and for parties involved in the inquiry to participate in our review process.

56. Second, we have not had any submissions to the inquiry setting out aspects of Ofwat's retail price controls that warrant re-examination, for example to protect the interests of consumers. CCWater has supported Ofwat's proposed retail price controls. Any review of retail controls would be an exploratory one. In contrast, for the wholesale price controls there were many significant matters of dispute between Ofwat and Bristol Water.

57. Third, for Bristol Water, the revenues associated with the two retail price controls (in total) represent around 11% of the total allowed revenues across wholesale and retail, with wholesale revenues accounting for 89%.[24] The wholesale price control concerns a much larger part of customers' bills than the retail price controls.

58. Fourth, even leaving aside the submissions from the main parties and other stakeholders, and the relative scale of retail activities compared with

[24] This is on Ofwat's final determination allowances. It would be 10% using Bristol Water's forecasts. CMA calculation using data from Bristol Water SoC (p260).

wholesale activities, we considered the determination of the wholesale control to be more important to review than the retail control. Whilst there are potential risks of inaccuracy in cost assessment for both the retail and wholesale price controls, there are reasons to be more concerned about potential inaccuracies in the cost assessment for wholesale controls than for retail controls. Ofwat's approach to household retail controls used cost benchmarking analysis that we would expect to be less vulnerable to risks of inaccuracy than Ofwat's benchmarking analysis for wholesale activities. Although all benchmarking analysis will be imperfect, the problems in making fair comparisons of retail costs seem smaller than for comparisons of aggregate wholesale expenditure. This is because we would expect retail activities to be more similar across companies than wholesale activities. Wholesale activities may differ between companies according to local operating and environmental conditions and the effects of historical investment decisions.

59. Finally, our assessment is conditional on the circumstances and facts of the case, including the submissions from the main parties and other stakeholders. It should not be taken to imply anything more generally about our views on wholesale and retail price controls.

Ofwat's approach to cost assessment

1. This appendix discusses the following topics in turn:

   (a) Emphasis on totex benchmarking analysis.

   (b) Separate analysis of enhancement expenditure.

   (c) Triangulation.

   (d) Upper quartile efficiency benchmark.

   (e) Costs excluded from benchmarking analysis (policy items).

   (f) Adjustments for special cost factors.

   (g) Further adjustments outside the main special cost factor process.

   (h) Cases where Ofwat's cost assessment exceeded a company's forecasts.

2. In a final subsection, we briefly compare Ofwat's approach to cost assessment for PR14 with its approach to its previous price control reviews.

Emphasis on totex benchmarking analysis

3. Ofwat's approach to PR14 was based on benchmarking analysis that compared measures of totex between companies. Totex represents the expenditure on a cash basis allocated to wholesale activities and does not include depreciation or amortisation of investment.

4. Ofwat used several strands of benchmarking analysis:

   (a) Econometric benchmarking models that make comparisons of measures of totex between companies.[1] The totex measure used for each company in each year was opex on wholesale activities in that year plus average capex on wholesale activities in the last five years.[2]

   (b) Econometric models that compared measures of base expenditure between companies. The base expenditure measure used for each company for each year was opex on wholesale activities in that year plus

[1] Ofwat excluded certain costs from the benchmarking comparisons of totex and base expenditure. It referred to these as policy items and made separate allowances for them.
[2] Ofwat adopted an approach of 'smoothing' capex over a five-year period before making benchmarking comparisons between companies.

average capital maintenance expenditure attributed to wholesale activities in the last five years (ie excluding capex on enhancement projects).

(c) A separate strand of benchmarking analysis focused on enhancement expenditure. This took different categories of enhancement expenditure separately.

5. Ofwat's benchmarking analysis used a number of different models and covered different categories of expenditure (totex, base expenditure and enhancement). Ofwat used an explicit methodology, which it called triangulation, to combine and weight these estimates to produce an overall estimate of each company's totex requirements (see paragraphs 15 to 26). Ofwat then sought to estimate what each company's costs would be if it were at the upper quartile of efficiency within the sample of companies in its analysis of historical data (see paragraphs 27 to 31).

6. The outcome was a single estimate of each company's totex requirements over the period from 1 April 2015 to 31 March 2020. Ofwat referred to this estimate as the 'basic cost threshold', or BCT.

7. In addition to the benchmarking analysis, Ofwat made a series of adjustments to capture specific areas of companies' costs that may not have been assessed sufficiently well by the benchmarking exercise (see paragraphs 34 to 46). These adjustments, as well as allowances for certain types of costs excluded from the benchmarking analysis (see paragraphs 32 and 33), fed into Ofwat's 'final cost threshold'.

Separate analysis of enhancement expenditure

8. Some of the econometric models used by Ofwat compared measures of totex between companies; these models cover both base and enhancement expenditure. In addition, Ofwat also carried out separate analysis for base service and enhancement expenditure.[3] It formed estimates of each company's totex requirements by summing:

(a) estimates of the company's efficient base expenditure requirements derived from econometric models that compare measures of base expenditure across companies; and

[3] Ofwat refers to the combination of *(a)* and *(b)* as its 'bottom-up totex model'. The use of the term 'bottom-up' may be misleading. Ofwat's analysis does not involve what would normally by described as a bottom-up approach to cost assessment in the context of UK price control regulation. For example, it is not a cost forecast built up from the individual investments and activities that are needed to provide the service.

(b) estimates of the company's efficient enhancement expenditure requirements that were built up from a series of separate analyses for different categories of enhancement expenditure.

9. For some categories of enhancement expenditure, Ofwat carried out analysis based on measures or models of the unit cost of historical enhancement expenditure from data across Ofwat's sample of water companies. Table 1 lists the three categories of enhancement expenditure that were treated in this way, and the volume measure used to calculate unit costs.

Table 1: Ofwat's enhancement expenditure unit cost models

Category of enhancement expenditure	*Volume measure used*
Enhancements to supply-demand balance (eg new reservoirs to increase the amount of water available in peak times)	Total enhancements to the supply demand balance (dry year critical / peak conditions) unless zero then used annual/ average
Lead reduction	Number of lead communication pipes replaced for water quality
New developments	Number of new connections

Source: Ofwat (April 2014), Basic cost threshold model Appendix C Enhancement modelling, p12.

10. Ofwat's analysis of the unit costs of these categories of enhancement projects used four different ways to model unit costs: *(a)* calculation of the unweighted average of the unit costs of each company; *(b)* calculation of unit costs at the industry level (ie weighted average across companies); *(c)* OLS regression of costs against the volume measure; and *(d)* OLS regression of the natural logarithm of costs against the natural logarithm of the volume measure. Ofwat had no preference across these models and gave them equal weight in its unit cost analysis.

11. To produce expenditure forecasts for each company, for each of the three categories of enhancement expenditure in the table above, Ofwat combined the results of its unit cost analysis with forecasts prepared by Jacobs of the volumes of each activity that the company will need to carry out in the period 1 April 2015 to 31 March 2015. For some of the volume forecasts, Jacobs' forecasts were simple extrapolations from past trends. For enhancements to the supply/demand balance, for a company with a predicted deficit, Jacobs' forecasts of the relevant volume measures were taken directly from the company's own draft water resources management plan. Jacobs explained that the use of draft Water Resource Management Plan data in its forecasts was a departure from the original aspiration of independent forecasts, but said that the draft Water Resource Management Plans had undergone a level of external scrutiny.[4]

[4] Jacobs (March 2014), *PR14 Forecast of Exogenous Variables Summary Report*.

12. Ofwat found that it was 'not possible to find a robust cost driver for every enhancement cost category' and consequently treated some categories of enhancement expenditure as 'unmodelled' and applied a different approach.[5] Ofwat's approach for unmodelled expenditure was, essentially, to calculate a mark-up or uplift on each company's 'modelled' expenditure to make some allowance for enhancement expenditure not covered by the unit cost models.

13. Ofwat's approach for the unmodelled allowance was as follows:[6]

(a) Ofwat identified the categories of enhancement expenditure that applied over the period from 1 April 2010 to 31 March 2015 and which it had not covered in its unit cost models. For each of these categories, Ofwat decided whether they were (i) non-recurring or (ii) likely to recur in the period from 1 April 2015 to 31 March 2020.

(b) Ofwat used a data submission from August 2013 to calculate the totex for the recurring categories of enhancement expenditure from *(a)* across the industry over the period 1 April 2010 to 31 March 2015. The expenditure data taken from the August 2013 data submission included a mix of historical costs and companies' forecasts of costs for the remainder of the period to 31 March 2015.

(c) Ofwat calculated the total industry level of 'modelled expenditure' across the industry, over the period from 1 April 2010 to 31 March 2015, using the same data sources as for *(b).* Modelled expenditure comprised base expenditure plus the part of enhancement expenditure covered by Ofwat's unit cost models.

(d) Ofwat calculated a percentage uplift for unmodelled enhancement expenditure as *(b)* divided by *(c)*, multiplied by 100%. This was 8.4% for the water service.

14. Ofwat then made an estimate of each company's unmodelled enhancement expenditure requirements by taking its estimate of the company's modelled expenditure requirements for the period 1 April 2015 to 31 March 2020 and multiplying this by 8.4%.

[5] Ofwat (April 2014), *Basic cost threshold model Appendix C Enhancement modelling*, p4.
[6] CMA working interpretation of description from Ofwat (April 2014), *Basic cost threshold model Appendix C Enhancement modelling*, p10.

Triangulation

15. Ofwat used the term ‘triangulation’ to refer to the approach and calculations that it used to bring together the results from its econometric models and its separate analysis of enhancement expenditure.

16. Ofwat told us that it recognised that there may be different plausible ways and models to use to arrive at an expenditure forecast and that, by using a suite of models, it had mitigated the risk of choosing any single model which, for any given company, may have a large variance between the estimate and the ‘correct’ answer.

17. For wholesale water services, Ofwat calculated the basic cost threshold for each company as the unweighted average of results from three modelling approaches:

(a) results from its ‘full’ totex econometric modelling;

(b) results from its ‘refined’ totex econometric modelling; and

(c) results from its separate analyses of base and enhancement expenditure, under which estimates of a company’s totex requirements are calculated by adding an estimate from its base expenditure econometric models to separate estimates of its expenditure requirements across different categories of enhancement.

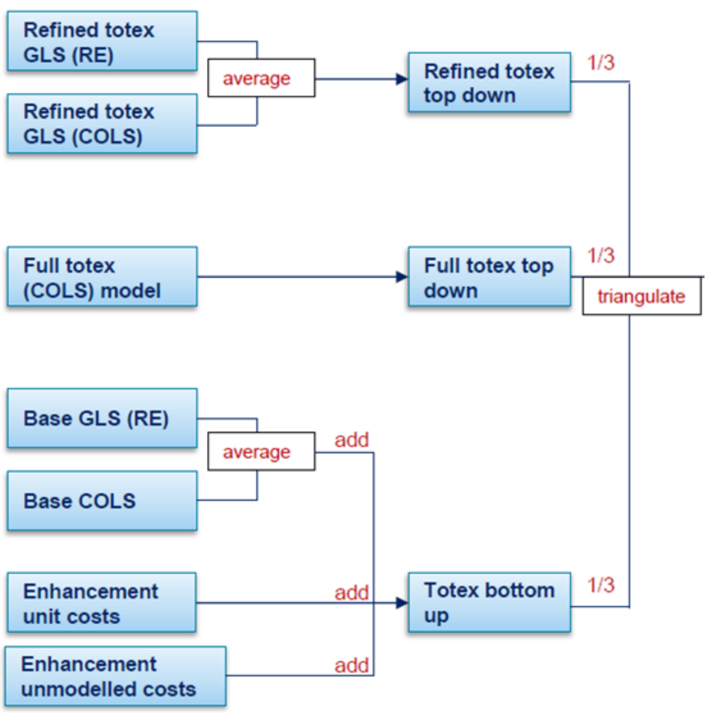
18. We describe Ofwat’s full and refined totex econometric models and its base expenditure econometric models in more detail in Appendix 4.1.

19. The main difference between the full model specification and the refined model specification is that the former is a model with 27 explanatory variables (and a constant term) while the refined models have 11 explanatory variables.

20. For the refined totex econometric modelling, Ofwat used two variants in terms of models specification and estimation technique: *(a)* pooled OLS (which Ofwat also referred to as corrected OLS or COLS) and *(b)* a random effects model estimated using the GLS technique (which Ofwat also referred to as GLS (RE)). Ofwat took the average result from these two different refined totex models as the result for its refined totex econometric modelling work-stream. Similarly, Ofwat’s separate analysis of base expenditure used two different variants of the base expenditure model (pooled OLS and GLS random effects) and took the average of the results from these two models, before adding separate estimates for enhancement expenditure.

21. Ofwat illustrated its approach to triangulation in Figure 1 below.

Figure 1: Ofwat's illustration of its approach to triangulation



Source: Ofwat.

22. We have summarised above the approach to triangulation that Ofwat set out in its price control methodology and its draft determinations. This is also the approach that it applied to most companies for the final determinations.

23. However, in the case of Bristol Water, Ofwat made a decision between its draft and final determinations to apply what was, in effect, a different approach to triangulation. Ofwat made a special adjustment for Bristol Water which it explained as follows:[7]

> In Bristol Water's case we made an adjustment to the refined totex model to increase the allowance for enhancement spend so it is consistent with our bottom up modelling stream. We have done this by increasing the allowance for enhancement in the refined model by £84 million so that it matches the value from our base plus unit cost model of £97 million. Overall totex is taken as the average of the three models and so after triangulation this increases overall totex by £27.8 million.

24. In reaching the decision to make this adjustment, Ofwat had found that its refined totex model gave Bristol Water 'a relatively low allowance for enhancement expenditure of £13 million compared to approximately

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[7] Ofwat (December 2014), Final price control determination notice: company-specific appendix – Bristol Water, p72.

£80 million from our other models'.[8] Ofwat obtained this figure of £13 million by subtracting the estimated totex for Bristol Water from Ofwat's refined econometric models of totex from the results for Bristol Water from its refined econometric models of base expenditure. The explanatory variables and functional form for these two sets of models were the same, and the only difference in model specification is that the totex models included enhancement expenditure.

25. This adjustment was, in essence, a disapplication of Ofwat's approach to triangulation for the case of Bristol Water. Its effect was that no weight was given in Ofwat's final cost assessment to the results for Bristol Water from the refined totex models and that greater weight was given to the results from the modelling workstream that combined econometric models of base expenditure with separate analysis of enhancement expenditure.

26. Ofwat's final triangulation for Bristol Water seems to be:

(a) a weight of one-third to the results from the full totex econometric model; and

(b) a weight of two-thirds to the results from the separate analyses of base expenditure and enhancement expenditure.

Upper quartile efficiency benchmark

27. In applying the results from its benchmarking analysis, Ofwat used an upper quartile efficiency benchmark. The basic cost threshold that Ofwat calculated for each company is an estimate of the level of totex that it would require if it operated at a level of efficiency that reflected the upper quartile of efficiency performance within the companies covered by Ofwat's analysis.

28. To make these estimates, Ofwat used the concept of an efficiency score which it defined as the ratio of the actual cost of the company relative to the level of cost that the models predicts for the company if it were averagely efficient.

29. Using historical data, Ofwat calculated a single efficiency score for each company. This was based on a comparison of each company's actual historical costs with the average estimated costs from the three modelling workstreams. Ofwat was then able to identify the upper quartile level of performance for the efficiency score among the companies in the sample.

[8] Ofwat (December 2014), Final price control determination notice: company-specific appendix – Bristol Water, p72.

Ofwat found that, for wholesale water, the upper quartile efficiency score implied a level of costs that was 6.53% lower than the industry average costs.

30. On this basis, Ofwat made a downward adjustment of 6.53% to the level of predicted expenditure from its modelling workstreams to produce an estimate of each company's expenditure requirements if it were at the upper quartile level of efficiency.

31. The interpretation of the efficiency scores as measures of relative efficiency of companies rests on the assumption that the benchmarking analysis fully accounts for any differences in companies' operating environment and circumstances that affect their costs, besides efficiency. If that is not the case, then differences in the calculated efficiency scores between companies will reflect factors besides efficiency. For example, some of the companies with relatively high efficiency scores may be companies for which Ofwat's modelling overestimates their expenditure requirements, rather than companies which are relatively efficient.

Costs excluded from benchmarking analysis (policy items)

32. Ofwat did not include all of companies' wholesale expenditure within its totex benchmarking analysis and triangulation exercise. Its final determinations explained that some items of expenditure were excluded and that these 'reflect categories of costs excluded from our modelling, typically where future allowed expenditure is not best determined by reference to historical industry trends'.[9]

33. For the wholesale water price controls, the adjustments that Ofwat made for these policy items varied between companies and contributed between 7% and 18% of Ofwat's final totex assessment for each company. The average was 11%. For Bristol Water, it was 7%.[10] The policy items for Bristol Water included local authority rates and Ofwat's allowance for pension deficit repair contributions.

Adjustments for special cost factors

34. Ofwat's approach included adjustments for special cost factors. Its final determinations said that it considered special cost factor claims made by companies for factors within their business plans that had not been

[9] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p26.
[10] CMA analysis of data from: Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p26.

adequately taken into account in Ofwat's basic cost threshold modelling or assumptions on policy items.[11]

35. The process for reviewing special cost factor claims was a substantial part of the cost assessment work for Ofwat's PR14 determinations. Ofwat used its modelling as the starting point for determining each company's cost allowance, rather than companies' business plan forecasts; each company had to explain and justify to Ofwat any difference ('gap') between the projections of expenditure requirements from Ofwat's modelling and the company's business plan forecasts.

36. Ofwat established and applied a set of criteria to assess companies' special cost factor claims. Ofwat also made a small number of negative special cost factor adjustments to reduce the allowances for some companies. We Ofwat's approach to special cost factors further in Appendix 3.1.

37. For the wholesale water price controls, the net adjustments that Ofwat made for special cost factors varied between companies. As a proportion of the sum of the basic cost threshold and policy additions, the adjustments for special cost factors varied between –3% and 24%, with an average of 5%.[12] The net adjustment for Bristol Water was 16%.[13]

Further adjustments outside the main special cost factor process

38. Ofwat's final determinations report that it carried out an additional step to consider adjustments outside of its established criteria for the special cost factor process:[14]

> In order to ensure that our final cost thresholds represent efficient cost we have added an additional step to our process that has involved considering whether there was any other evidence that justified a change to the cost threshold, even if an associated special cost factor claim did not meet the established criteria. For instance, in relation to Bristol Water we have made an extra adjustment to correct for a low allowance for enhancement

[11] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p26.
[12] CMA analysis of data from: Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p26.These figures exclude from the special cost factor allowances the large negative adjustment for Thames Water which resulted not from the special factor process but rather from Ofwat's approach to capping, described in a separate sub-section below.
[13] This excludes the effect of Ofwat's special adjustment to its triangulation approach in the case of Bristol Water but includes the adjustments for treatment complexity and congestion
[14] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p33.

spending associated with the refined totex model, in addition to considering its representations.

39. The specific adjustment for Bristol Water in relation to the refined totex model can be seen as an adaptation of Ofwat's approach to triangulation that led to the basic cost threshold (see paragraph 23).

40. In addition, as a result of its further consideration, Ofwat's final determinations for Bristol Water included upward adjustments for treatment complexity and congestion in the city of Bristol, even though Ofwat had found that Bristol Water's claims for these items had not met the criteria for special cost factor adjustments.

Cases where Ofwat's cost assessment exceeded a company's forecasts

41. For some companies, the sum of Ofwat's basic cost threshold (from its benchmarking analysis, after any further adjustments), and its adjustments for policy items and special cost factors, produced an estimate of totex requirements that was greater than the level of expenditure that the company had forecast, and sought, in its business plan submissions to Ofwat.

42. Two of these companies were the companies that Ofwat had decided to treat as 'enhanced companies', which were given draft determinations earlier than other companies. These companies were South West Water and Affinity Water. Ofwat's assessment of whether to treat companies as enhanced reflected a number of factors, including Ofwat's view of the quality of the company's business plan and the extent to which Ofwat's benchmarking analysis supported the view that the company's business plan expenditure forecasts represented an efficient level of expenditure.[15] For these two companies, Ofwat made an adjustment to the way that it calculated the basic cost threshold, using each company's forecasts of the relevant explanatory variables for the modelling rather than Ofwat's forecasts, before finalising its cost assessment.

43. For South West Water's wholesale water service, the final cost allowance that Ofwat set was 8% higher than the companies' business plan forecasts. For Affinity Water, the final cost allowance that Ofwat set was 5% higher than the companies' business plan forecasts.[16]

[15] CMA analysis of data from: Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p37.
[16] CMA analysis of data from: Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p37.

44. Ofwat adopted a different approach for other companies that it had not treated as enhanced companies. For Thames Water (in respect of its wholesale water service) and Severn Trent (in respect of its wholesale sewerage service), Ofwat adopted an approach whereby the final cost allowance it set was 'capped' at no more than 5% above the company's revised business plan forecast. Ofwat said that this approach reflected 'strong arguments in favour of customer protection'.[17]

45. Ofwat recognised that such an approach of capping expenditure allowances by reference to business plan forecasts 'could have the potential to distort the incentives on preparing business plan forecasts at future price control reviews', and said that it would be mindful of this risk in deciding on its approach to future price control reviews.[18]

46. For the remaining companies, Ofwat's final cost allowance reflected the sum of Ofwat's basic cost threshold, plus allowances for policy items, plus any adjustments for special cost factors.

Comparison between Ofwat's approach for PR14 and PR09

47. Ofwat's approach to cost assessment for the PR14 price control review was different from the approach it had taken at its previous price control reviews.

48. We provide in this subsection a brief overview of Ofwat's approach to cost assessment at its PR09 review, which set price limits for the period from 1 April 2010 to 31 March 2015. Ofwat's approach at PR09 was similar in many ways to that which it had taken at the PR04 price control review, which set price limits for the period from 1 April 2005 to 31 March 2010.

49. Ofwat's approach at PR09 was based on separate assessments of companies' opex requirements and capex requirements. Not only were these assessments separate, but they also involved different types of approach to cost assessment.

50. Note that, at previous price control reviews, Ofwat set single price controls covering both of what Ofwat now classifies as wholesale and retail. Wholesale costs were the vast majority of these costs.

51. For opex analysis, Ofwat's approach was approximately as follows. Ofwat took each company's opex in a specific base year (the last year of available

[17] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p39.
[18] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p39.

data) and used this as the basis of a projection of the company's opex requirements over the five-year price control period. Ofwat reviewed and, if necessary, adjusted the base year expenditure figure (eg if it included abnormal costs which were not a good basis for extrapolation). The projection (or 'roll-forward') involved the following adjustments and assumptions:

(a) The application of an annual rate of 'catch-up' efficiency improvement that Ofwat assumed for each company. This rate was calculated using the results from econometric models of opex; these used cross-sectional data from the sample of companies regulated by Ofwat. For the water service, Ofwat used four different econometric models, which related to different parts of the business or different activities. Ofwat used separate models for: *(i)* water resources and treatment; *(ii)* water distribution; *(iii)* power costs; and *(iv)* business activities. In setting the catch-up rate, Ofwat assumed that around 60% of the difference in costs between companies that was not explained by its econometric models would be gradually caught up by the end of the five-year price control period.

(b) The application of an annual rate of 'continuing efficiency' improvement. This was the same for all companies and applied in addition to the company-specific catch-up assumption. It reflected Ofwat's assumption on the extent to which companies would make cost reductions (relative to the RPI used for price control indexation) in addition to any catch-up efficiency improvements.

(c) Adjustments for some additional operating costs that Ofwat considered that companies would incur in the price control period but which were not adequately captured by its extrapolation from past levels of spend.

52. One point of comparison is that, while Ofwat's opex econometric models were still a matter of dispute with companies at PR09, the effect of the modelling results on companies' price controls was limited to whether the annual assumed catch-up for opex was between 0% and 2.9% per year.[19] The influence of model results on a company's allowed revenues seems less than for PR14, where an upper quartile benchmark was imposed from the start of the new price control period.

53. Ofwat's PR14 econometric models differ from those from PR09, not only by taking opex and capex together, but also because for PR14 Ofwat used models that each covered the whole of the water value chain (excluding

[19] Ofwat (November 2009), Future water and sewerage charges 2010-15: Final determinations, p108.

retail), from raw water abstraction, storage and treatment through to treated water distribution.

54. For capex assessment at PR09, Ofwat took the investment forecasts in each company's business plan as a starting point. Ofwat reviewed and challenged these forecasts on a number of grounds, including (but not limited to) the following:

(a) **Scope** – for example, whether the proposed volumes of asset replacement activity seemed too high or the plan included unnecessary expenditure projects.

(b) **Efficiency** – for example, whether the unit costs of specific asset replacement tasks or projects were too high.

55. For the analysis under *(b)*, Ofwat made assumptions on two types of capital efficiency: *(i)* a single continuing efficiency assumption that was the same for each company and *(ii)* a company-specific relative efficiency assumption compared to that of a middle-ranked company. For the analysis under *(ii)*, Ofwat drew relied on the 'cost base'. This was a data set complied by Ofwat which contained companies' estimates of the unit costs of for a series of defined capex projects (eg relining 100mm water mains in an urban area, or installing a new household meter). Ofwat used the cost base to carry out benchmarking analysis at the granular level of specific types of investment. Ofwat was able to make adjustments to companies' business plan forecasts by applying an efficiency challenge to the companies' cost forecasts. It calculated the efficiency challenge by weighting the difference between companies' unit costs and those of a middle-ranking company for each individual project.

56. Ofwat's approach to capex involved a greater emphasis on engineering assessment of the constituent elements of each company's cost forecasts than Ofwat's approach to PR14.

57. Besides differences in the approach to cost assessment, other parts of the price control framework that applied to companies following the PR09 review were quite different to those from PR14. For instance, the financial incentives on companies for capex were weaker (ie more pass-through of actual expenditure to consumers) than the totex incentives that Ofwat set for PR14.

Ofwat's menu scheme

Introduction

1. This appendix concerns the 'menu regulation' scheme that Ofwat applied to water companies as part of its PR14 price control framework. It is structured as follows:

   (a) The first section provides an overview and explanation of Ofwat's menu scheme. We use some illustrative examples to help show the effects of the scheme. We also provide information on the purposes of the scheme.

   (b) The second section summarises Bristol Water's submissions on Ofwat's menu scheme. These relate in particular to the effect of the scheme on Bristol Water's revenues in the price control period from 1 April 2015 to 31 March 2020, and the way that Ofwat has treated these effects in its financeability analysis.

   (c) The third section presents an assessment of a number of issues concerning Ofwat's use of the menu scheme which are relevant to our inquiry. It considers, in particular, Ofwat's objectives in using its menu scheme and also the interactions between the menu scheme and Bristol Water's revenues in the price control period from 1 April 2015 to 31 March 2020. It also considers the way that Ofwat has treated the menu scheme in its financeability analysis.

   (d) The final section discusses the approaches that we could take towards the menu scheme for our determination of a new wholesale price control for Bristol Water.

Overview and explanation of Ofwat's PR14 menu scheme

2. This section is structured as follows:

   (a) We provide an overview of Ofwat's PR14 menu scheme.

   (b) We use an illustrative example to show how such a scheme may provide financial incentives for regulated companies to provide more accurate expenditure forecasts in their price control business plans.

   (c) We use an illustrative example to explain how such a scheme may affect the balance of a regulated company's revenues between different price control periods.

(d) We provide information on the original objective of this type of incentive scheme.

(e) We provide information on Ofwat's stated approach and rationale for its PR14 menu scheme.

(f) We highlight some practical implementation issues that arose under Ofwat's scheme, due to companies providing menu choices to Ofwat after it had published its final determinations.

Overview of Ofwat's PR14 menu scheme

3. Ofwat's menu regulation scheme for PR14 was a development and extension of the CIS which it applied to capital expenditure at is previous price control review, PR09, in 2008 to 2009. The CIS that Ofwat introduced at PR09 was, in turn, based on the IQI that Ofgem had used as part of its regulation of electricity distribution companies and gas distribution companies in Great Britain.[1] Ofgem first introduced the IQI to have effect for the electricity distribution price controls that were effective from 1 April 2005.

4. Ofwat's PR14 menu scheme applied to a measure of total expenditure, including both operating and capital expenditure. In contrast, Ofwat's previous CIS scheme had applied only to capital expenditure. The extension of the scheme to cover both operating and capital expenditure followed Ofgem's development of its own scheme. Ofwat excluded some costs from the PR14 menu scheme. These related to pension deficit repair, third party services and an allowance for costs incurred in 2014/15 in relation to the Open Water programme.[2] Ofwat's PR14 menu scheme applied to the majority of companies' expenditure.

5. Ofwat's menu scheme and Ofgem's IQI are complicated regulatory mechanisms that are vulnerable to misinterpretation. We seek to provide a description below that draws out the important elements. It is not intended as a full explanation of the scheme or its properties.

[1] Ofgem previously used the term 'sliding scale' but now uses the term IQI.
[2] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p39.

6. Ofgem explained the purpose of the IQI (on which Ofwat's menu scheme is based) as follows:[3]

> 'The aim of the IQI is to encourage companies to submit more accurate expenditure forecasts in their business plans.'

7. We focus in this subsection on this interpretation of the scheme. We consider in a subsequent section the wider set of objectives that Ofwat seems to have had for the scheme for PR14.

8. To help understand the menu scheme, it is useful to set out the main elements of the price control framework that interact with it. Table 1 highlights five elements. We refer to these five elements repeatedly in the remainder of this appendix. Apart from the additional income element, each of these elements can be relevant to price control frameworks that do not employ similar menu schemes. The essence of the menu scheme lies not so much in its use of these five elements but in the relationships it determines between these elements.

Table 1: Key elements of Ofwat's menu scheme

Element	*Summary description*
Cost sharing incentive	The cost sharing incentive (also known as the efficiency incentive rate in Ofgem's scheme) is a parameter of the price control framework that determines the proportion of any over- or under-spend against the wholesale expenditure allowance (described below) that is not subsequently passed through to consumers. It affects the degree of profit incentives that the company has to operate efficiently during the price control period, and the financial risk that the company faces in relation to the outcome of Ofwat's cost assessment. The cost sharing incentive applies equally to capital expenditure and operating expenditure. A lower rate for the cost sharing incentive means that, over time, consumer bills will be more reflective of the company's outturn expenditure than Ofwat's wholesale cost baseline. The cost sharing incentive can only be implemented once the company's outturn expenditure is known. In the case of Ofwat's scheme, it is implemented through financial adjustments to the calculation of the company's allowed revenue in future price control periods.
Ofwat wholesale cost baseline	This is Ofwat's assessment of the regulated company's efficient expenditure requirements for its wholesale activities, over the price control period. It reflects the outcome of Ofwat's cost assessment, including the results of its econometric modelling and special cost factor adjustments. The Ofwat wholesale cost baseline refers to the outcome of the cost assessment process before any adjustments that arise from the application of the menu scheme.
Company's expenditure forecast	A necessary input to the menu scheme is the company's estimate of its expenditure requirements over the price control period. This is fed into the menu scheme expressed as a percentage of the Ofwat wholesale cost baseline. Ofwat refers to this percentage as the company's 'menu choice'. The company forecast could be the expenditure forecast from the company's business plan or a separate forecast that the company makes purely for the purposes of the menu scheme. For PR14, Ofwat took the latter approach.

[3] Ofgem (4 March 2013), Strategy decision for the RIIO-ED1 electricity distribution price control: overview, p34.

Element	*Summary description*
Wholesale expenditure allowance	This is the expenditure allowance for the price control period which is taken as an input to the price control financial model and used to calculate the company's maximum allowed wholesale revenue and RCV for the price control period. Under Ofwat's scheme the wholesale expenditure allowance is calculated as the weighted average of Ofwat's cost assessment and the company's expenditure forecast (or menu choice), with a 75% weight for the former and 25% for the latter.
Additional income element	This is a parameter of the menu scheme. It may be positive or negative.

Source: CMA analysis.

9. Perhaps the core feature of the menu scheme is that it determines the cost sharing incentive as a declining function of the company's expenditure forecast. The higher the company's expenditure forecast relative to Ofwat's wholesale cost baseline, the lower the cost sharing incentive (and the greater proportion of any variations in outturn expenditure that is passed through to consumers). This feature of the scheme enables it – under certain assumptions – to provide financial incentives for the regulated company to submit an expenditure forecast that reflects its own expectations of what it will need to spend during the price control period (hence Ofgem's terminology of the scheme as the Information Quality Incentive).

10. A second relevant feature of the menu scheme is that the wholesale expenditure allowance, which feeds into the calculation of the maximum allowed revenue for the company in the price control period from 1 April 2015 to 31 March 2020, is not simply Ofwat's best assessment of the company's efficient expenditure requirements (if it operates and invests efficiently) over that period (ie Ofwat's wholesale cost baseline). Instead, it is a weighted average of Ofwat's cost assessment and the company's forecast. The greater the company forecast, the higher is the allowed revenue in the price control period from 1 April 2015 to 31 March 2020.

11. While this second feature may appear to provide for a price control that represents a compromise between Ofwat's assessment and the company's own expenditure forecast, this is illusory – at least if a perspective beyond a single price control period is considered. The 25% weight to the company forecast has an effect on the revenues allowed during the price control period, but this effect will be offset by financial adjustments that are made, under the terms of the scheme, in future price control periods. In net present value terms, and using the same discount rate as Ofwat applies to implement the scheme, the overall effect of the 25% weighting to the company's forecast is zero. If this were not the case, the scheme would provide companies with an incentive to submit higher expenditure forecasts than they otherwise would, as doing so would mechanically increase future revenues and profits.

12. Ofwat's menu scheme is presented in the form of a complex table or matrix, which shows the relationship between the five elements highlighted in

Table 1. Table 2 below provides, for the purposes of illustration, a short extract from the menu scheme that Ofwat set out for its PR14 final determinations.

Table 2: Extract from Ofwat PR14 menu scheme

			%
Company forecast (as percentage of Ofwat wholesale cost baseline)	100	115	130
Cost sharing incentive	50	47	44
Additional income (as percentage of Ofwat wholesale cost baseline)	0	–1.99	–4.2
Wholesale expenditure allowance for price control period (as percentage of Ofwat wholesale cost baseline)	100	103.75	107.5

Source: Ofwat PL14W004 - Wholesale water menu model.

13. Table 2 shows how the cost sharing incentive, additional income element and wholesale expenditure allowance for the price control period vary according to the company's forecast. For example, we can see that if the company submits a company forecast of 115% rather than 100%, its cost sharing incentive reduces from 50% to 47%, it faces a negative additional income adjustment of 1.99%, and its wholesale expenditure allowance increases by 3.75%.

14. The cost sharing incentive rates in the table are substantially above zero. The company can, in each case, expect to profit from expenditure reductions and by avoiding inefficient expenditure. Thus, the scheme can help provide financial incentives for the company to restrain expenditure and operate efficiently during the price control period.[4] It is important to recognise that cost incentives such as these (sometimes known as efficiency incentives) are not an integral part of the menu scheme and can be applied without using a menu scheme.

15. We use the example above to illustrate two features of the menu scheme:

(a) The scheme may provide financial incentives for companies to submit more accurate expenditure forecasts.

(b) While the scheme sets a wholesale expenditure allowance giving a 25% weight to the company forecast, this has little (if any) effect on the total revenues that the company can collect over the long term and mainly affects the balance of revenues between different price control periods.

[4] These efficiency incentives might be undermined if the regulator uses past spend, and hence past efficiency savings, to set more challenging price controls for the company in the future. This is an argument for placing little, if any, weight on each company's own past spend when carrying out cost assessment under this type of price control framework.

Financial incentive for more accurate expenditure forecasts from companies

16. The original intention of this type of regulatory scheme was to provide financial incentives for companies to submit more accurate business plan expenditure forecasts, which could feed into the regulatory assessment of the company's expenditure requirements over the price control period. We illustrate below how this works.

17. Suppose we have a hypothetical company that expects to spend 115 compared with the Ofwat baseline of 100 (the units could be £ million, but it does not matter for the example). Suppose the company is faced with the menu scheme set out in Table 2 above. We can consider the net financial effect of the company submitting different expenditure forecasts.

18. Specifically, we consider three possible forecasts: 100, 115 and 130. Table 3 shows the outcome of the company submitting these alternative forecasts under the menu scheme above. The net overall outcome reflects three different ways in which the company forecast affects the company's revenues. First, through the 25% contribution to the wholesale expenditure allowance. Second, through the impact of the forecast on the additional income adjustment. And third, through the impact of the forecast on the financial adjustment that the company expects from the implementation (in future price control periods once outturn expenditure is known) of the cost sharing incentive, for which the applicable rate depends on the company forecast.

19. We can see from the table that the company's aggregate expected future revenues are (slightly) greater if the company submits a forecast of 115 rather than 100 or 130. This feature of the scheme provides the basis for the purported incentive properties of the scheme: encouraging companies to submit more accurate expenditure forecasts in their business plans. The menu scheme works in a similar way across all scenarios for the Ofwat wholesale cost baseline such that, in all cases, its expected revenue is greatest if it submits a forecast in line with what it expects to spend. Because of this, the financial incentive applies even if the company submits its forecast (or makes its menu choice) before Ofwat has determined its wholesale cost baseline.

Table 3: Illustrative scenarios where company expects to spend 115

Company forecast	*Wholesale expenditure allowance**	*Additional income adjustment*	*Expected future adjustment to implement cost sharing incentive†*	*Net effect on company's expected revenues over long term‡*
100	100	0	7.5	107.5
115	103.75	–1.99	6.0	107.7
130	107.5	–4.2	4.2	107.5

Source: CMA analysis.
*This is calculated as 0.75 multiplied by the Ofwat wholesale cost baseline plus 0.25 multiplied by the company forecast
†This is calculated as (1 – applicable cost sharing incentive) * (Company's expected future spend minus wholesale expenditure allowance).
‡This is calculated as the wholesale expenditure allowance plus the additional income adjustment plus the expected future adjustment to implement cost sharing incentive

20. There are a number of qualifications and caveats to the incentive properties of the scheme. We draw attention to the following:

(a) The financial incentive properties of the menu scheme in encouraging a company to submit an accurate forecast of their expenditure requirements may weaken – and may even be undermined – if the company expects the regulator to put weight on the company's expenditure forecast in making its own cost assessment to set the level of the wholesale cost baseline.

(b) If the company has a preference for a relatively high or relatively low cost sharing incentive – ie it is not indifferent to the rate of the cost sharing incentive – this may affect the expenditure forecast it submits. The company will be aware that submitting a higher forecast will, all else equal, reduce its cost sharing incentive.

(c) If the company uses a different discount rate (or has a different implied discount rate) to that used by Ofwat to calculate financial adjustments to implement the cost sharing incentive, this may affect the expenditure forecast it submits. The company will be aware that submitting a higher forecast will, all else equal, increase revenues in the coming price control period and decrease revenues in future periods.

21. In addition, Bristol Water argued that the 'truth telling' incentives of the menu scheme are likely to be very small in practice. The differences in expenditure forecasts of 15 in the example in Table 3 would affect revenue by 0.2 (the difference between 107.7 and 107.5). Bristol Water said that this difference is less than the inherent uncertainty in company cost estimates to deliver the required outcomes and that reputational and consumer-facing incentives are likely to be much greater than the incentive effect from the menu scheme. More generally, Bristol Water highlighted that reputational and wider incentives on companies in respect of their business plans would be more important than a narrow consideration of menu incentives.

The effect on the balance of revenues between different price control periods

22. We now turn to consider the impact of the 25% weighting of the company forecast in the wholesale expenditure allowance. We highlighted above that this is a temporary effect that is offset over the longer term.

23. In Table 4 we compare the Ofgem menu scheme for PR14 with three alternative versions of the menu scheme which would give different weight to the company forecast in setting the wholesale expenditure allowance. Rather than the 25% weight under the Ofwat scheme, these would give 50%, 100% or 0% weight to the company forecast in setting the wholesale expenditure allowance. We also compare these scenarios with a further scenario that has no menu scheme and the same cost sharing incentive that applies in the other cases.

24. Under Ofwat's menu scheme, both the wholesale expenditure allowance and the additional income adjustment feed into the level of revenues the company can collect in the price control period 1 April 2015 to 31 March 2020. Only part of the wholesale expenditure allowance is remunerated through revenues in that five-year period (this proportion depends, in particular, on the PAYG rate). In contrast, the adjustment to implement the cost sharing incentive will not be implemented until subsequent price control periods.

25. We can see by comparing the scenarios in Table 4 that increasing the weight given to the company business plan in the calculation of the wholesale expenditure allowance will act to increase revenues in the price control period 1 April 2015 to 31 March 2020. However, there is little (if any) effect on total revenues over the longer term as the increase is offset by a reduction to the future revenue adjustments that implement the cost sharing incentive.

26. The main effect of the weight given to the company forecast, in the calculation of the wholesale expenditure allowance, is to affect the balance of revenue that is remunerated in the forthcoming price control period compared to subsequent periods.

Table 4: Alternative scenarios for wholesale expenditure allowance

Scenario	*Wholesale expenditure allowance*	*Additional income adjustment*	*Expected future adjustment to implement cost sharing incentive*	*Net effect on company's expected revenues over long term*
Ofwat scheme 25% weight to company forecast Company forecast 115	103.75	–1.99	5.96	107.73
50% weight to company forecast Company forecast 115	107.5	–3.75	3.98	107.73
100% weight to company forecast	115	–7.28	0	107.72
0% weight to company forecast Company forecast 115	100	–0.40	7.95	107.55
No menu scheme Wholesale expenditure allowance set equal to wholesale cost baseline Cost sharing incentive of 47%	100	N/A	7.5	107.50

Source: CMA analysis based on Ofwat menu feeder model.

27. The example above helps to demonstrate how the menu scheme can affect the balance of revenues that the company collects during different price control periods. However, in practice, the effects on revenues in different time periods may not be material for some companies.

The original objective of this type of incentive scheme or menu scheme

28. We have set out some of the important features of Ofwat's menu scheme. We now turn to the role and purpose of the scheme in Ofwat's PR14 review. We first consider the original objective of this type of scheme.

29. As stated above, Ofwat's PR14 menu scheme was based on Ofgem's IQI scheme. As far as we can tell, there is no material difference between Ofwat's PR14 menu scheme and Ofgem's IQI in the matrix or formulae that underpin the scheme, besides the calibration of the parameters of the scheme.

30. In its recent review of electricity distribution company price controls, Ofgem applied its IQI scheme and was clear that the purpose of the IQI concerns the accuracy of companies' business plan forecasts:[5]

> 'The aim of the IQI is to encourage companies to submit more accurate expenditure forecasts in their business plans.'

[5] Ofgem (4 March 2013), Strategy decision for the RIIO-ED1 electricity distribution price control: overview, p34.

31. Similarly, Ofgem explained that:[6]

> 'The IQI is designed to encourage [electricity distribution network companies] to provide business plans that reflect best available information about future efficient expenditure requirements.'

32. At its PR09 price control review, Ofwat explained the purpose of the CIS in a manner consistent with this:

> 'The CIS is an important new feature for this price review. It provides strong incentives for companies to put forward challenging and efficient business plans before our determinations and to strive to beat our price limit assumptions after them.'

33. Similarly, in its 2010 determination for Bristol Water, the CC interpreted the CIS as a scheme to encourage more accurate business plan expenditure forecasts from companies:[7]

> 'The CIS is a method that Ofwat has devised to encourage companies to make realistic and well-evidenced capex plans without undermining their incentives to achieve efficiencies in realising those plans. It is intended to penalise companies that do not make such plans.'

Ofwat's stated approach and objectives for its PR14 menu scheme

34. In its decision paper on the methodology for its PR14 price control review, Ofwat confirmed its use of menu regulation and said the following:[8]

> 'Menu regulation can provide extra incentives for companies to reveal information, allows for some extra flexibility in setting totex baselines, provides some additional flexibility in setting efficiency sharing factors and allows companies to better manage risks and rewards. Menus can be constructed such that menu choices are incentive consistent, in that companies gain from both revealing information and achieving greater efficiencies. Customers gain from sharing in these efficiencies.'

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[6] Ofgem (28 September 2012), Strategy consultation for the RIIO-ED1 electricity distribution price control: overview, p33.
[7] CC10 Final determination, paragraph 5.2.
[8] Ofwat (July 2013), Setting price controls for 2015-20 – final methodology and expectations for companies' business plans, page 88.

35. Ofwat went on to say that it had considered two alternative approaches to the implementation of menu regulation:[9]

> *(a)* 'Using information in companies' business plans to determine which menu option the company should receive in the light our assessment of its costs (the broad approach used by Ofgem for its Information Quality Incentive, and by [Ofwat] for the CIS at the last price review).
>
> *(b)* Allowing companies to choose their own menu option later in the price setting process after we have prepared our own independent cost assessments.'

36. Ofwat said that the advantage of the first approach is that 'it would further encourage companies to reveal information during the business planning process'.[10] However, it identified that this approach has tended to be used where regulators have asked for two rounds of business planning information (which was not what Ofwat had envisaged for PR14). Furthermore, Ofwat identified the following drawback of the first approach:[11]

> 'It also does not allow companies any choice – and so contributes less to an efficient approach to risk management.'

37. Ofwat ultimately decided to adopt the second approach. Companies were allowed to 'choose their menu option' in January 2015, after Ofwat had completed its own final cost assessment and published its final determinations. Ofwat identified that this approach would be compatible with a single stage approach to business plans and that it would have advantages in terms of 'baseline flexibility, setting differential efficiency factors and risk management'.[12] Ofwat clarified its view on these benefits as follows:[13]

> 'A menu provides a framework which allows companies a degree of flexibility to determine its price control baseline and cost sharing incentive rate.'

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[9] Ofwat (July 2013), Setting price controls for 2015-20 – final methodology and expectations for companies' business plans, pp88-89.
[10] Ofwat (July 2013), Setting price controls for 2015-20 – final methodology and expectations for companies' business plans, p89.
[11] Ofwat (July 2013), Setting price controls for 2015-20 – final methodology and expectations for companies' business plans, p89.
[12] Ofwat (July 2013), Setting price controls for 2015-20 – final methodology and expectations for companies' business plans, p89.
[13] Ofwat (April 2014), Setting price controls for 2015-20 – policy and information update, p34.

38. The following features of the menu scheme, as discussed above, are relevant in understanding Ofwat's view on the role of the menu scheme for PR14:

(a) Under the menu scheme, different companies are likely to face different cost sharing incentive rates and each company's forecasts (or menu choices) will affect the rate that it faces. This feature relates to Ofwat's view that the menu scheme is beneficial because it allows differential efficiency factors (cost sharing incentive rates).

(b) Under the menu scheme, the revenues allowed during the price control period will be affected by the company's menu choice, through the 25% weight to the company business plan in the wholesale expenditure allowance. This feature relates to Ofwat's view that the menu scheme brings benefits by allowing 'baseline flexibility'.

39. From this perspective, Ofwat's approach to the choice between the two implementation options it identified reflects a trade-off between different potential roles for the scheme:

(a) If each company is asked to provide its expenditure forecast for use in the menu scheme before Ofwat has completed its cost assessment, this may contribute to Ofwat's overall cost assessment. However, because the company will not know the level of Ofwat's wholesale cost baseline, it will only have limited influence over the cost sharing incentive and the wholesale expenditure allowance that it faces.

(b) If each company is asked to provide its expenditure forecast for use in the menu scheme after Ofwat has completed its cost assessment, this would be too late to contribute to Ofwat's overall cost assessment. However, the company would know exactly what expenditure forecast it would need to submit to achieve any specific cost sharing incentive or wholesale expenditure allowance (subject to the upper and lower limits that applied to these under Ofwat's scheme).

40. Ofwat identified a choice between using the menu scheme as a means to 'encourage companies to reveal information during the business planning process',[14] and using the menu scheme to allow a company 'a degree of flexibility to determine its price control baseline and cost sharing incentive rate'.[15]

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[14] Ofwat (July 2013), Setting price controls for 2015-20 – final methodology and expectations for companies' business plans, p89.
[15] Ofwat (April 2014), Setting price controls for 2015-20 – policy and information update, p34.

41. Ofwat's approach for PR14 adopted the second option. This is reflected in the language it used. Ofwat referred to its scheme as 'menu regulation' and consistently referred to the company forecast, which is an input to the scheme, as the company's 'menu choice'.

42. Ofwat's submissions to our inquiry emphasised the role of its PR14 scheme in providing companies with flexibility in relating to the cost sharing incentives, which affect a company's financial exposure to over- and under-spend against the wholesale expenditure allowance used to calculate the price control:[16]

> 'The PR14 methodology provides companies with enhanced ability to manage risk by their menu choices, which determine risk sharing on totex outperformance.
>
> Companies can choose their point on the menu and so the sharing rate for outperformance and underperformance of the expenditure allowances.'

Practical implementation issues with the January 2015 menu choice

43. While Ofwat's clear intention for PR14 was that companies would make menu choices after it had published final determinations, this raised a practical problem. Companies made menu choices in January 2015. At that stage it was too late to reflect the impact in final determinations. Ofwat addressed this practical issue as follows:[17,18]

(a) The calculations of allowed revenues in Ofwat's final determinations are based on an 'implied' menu choice for each company, which was determined by Ofwat, based on the company's business plan. In the case of Bristol Water, Ofwat used a menu choice of 130 (ie company forecast 130% of Ofwat's wholesale cost baseline), which was the upper bound in Ofwat's menu scheme.

(b) The cost sharing incentive that is applicable during the period 1 April 2015 to 31 March 2020 is the one arising from the application of the company's January 2015 menu choice (not the implied menu choice).

(c) Ofwat said that it would make financial adjustments, as part of the subsequent price controls from 1 April 2020 onwards, that will give effect

[16] Ofwat (March 2015), Referral of Bristol Water's determination of price controls for the period from 1 April 2015 – introduction for the Competition and Markets Authority, pp56-58.
[17] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p42.
[18] Ofwat (March 2015), Referral of Bristol Water's determination of price controls for the period from 1 April 2015 – introduction for the Competition and Markets Authority, p20.

to the company's actual menu choice made in January 2015 (ie to adjust for any differences between Ofwat's implied menu choice and the company's actual menu choice).

Bristol Water's submissions

44. In its SoC, Bristol Water raised several specific concerns with Ofwat's approach to the PR14 menu scheme.

45. First, Bristol Water argued that while it is open to each company to choose a menu position, the effect of that choice does not impact a determination until AMP7 (ie from 1 April 2020 onwards) and that for AMP6 (ie 1 April 2015 to 31 March 2020) Ofwat has assumed a menu choice based on companies' business plan submissions.[19] Ofwat's implied or inferred menu choice, on which its final determinations were based, was higher than Bristol Water's actual menu choice. Bristol Water said that, following Ofwat's final determinations, Bristol Water made a menu choice of 125, which reflected its view of the costs of delivering its plan excluding the costs of Cheddar 2. Cheddar 2 was not part of the outcomes required from Bristol Water under Ofwat's final determinations.[20]

46. Second, Bristol Water was concerned that Ofwat applied penalties (that reflect a cost-share of overspend between companies and customers) to revenue despite overspend relating to operating and capital expenditure.[21]

47. Bristol Water said that if the regulatory cost assessment for wholesale totex was at, or close to, an appropriate level, the impact of these weaknesses would not be material, but where a large difference in views on totex exists, the size of penalty is significant and may lead to possibly unintended financeability issues.[22]

48. Third, Bristol Water went on to identify further concerns with the analytical approach that Ofwat took towards the menu scheme in its analysis of Bristol Water's financeability:[23]

> 'While Ofwat's wholesale totex estimate for Bristol Water was £409 million, through the menu choice mechanism Ofwat has assumed Bristol Water will spend £437 million, partially reflecting our Business Plan. Revenues have been set based on this higher

[19] Bristol Water SoC, page 408.
[20] Bristol Water SoC, page 409.
[21] Bristol Water SoC, page 408.
[22] Bristol Water SoC, page 408.
[23] Bristol Water SoC, page 569.

level of spend. To reflect a cost-sharing mechanism between Bristol Water and its customers for an overspend compared to its estimate, a revenue penalty of £17 million has also been included. The penalty is large due to the size of the wholesale totex gap created by FD14.

Ofwat has assessed financeability assuming the higher revenues and higher costs associated with £437 million, with allocations to revenue and RCV and operating and capital expenditure in line with the PAYG ratio. The penalty is then fully applied to revenues. The result is that the additional revenue is cancelled by the penalty, leaving an assumption of higher operating costs and therefore lower profitability.

As Ofwat has excluded the penalty from its financeability calculations, the assumption of lower profitability is ignored.'

49. Bristol Water set out in its SoC two options for how we should approach the menu scheme for the inquiry:[24]

> 'We believe Ofwat's cost assessment process has been too narrow and that it has inherent weaknesses. The menu choice penalty therefore reflects the results of a weak process, rather than acting as a genuine efficiency incentive. In reaching a redetermination, we consider it would be appropriate for the menu penalty to be based on our response to the CMA's provisional findings or simply assume 100. In effect, this would replicate the process that other water companies have gone through, where the cost assessment process appears to have been satisfactory.'

Our assessment

50. This section presents our assessment of a number of issues concerning Ofwat's use of the menu scheme which are relevant to our inquiry. We take the following in turn:

(a) Ofwat's use of the menu scheme for PR14.

(b) The implications of Ofwat using an implied menu choice in its final determinations.

(c) Ofwat's treatment of the menu scheme in its financeability analysis.

[24] Bristol Water SoC, page 571.

(d) The effects of the scheme on Bristol Water's revenues in the period from 1 April 2015 to 31 March 2020.

Ofwat's use of the menu scheme for PR14

51. In contrast to both the practice of Ofgem and Ofwat's own approach at PR09, Ofwat has applied its PR14 menu scheme in a way that departed from the original objective of this type of scheme – providing financial incentives to submit more accurate business plan expenditure forecasts that could feed into the regulatory cost assessment for the price control review. Ofwat appears to have perceived, and used, its menu scheme in a different way for PR14.

52. Ofwat did not present its PR14 menu scheme primarily as a means to provide financial incentives for water companies to submit more accurate business plan forecasts. Instead, Ofwat treated the following properties of its menu scheme as beneficial:

    (a) It allowed a company to influence the cost sharing incentive that it faces (within a range of 44 to 54%).

    (b) It allowed a company to influence the wholesale expenditure allowance (up to a maximum of 107.5% of the Ofwat wholesale cost baseline).

53. Ofwat implemented the menu scheme in a way that prioritised these features.

54. We have not been able to identify how the menu scheme that Ofwat implemented would have made an effective contribution to the original objective of providing financial incentives to submit more accurate business plan expenditure forecasts, as a means to contribute to the cost assessment at the price control review. This is for two reasons:

    (a) The scheme did not apply to companies' business plan forecasts.[25] Instead, the scheme applied to a decision (menu choice) that companies made in January 2015, after Ofwat had completed its review and assessment of companies' business plans and after it had published final determinations.

    (b) Even if the scheme encouraged each company to submit an accurate forecast, in January 2015, of its expenditure forecasts over the period 1 April 2015 to 31 March 2015, this would have been too late to contribute to the cost assessment on which the PR14 price controls were based.

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[25] Other than through the implied menu choice, the effect of which Ofwat plans to cancel out in the next price control period.

55. Ofwat's approach to the PR14 menu scheme raises two questions:

(a) Should it be a regulatory objective to provide a company with the ability to choose its own cost sharing incentive (within the range 45 to 55%) or to choose the wholesale expenditure allowance that it faces (up to a maximum of 107.5% of the Ofwat wholesale cost baseline)?

(b) Is Ofwat's menu scheme likely to be an effective and proportionate way to meet such an objective?

56. We below focus on the second of these questions.

57. Any attempt to present the menu scheme as a scheme that provides companies with choice or flexibility on price control parameters such as the cost sharing incentive or the wholesale expenditure allowance must confront the incentive properties of the scheme.

58. Ofwat's PR14 menu scheme was based on a scheme that was originally designed to provide financial incentives for a company to submit an expenditure forecast that fits with its estimates of what it will spend during the price control period. It is unclear whether the scheme in practice provides companies with flexibility to make choices.

59. While it is true that the company forecasts that are taken as inputs to the scheme affect the cost sharing incentive and the wholesale expenditure baseline, these are not free choices for the company to make. Attempting to use the scheme to achieve a specific cost sharing incentive or wholesale expenditure allowance comes at a price.

60. The properties of the menu scheme mean that a company will tend to maximise the expectation value of its future revenues (and profits) if it chooses to submit a forecast for use in the menu scheme that is consistent with its expenditure requirements over the price control period (subject to any differences in its discount rate compared to that used in Ofwat's calculations). Submitting such a forecast will lead to it facing a specific value for the cost sharing incentive and wholesale expenditure allowance. If the company wishes to face a different rate for the cost sharing incentive, or to have a different wholesale expenditure baseline, it must accept a lower level of expected future revenues. There is, in effect, a financial penalty for making such choices.

61. Table 5 illustrates the financial penalty under Ofwat's scheme that a company must accept if it wishes to achieve a specific rate for the cost sharing incentive. The table considers the two extremes of the range allowed by

Ofwat. The penalty varies according to the ratio of the company's own expenditure forecast to the Ofwat baseline.

Table 5: Illustration of penalty from targeting a specific cost incentive rate

		% of Ofwat wholesale cost baseline
Company's expected expenditure during price control period	*Penalty from submitting forecast that achieves 54% cost sharing incentive**	*Penalty from submitting forecast that achieves 44% cost sharing incentive**
80	0.0	–2.5
90	–0.1	–1.6
100	–0.4	–0.9
110	–0.9	–0.4
120	–1.6	–0.1
130	–2.5	0.0

Source: CMA analysis of Ofwat menu feeder model
*This calculation assumes the company has the same discount rate for future revenues as Ofwat uses (eg to implement the cost sharing incentive)

62. A similar analysis could be provided to show the implied revenue penalties for a company that wishes to use the menu scheme to achieve a specific wholesale expenditure allowance.

63. The penalties identified in Table 5 above are, in some cases, significant. These penalties are an integral part of the menu scheme and are likely to limit its effectiveness in providing any genuine choice or flexibility to companies over the cost sharing incentive rate.

64. If Ofwat had wanted each company to have flexibility to choose the cost sharing incentive that it faces, it may have been simpler and more effective not to use the menu scheme and instead to set a cost sharing incentive separately for each company based on that company's choice, within a range specified by Ofwat.

65. Similarly, if Ofwat had wanted each company to have flexibility in its wholesale expenditure baseline, it may have been simpler and more effective not to use the menu scheme and instead to set the baseline in light of a company choice within a range specified by Ofwat.

66. Bristol Water told us that it agreed with our analysis that Ofwat's PR14 menu scheme does not represent a good way to provide companies with flexibility on the cost sharing incentives.

67. Ofwat told us that while the flexibility with respect to cost sharing rates is limited, 'the broader flexibilities and truth telling characteristics that menus provide remain beneficial additions to the regulatory regime'. Ofwat did not elaborate on what the 'broader flexibilities' were. Based on our own analysis, we did not consider that there were any beyond the limited influence on the cost sharing rate and wholesale expenditure allowance discussed above.

68. We sought further information from Ofwat on what it saw as the truth telling characteristics of the scheme it had used for PR14. More specifically, we asked Ofwat to explain the benefit from providing companies with incentives to reveal information at a point in time when it had already published its final determinations. Ofwat told us that the menu choices that companies made subsequent to its final determinations provided information on what level of total expenditure companies were targeting. Ofwat said that this was information that would be useful for the purposes of Ofwat's next price control review, PR19, when it starts to consider potential changes to its (econometric benchmarking) models.

69. We considered that it was possible that Ofwat's menu scheme would help provide some relevant information for its PR19 price control review. However, we did not consider this a strong reason for using the scheme. This was for two reasons:

(a) This potential future benefit of the scheme had not been highlighted in Ofwat's original submissions to us or its PR14 methodology documents which, as explained above, had instead emphasised the desire to provide companies with flexibility. If the benefits to Ofwat's PR19 price control review were very important, we would have expected Ofwat to have mentioned them at an earlier stage.

(b) The information from companies' menu choices in January 2015 does not lead to strong conclusions about the approach to cost assessment for PR19. Indeed, Ofwat provided alternative interpretations of the menu choices. First, Ofwat told us that the fact that seven companies submitted menu choices (expenditure forecasts) in January 2015 that were lower than the ones Ofwat had assumed for its final determinations (based on companies' price control review business plans) showed that Ofwat's approach had worked for consumers because the companies that had provided an explanation of their choice said that they took the opportunity to further challenge themselves. Subsequently, Ofwat agreed that it was possible that, for companies whose January 2015 menu choices were below what Ofwat had assumed, its models had provided estimates that were too high. These examples highlight the difficulty of drawing firm conclusions from the January 2015 menu choices, which reduces the value of the information generated by the scheme.

Ofwat's use of an implied menu choice for its final determinations

70. Because Ofwat asked companies to make their menu choices after it had published final determinations, it was not practical for the price controls from 1 April 2015 to 31 March 2020 to give effect to the company's menu choice.

Instead, as an interim measure, Ofwat used an implied or inferred menu choice based on company business plans. Ofwat said that it intends to make financial adjustments in the subsequent price control period to give effect to the company's actual menu choice (to the extent that it differs from the implied menu choice that Ofwat used for final determinations).

71. This aspect of Ofwat's approach may reduce or undermine the value of the scheme in providing companies with flexibility on the wholesale expenditure allowance, which Ofwat had originally intended in its comments about 'baseline flexibility'. What Ofwat refers to as the company menu choice under the PR14 menu scheme does not affect its allowed revenues in the price control period from 1 April 2015 to 31 March 2020.

Ofwat's treatment of the menu scheme in its financeability analysis

72. Bristol Water raised some concerns about Ofwat's treatment of the menu scheme in its financeability analysis.

73. Our reading of Ofwat's financeability analysis for Bristol Water is that it does the following:

(a) It assumes revenues for Bristol Water that are based on the post menu wholesale expenditure allowance of around £438 million.

(b) It assumes that Bristol Water's wholesale expenditure over the price control period is also £438 million.

(c) It does not take account of the negative adjustment from the menu scheme for Bristol Water of around £17 million over the price control period (Bristol Water refers to this as a penalty, but we found this terminology to be confusing).

74. We disagreed with Ofwat's approach to financeability analysis in the context of Ofwat's menu scheme.

75. Ofwat's approach seems to involve an inconsistency in the way that the effects of the menu scheme feature in the analysis. Ofwat's analysis seems to take account of the positive effect on revenues of the menu scheme: the uplift to the wholesale expenditure allowance arising from the implied Bristol Water menu choice of 130, which is given a 25% weight in the wholesale expenditure allowance on which the price control is based. However, it does not seem to account for the negative effect on revenues: the additional income adjustment, which takes a negative value because of the implied menu choice of 130. One way to see this inconsistency is to consider an alternative scenario in which Bristol Water had a menu choice of 100. In this

scenario, it would face an additional income adjustment of zero rather than £17 million (no 'penalty' in Bristol Water's terminology). However, its wholesale expenditure allowance would be around £30 million lower and the revenues used for the financeability analysis would need to be adjusted downwards accordingly.

76. A further issue is the assumption made about Bristol Water's level of expenditure over the five-year period from 1 April 2015. Ofwat's financeability analysis was based on the assumption that Bristol Water would incur expenditure of £438 million. This seems difficult to explain because:

(a) it is not the efficient level of expenditure arising from Ofwat's cost assessment for Bristol Water. On a comparable basis, Ofwat's assessment implies wholesale expenditure of £409 million; and

(b) it is not the level of expenditure forecast by Bristol Water, which was substantially higher.

77. Ofwat repeatedly told us that the financeability assessment should be based on an efficient company.[26] However, if Ofwat had wanted to carry out a financeability assessment for what it considered to be an efficient company, it would have been more logical to use the figure of £409 million for the assumed level of Bristol Water's expenditure and then to exclude both of the menu adjustments: the upward adjustment to allowed wholesale allowance to move from £409 million to £438 million and the downward adjustment of £17 million.

78. If Ofwat had applied this alternative approach, it may have obtained similar results from its financeability analysis for the period from 1 April 2015. Reducing both the assumed wholesale expenditure allowance and the assumed Bristol Water expenditure by a similar amount would tend to have effects that offset each other.

79. Thus, although we did not understand the logic for Ofwat's approach, and found Ofwat's description of its approach confusing, it may not have introduced any significant errors to the overall analysis.[27]

80. One implication that we have drawn is that the PR14 menu scheme is a complex part of Ofwat's regulatory framework and that there has been

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[26] Ofwat (March 2015), Referral of Bristol Water's determination of price controls for the period from 1 April 2015 – introduction for the Competition and Markets Authority, pp56-58.
[27] We did not consider this in detail because we provisionally decided not to apply the menu scheme for our determination, so this was not relevant to our financeability analysis.

particular confusion and uncertainty as to the appropriate way to take account of the scheme in the financeability analysis.

The effects of the scheme on Bristol Water revenues up to 31 March 2020

81. We have carried out some analysis to better understand the effects of Ofwat's menu scheme on Bristol Water's revenues in the period 1 April 2015 to 31 March 2020 and the implications for its financeability in that period.

82. We considered three scenarios. In each scenario, we take as given Ofwat's wholesale cost baseline of £402.4 million.[28] The scenarios vary in whether Ofwat's menu scheme applies and, if so, what the menu choice for Bristol Water is:

- *(a)* In scenario *(a)*, Ofwat's menu scheme is retained and the implied menu choice for Bristol Water is 130. This scenario is based on Ofwat's final determinations in respect of the period from 1 April 2015 to 31 March 2020 (under Ofwat's approach, Bristol Water's actual menu choice in January 2015 would not have affected revenues before the subsequent price control from 1 April 2020). In this scenario the expenditure allowance ultimately feeding into the financial model used to calculate price control revenues is £432.6 million.[29]

- *(b)* Scenario *(b)* is a hypothetical scenario in which Ofwat's menu scheme is retained, but Bristol Water's menu choice is 100. In this case the wholesale expenditure allowance feeding into the financial model used to calculate price control revenues is the same as Ofwat's wholesale cost baseline (£402.4 million).

- *(c)* Scenario *(c)* is a hypothetical scenario. Ofwat's menu scheme is abandoned and the wholesale expenditure allowance feeding into the financial model used to calculate price control revenues is simply Ofwat's wholesale cost baseline (£402.4 million).

83. Table 6 below shows indicative figures for revenues relating to the expenditure allowance covered by the menu scheme.[30] Our focus here is revenue impacts over the five-year price control period from 1 April 2015 to 31 March 2020: the tables are not representative of the overall impacts of the different scenarios on revenues (the menu scheme has potentially substantial

[28] Ofwat final determination cost threshold of £409.2 million less £6.7 million costs excluded from the menu.
[29] This expenditure allowance gives a 25% weight to the company forecast (menu choice) and a 75% weight to Ofwat's wholesale cost baseline. With a forecast of 130% of the baseline, this works out as an expenditure allowance of 107.5% of Ofwat's wholesale cost baseline.
[30] In these three scenarios we leave aside the costs such as pension deficit repair that are treated outside of the menu.

impacts on revenues in future price control periods). These calculations are based on data from Ofwat's final determinations menu feeder model, an average PAYG rate of 55% and RCV additions depreciated straight line over 30 years. The figures are indicative and have not been verified through separate scenario modelling using Ofwat's complex financial model.

Table 6: Indicative revenues allowance 1 April 2015 to 31 March 2020

£m

Scenario	*2015-2020 revenue from wholesale expenditure allowance*	*Additional income adjustment*	*Net effect*
(a) Ofwat menu with Bristol Water at 130	296	(17)	280
(b) Ofwat menu with Bristol Water at 100	276	0	276
(c) No menu applies	276	N/A	276

Source: CMA analysis.

84. The figures in Table 6 are indicative only, but they suggest that the differences between the scenarios are small, less than £1 million per year (which is below 1% of revenues). Under Ofwat's menu scheme, the impact of a menu choice of 130 versus 100 seems to have little impact on revenues. This is because, under the menu choice of 130, the positive impact on revenues from the 25% weight to the company forecast (menu choice) is mostly offset by the additional income element.

85. Our analysis is consistent with Ofwat's view that the menu choices have a small impact on revenues in the period 1 April 2015 to 31 March 2020:[31]

> 'We also noted that menu choices (even extreme ones) are likely to have a relatively small impact on allowed revenue and customer bills in the period from 2015-20 due to the offsetting effects of the allowed expenditure and the menu's 'additional income'. We therefore stated that any adjustment to companies' allowed revenues resulting from their menu choice arising from our PR14 decisions will be made as part of the price control review in 2019 (PR19).'

86. Our analysis – and Ofwat's statement above – suggest that, at least for Bristol Water, the Ofwat PR14 menu scheme makes no positive contribution to Bristol Water's revenues in the period 1 April 2015 to 31 March 2020. At the same time, the menu scheme does not seem to impose any substantial net financial penalty on Bristol Water in that period.

[31] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p41.

87. Of course, to the extent that Ofwat’s cost assessment (ie its wholesale cost baseline) for Bristol Water was substantially lower than what Bristol Water considered appropriate, this would cause financial detriment from Bristol Water’s perspective. But this is simply a result of Ofwat’s cost assessment and is not attributable to the menu scheme.

Approach to menu scheme for our determination

88. We considered whether, and how, to use the menu scheme for the purposes of our determination.

89. We faced a practical issue. Ofwat’s menu scheme was predicated on the assumption that Bristol Water would make a menu choice in January 2015 in the knowledge of the wholesale cost baseline. Our determination may lead to material changes to the wholesale cost baseline. It did not seem consistent with Ofwat’s approach to the PR14 menu to take Bristol Water’s January 2015 menu choice which was made before our assessment of the appropriate level of the wholesale cost baseline.

90. We considered whether it would make sense to retain the spirit of Ofwat’s approach and do the following:

(a) Make our determination on an implied or inferred menu choice for Bristol Water (eg comparing Bristol Water’s business plan forecasts with our final cost assessment).

(b) Provide for Bristol Water to make a menu choice after our final determination has been published. We would then look to Ofwat to give effect to that menu choice through financial adjustments to the subsequent price control from 1 April 2020 onwards.

91. We found limited grounds for adopting this approach within the context of our inquiry.

92. We recognise that a menu scheme along the lines of that used in the past by Ofwat (the CIS), and originally developed by Ofgem (the IQI), may contribute to the accuracy of companies’ business plan forecasts as a means to improve the regulator’s cost assessment during the price control review process. This objective may justify the use of such schemes and there would be concerns about undermining the incentive effects of such schemes if the CMA departed from them retrospectively. However, the specific way in which Ofwat implemented its PR14 menu scheme, with companies making menu choices after final determinations, did not target the accuracy of the company business plan forecasts that fed into Ofwat’s PR14 cost assessment.

93. We did not consider Ofwat's argument that its menu scheme provided useful information for PR19 to be sufficiently strong that we should retain the scheme for our determination. As explained above, we did not consider that a strong argument in favour of the scheme. Furthermore, this argument for the scheme seemed weaker for our determination for Bristol Water. Regardless of what we decided to do, our approach would not affect Ofwat's ability to use the information from the menu choices from the other 17 companies when developing its approach for the PR19 review.

94. Apart from information revelation, Ofwat saw its PR14 menu scheme as a scheme to provide flexibility to companies, in particular in relation to the cost sharing rate (within a range defined by Ofwat). This is reflected in its language: it refers to a company's 'menu choice' for what was previously treated as the company's expenditure forecast. However, as we have explained, Ofwat's PR14 menu scheme does not seem a good way to provide flexibility to companies because any attempt by a company to exercise choice in the cost sharing incentive rate could bring about significant financial penalties to the company. Furthermore, we have not seen any evidence or argument that it is important to provide companies with a choice over their cost sharing incentive rate within the range of 44 to 54%.

95. We identified an alternative approach:

(a) We would not apply Ofwat's PR14 menu scheme for our determination. There would be no implied or actual menu choice available for Bristol Water.

(b) The wholesale expenditure allowance for Bristol Water, which feeds into the calculation of allowed revenues and RCV for the period 1 April 2015 to 31 March 2020, would be based directly on our assessment of Bristol Water's expenditure requirements over that period.

(c) The cost sharing incentive would be 50%.

96. This approach has equivalent effect, in technical terms, to retaining the Ofwat PR14 menu scheme and assuming a Bristol Water expenditure forecast (menu choice) as 100% of our allowance. As such, this approach was consistent with one of the two suggested approaches that Bristol Water advocated for our inquiry: that we 'simply assume 100[%]'.[32]

97. Under this approach, there would be no weighted average between a Bristol Water forecast and our assessment. The price control would be set giving

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[32] Bristol Water SoC, paragraph 2405.

100% weight to the outcome of our cost assessment (though our cost assessment can draw on Bristol Water's business plan forecasts insofar as we consider appropriate). While this might seem a change from Ofwat's PR14 scheme, this has a limited effect. Our analysis above, and statements from Ofwat, indicate that the menu scheme has limited effect on revenues in the period 1 April 2015 to 31 March 2020.

98. An approach to our determination that does not involve the menu scheme has some further benefits. In particular, it is not vulnerable to two specific concerns that Bristol Water raised about Ofwat's PR14 menu scheme, which were that:

(a) for the period 1 April 2015 to 31 March 2020, Ofwat has set the price control using an assumed menu choice based on companies' business plan submissions. This differed from Bristol Water's actual menu choice; and

(b) the additional income adjustment applied by Ofwat was a revenue adjustment (or penalty) despite the implied over-spend relating to operating and capital expenditure.

99. This approach would also help to reduce an area of complexity and dispute in relation to the financeability assessment.

100. We shared our proposed approach to the menu scheme with the main parties.

101. Bristol Water told us that it welcomed our proposal to dis-apply the scheme and set a cost sharing incentive of 50%. Bristol Water said that this would result in slightly higher incentive risk for Bristol Water, but more importantly it would avoid unintended financeability consequences.

102. Ofwat identified that our proposed approach would increase the cost sharing rate from 45 to 50% and that this would provide a stronger efficiency incentive for Bristol Water but also expose customers further to the risk of over-spend. We agreed that the incentive rate would be slightly higher, but did not consider this to be problematic.

103. Ofwat expected that, while the price impact of our proposal would depend on our cost assessment for Bristol Water, the impact of dis-applying the menu scheme on Bristol Water's revenues and cash flow would be small.

104. Ofwat said that it would be reviewing the use and operation of menus at PR19 drawing on how well the mechanism has worked and that it would be premature to draw conclusions at this stage about the use of menus in future price control reviews. We can confirm that our assessment of an appropriate

approach towards the menu scheme is exclusively an assessment of an appropriate approach for our determination for Bristol Water. There are significant differences between the context for our determination and Ofwat’s periodic price control reviews. While we consider that the analysis we have set out in this appendix would be relevant to Ofwat’s future consideration of the menu scheme, our provisional decision on the approach for our determination is not intended to constrain the approach that Ofwat may take at future price control reviews.

Submissions from other parties about the Ofwat PR14 approach

1. Submissions from other parties about the Ofwat PR14 approach were received from:

   (a) Bristol Water's LEF

   (b) CCWater

   (c) DWI

   (d) Anglian Water

   (e) Dŵr Cymru Welsh Water

   (f) South West Water

   (g) Wessex Water

Bristol Water's Local Engagement Forum

2. In its submission to the CMA,[1] the LEF said that it was difficult for it to understand how Bristol Water could deliver the proposed totex investment for significantly less than Bristol Water's estimates. The LEF was concerned that, as a result of Ofwat's investment allowances, Bristol Water's customers would not receive the levels of service and enhancement to their water supply in the period 2015 to 2020 on which they were consulted extensively and found to be acceptable.

3. The LEF said that it was content with the independent assurance (from Bristol Water's consultants) on Bristol Water's cost estimates and the asset planning methodologies employed, and that the LEF supported the overall package of work and the associated bill impacts.

CCWater

4. CCWater's submission to the CMA said that, in terms of wholesale costs, it sought assurance that the CMA's determination would allow the company to deliver the required outcomes for customers at a cost that reflected an efficient company and represented value for money for consumers. CCWater said that any exceptional costs to be allowed for in Bristol Water's totex must

[1] LEF submission, p9.

be clearly evidenced to justify why the company had higher input costs or required costs that were higher than comparable costs for other companies.[2]

DWI

5. DWI noted it had a position on all of the water companies' CCGs in England and Wales. DWI said that Bristol Water submitted six formal proposals for drinking water quality to the Inspectorate and that Bristol Water was to be commended on the quality of the submissions to the DWI, which complied with its PR14 guidance. The DWI was broadly aware of Bristol Water's plans for drinking water quality and was generally supportive of Bristol Water's approach.[3]

6. DWI said it would put legal instruments in place for three schemes (Purton & Littleton Catchment Management, Bristol Water Lead Strategy and Barrow WTW UV irradiation) to make these proposals legally binding programmes of work. It commended for support action to address raw water deterioration at Cheddar WTW, pH correction measures at Cheddar WTW and pH correction measures at Stowey WTW.[4]

Anglian Water

7. Anglian Water provided submissions that it had previously made to Ofwat in June 2014.[5] Anglian Water said that these set out what it considered to be systematic errors in Ofwat's modelling. Anglian Water also disputed Ofwat's approach to triangulation. It said that it was not appropriate to give different econometric models the same weight in the overall assessment when Ofwat's consultants had found that the models used were of differing quality.

8. Anglian Water also criticised Ofwat's approach of not making a separate assessment of RPEs.[6] It did not consider Ofwat's approach of extrapolating the time trend from its econometric models to be appropriate.

9. Anglian Water also commented on the interruptions to supply outcome delivery incentive and had the view that the committed performance level had been set without reference to the inherent differences in companies' networks which it said inevitably affect performance.

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[2] CCWater submission, paragraphs 3.2 & 3.22.
[3] DWI submission, pp1–2.
[4] DWI submission, p3.
[5] Anglian Water submission.
[6] RPEs reflect the extent to which the input prices (including wages) that a company faces may grow faster, or slower, than the RPI which is used for the wholesale price control indexation.

Dŵr Cymru Welsh Water

10. Dŵr Cymru Welsh Water said that overall it found the approach and transparency of PR14 was beneficial to securing the best outcome for its customers. It said there had been some material changes from previous price reviews; arguably the most significant was to the process and methodology for assessing allowed expenditure, in particular the setting of a totex baseline. Dŵr Cymru Welsh Water welcomed the more innovative approach taken which recognised the inherent complexity of modelling heterogeneous companies.[7]

11. Dŵr Cymru Welsh Water said that this approach contrasted with the approach to setting industry-wide performance level targets and ODIs in the autumn of 2014. It said that business plans were constructed after careful consideration of customer preferences and cost and bill impacts of the various options which resulted in a balanced plan submission. Dŵr Cymru Welsh Water said a unilateral change [by Ofwat] to performance targets at a late stage meant that the outcome was more crude and unsatisfactory than it needed to be.[8]

South West Water

12. South West Water said it would be concerned by a move from the risk-based framework that Ofwat had adopted back to a framework that required the regulator to scrutinise individual companies' plans in detail in a way that was not targeted by a sense of economic value and risk. It said the onus must remain with companies to make the case by understanding the delivery risks from customer and regulatory perspectives rather than the price review process being responsible for achieving this. South West Water said the water industry returning to a performance and comparative measure framework determined ex ante by Ofwat was unlikely to be fit for purpose and companies needed to continue to adapt to this.[9]

Wessex Water

13. Wessex Water said that[10] it shared Bristol Water's concerns about the appropriateness of the Ofwat cost assessment methodology. While Wessex Water's board had accepted the overall price limits 'in the round', Wessex Water said that, given the shortcomings in Ofwat's modelling approach, its continued use would not be in consumers' interests.

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[7] Dŵr Cymru Welsh Water submission, p1.
[8] Dŵr Cymru Welsh Water submission, p1.
[9] South West Water submission, paragraph 33.
[10] Wessex Water submission, p2.

14. Wessex Water said that Ofwat's approach[11] took no account of existing service levels and delivery outcomes – all companies were assumed to deliver a homogenous service level to consumers and the environment.[12] It also said that Ofwat's approach took limited account of future changes in service levels. It also noted that Ofwat's 'efficiency challenge' had increased since PR09 despite an increase in 'modelling uncertainty'.

15. Wessex Water said that the evidence suggested that the overall totex-based cost assessment approach used by Ofwat rewarded companies that were proposing to spend less rather than those proposing to spend efficiently on the right things. Wessex Water questioned whether Ofwat's approach was in the long-term interests of water consumers. It said that Ofwat's approach meant there was an incentive for companies to avoid proposing cost-beneficial improvements, since companies that avoided additional investment would be subject to less scrutiny; receive a lesser efficiency challenge; were more likely to gain rewards from Ofwat giving the company enhanced status; and would gain a reputation for efficiency.[13]

16. Wessex Water also gave details of discussions with Bristol Water about bulk supply offers made by Wessex Water in 2013 which Wessex Water said could provide Bristol Water with additional annual water resources of 16.9 Ml/d.

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[11] Wessex Water submission, pp9–10.
[12] It identified variations in companies' performance against the EA's environmental performance that are not taken into account in Ofwat's approach.
[13] Wessex Water submission, paragraphs 36–38.

Ofwat's approach to special cost factors

Introduction

1. This appendix concerns Ofwat's approach to special cost factors, which Ofwat used as a means to mitigate the limitations in the benchmarking models that it used for its cost assessment.

2. We consider that the special cost factor process was an important part of the cost assessment process that Ofwat established for PR14. However, we had two significant concerns, which were:

   (a) risks of asymmetry in the cost assessment process to the detriment of consumers; and

   (b) potential difficulties for companies making effective special cost factor claims.

3. We first describe Ofwat's special cost factor assessment process and then take these two issues in turn, before setting out the implications that we drew for our approach to cost assessment for Bristol Water.

Ofwat's special cost factor process

4. In reviewing submissions from companies on special cost factors, Ofwat first considered whether the submission was supported by substantial evidence and whether it was material. The materiality threshold was 0.5% of the company's business plan totex forecast.

5. Subject to this initial filter, Ofwat made an assessment of the 'implicit allowance' (if any) relating to the company's special cost factor claim. Ofwat's assessment of the implicit allowance is an attempt to estimate what part, if any, of the claim made by the company was already covered by, or allowed for, in the basic cost threshold based on the benchmarking analysis. Ofwat re-ran its materiality test on the value of the claim submitted by the company less Ofwat's assessment of the implicit allowance.

6. Subject to this second materiality test, Ofwat assessed the claim against four criteria, which it described as follows in its final determinations:[1]

(a) Whether there was persuasive evidence of a need for an adjustment to modelled allowances, as opposed to the claim reflecting no more than business as usual activities for a water company, and whether the programme of work was supported by a clear need case (for instance, a statutory driver or evidence of customer willingness to pay for new outcomes enabled by enhancement investment).

(b) Whether the claim represented the most cost beneficial solution or (where the decision could not reasonably be guided by cost benefit analysis) the lowest cost option.

(c) Whether there was persuasive evidence that costs were consistent with upper quartile efficiency.

(d) Whether adjusting the cost threshold would be consistent with protecting the interests of customers.

7. It seems that point *(d)* went beyond a criterion for accepting a claim and was used to make changes to the price control arrangements for outcomes, as part of Ofwat's adjustment following a special cost factor claim. Ofwat said that where it made a substantial additional allowance it also intervened, where necessary, in outcome delivery incentives to protect customers from the possibility of non-delivery by the company (ie to protect consumers from the risks that the company does not deliver what was intended by the additional allowance under the special cost factor claim).

8. For some claims, Ofwat decided that the criteria under *(b)* and/or *(c)* were not applicable to the assessment of the claim.

9. Ofwat said that following its assessment against its criteria, it did one of the following:[2]

(a) It accepted a company's claim in full, minus an adjustment for Ofwat's assessment of the implicit allowance, where it had passed a claim against the first three criteria above.

[1] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, p27.
[2] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, pp27–28.

(b) It made a partial adjustment, representing less than the value in *(a)*. Ofwat said that this was typically where it had concerns that the costs proposed by the company did not reflect upper quartile efficiency.

(c) It made no allowance if its assessment failed the claim against one or more of the first three criteria.[3]

10. The main processes described by Ofwat, and summarised above, concerns companies' claims for additions to the calculated basic cost threshold. Ofwat's assessment also included a small number if negative adjustments to the basic cost threshold which had the effect of reducing Ofwat's assessment of the company's expenditure requirements.

Risks of asymmetry in cost assessment process

11. There may be an asymmetry in Ofwat's approach that presents risks that the customers of some companies are not fully protected.

12. The type of benchmarking analysis used by Ofwat cannot be expected to provide an entirely accurate estimate of each company's expenditure requirements. In some cases it will over-estimate costs, and in others it will under-estimate costs. We set out our concerns about Ofwat's benchmarking models in Section 4 of our provisional findings and in Appendix 4.1.

13. Where a company considered that the benchmarking analysis has under-estimated its costs, the company had opportunities to make representations to Ofwat for upward adjustments through the special cost factor process. However, we did not identify an effective process for potential downward adjustments to be assessed in the cases where Ofwat's modelling may have over-estimated a company's costs.

14. The risks from an asymmetric approach seemed particularly high for enhancement expenditure, for which the majority of Ofwat's special cost factor adjustments were made.

15. We did not consider that this issue was fully mitigated by Ofwat's use of an upper quartile efficiency benchmark. The use of such a benchmark would generally lead to lower estimates of each company's efficient levels of totex (before special cost adjustments) than if an industry-average efficiency benchmark were used. But there is no reason why it should compensate for

[3] We note that this statement seems to imply a contradiction. If Ofwat made no allowance at all in every case where a claim failed one or more of the first three criteria, there would be no allowance in all cases that lacked 'persuasive evidence' that the claimed costs were consistent with upper quartile efficiency. But if that was true, Ofwat would not have made the partial adjustments that it refers to.

the possibility that Ofwat's econometric models might significantly overstate expenditure requirements for a specific company.

16. We did not consider that this issue was fully mitigated by Ofwat's approach of 'capping', such that Ofwat's cost allowance for each company was set as the lower of: *(i)* Ofwat's own assessment of the company's total expenditure requirements over the five-year period from 1 April 2015; and *(ii)* the company's own (revised) business plan forecasts of its total expenditure, uplifted by 5%.[4] There is no guarantee that companies' business plan forecasts represent an efficient level of expenditure over the five-year period from 1 April 2015. Indeed, it is possible that business plans have a degree of slack in them in anticipation of costs being reduced following review by the regulator. Furthermore, if companies expect Ofwat to adopt such a capping approach, this could provide them with a financial motivation to submit higher forecasts at future price control reviews.

17. In practice, Ofwat made far more upward adjustments for special cost factors than downward adjustments. For the wholesale water price controls, the net adjustments that Ofwat made for special cost factors, expressed as a proportion of the sum of the basic cost threshold and policy additions, varied from –3 to 24%, with an average of 5%.[5]

18. Ofwat did make a small number of negative adjustments further to its approach of capping. Ofwat made a negative adjustment for Yorkshire Water's wholesale water service: the adjustment was a 3% reduction to the level of costs from the basic cost threshold and policy additions that Ofwat had calculated for Yorkshire Water. Only two other companies had negative net adjustments for wholesale water activities, both around 1%. The adjustment for Yorkshire Water reflected two separate negative adjustments:

   (a) Ofwat made a negative adjustment of £35 million for Yorkshire Water between draft and final determinations. This reflected a revision to Ofwat's unit cost modelling for enhancement expenditure so that it used Yorkshire Water's updated forecasts from its final water resources management plan rather than forecasts from Yorkshire Water's draft water resources management plan.

   (b) Ofwat made a negative adjustment of £12 million for Yorkshire Water in relation to the area of enhancement expenditure that Ofwat described as

[4] Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues*,* p38.
[5] CMA analysis of data from: Ofwat (December 2014), Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues, page 26. These figures exclude from the special cost factor allowances the large negative adjustment for Thames Water which resulted not from the special factor process but rather from Ofwat's approach to capping.

unmodelled. Ofwat had identified that its separate analysis of unmodelled enhancement expenditure would provide an allowance to Yorkshire Water of £103 million for these enhancement costs, but Yorkshire Water's own forecast for these costs was £67 million. Ofwat made a downward adjustment of £12 million, rather than an adjustment for the full difference of £36 million, because its separate analysis of unmodelled enhancement expenditure was only given a weight of one third in the triangulation process.

19. Yorkshire Water was the only company for which Ofwat made negative adjustments for wholesale water of more than 1%, and the negative adjustments that Ofwat applied reflect Ofwat making greater use of Yorkshire Water's own forecasts than it had done for its draft determination.

Ofwat's views

20. Ofwat agreed that, in principle, if its basic cost threshold were to over-estimate costs for a particular company there is no process analogous to the process for special cost factor claims to make a downward adjustment. But Ofwat concluded that in practice there was no evidence that suggested this was a problem at PR14.

21. Ofwat said that in relation to water supply, five out of the 18 companies had business plans forecasts below its cost projections. Ofwat said that Affinity Water and South West Water had particularly strong business plans and a clear focus on efficiency, and once Ofwat has aligned its forecasts of the explanatory variables used for the benchmarking models, their plans were about 5% and 8% below Ofwat's cost threshold. Ofwat considered this to be entirely plausible estimates of efficiency given its view that their business plans were high quality.

22. Ofwat said that Thames Water's business plan forecasts were significantly below the cost threshold and Ofwat subjected its position to detailed forensic assessment. Ofwat said that this revealed evidence suggesting that its modelling may have over-estimated Thames Water's costs because of its particular size and pattern of historical investment. Ofwat said that because these factors did not have a significant impact on the forecast revenues of other companies, it adopted a pragmatic approach of capping the model forecasts of Thames Water rather than revising its modelling.

23. Ofwat said that the other two other companies – Portsmouth Water and Yorkshire Water – both had strong reputations for efficient operation and were no more than 5% below its final determination cost threshold.

Potential difficulties for companies making special cost factor claims

24. The water companies submitted a large number of special cost factor claims to Ofwat, and Ofwat then made a series of adjustments.

25. Nonetheless, it seemed quite possible to us that a company with a good approach to asset management, which had developed good estimates of its efficient expenditure requirements over the five-year price control period, may have struggled to make effective claims for special cost factors even if its modelling substantially under-estimated its costs.

26. We identified several aspects of Ofwat's approach to cost assessment and its special cost factor process that would tend to impede companies' ability to make special cost factor claims, even where warranted.

27. Ofwat focused its benchmarking analysis on comparisons of total expenditure and base expenditure. As a consequence, where Ofwat's models imply that a company ought to spend less than the company had forecast, the models provide little information on which areas of expenditure or which aspects of its approach to asset management are treated as relatively inefficient. In this context, it may be difficult for a company to identify the basis for a special factor claim: the company may be adamant that Ofwat's benchmarking analysis underestimates its expenditure requirements but may be unable to identify the source of the underestimation. In contrast, if Ofwat had carried out more disaggregated benchmarking analysis for different activities and areas of expenditure, this would have identified the areas where the company was seen to be inefficient, which would help the company make relevant special cost factor submissions (or review the relevant parts of its plan to re-examine the potential for cost savings).

28. By its nature, any special cost factor adjustment to the results from benchmarking analysis concerns a difference between a specific company and other companies (or the industry as a whole) that is not adequately captured in the benchmarking. Ofwat's cost adjustment process required companies to explain why they are different or special, compared to other companies in the industry and/or the results from Ofwat's benchmarking analysis. Without access to detailed information on other companies' costs and activities, it may be difficult for a company to identify why, when Ofwat compares its costs to other companies, its costs appears relatively high.

29. Ofwat's adjustments for special cost factors were heavily dependent on Ofwat's assessment of the implicit allowances. We reviewed the way that Ofwat calculated implicit allowances, both for Bristol Water and for some of the other companies' wholesale water activities. We were concerned that

Ofwat's calculation of implicit allowances lacked a logical foundation. This may reflect, in part, the issues in the preceding paragraphs: in short, it may be difficult to estimate the extent to which Ofwat models take effect of a particular aspects of their characteristics or operating environment.

30. One specific issue that we were concerned with was that a company may have relatively high expenditure requirements in the five-year price control period from 1 April 2015 to 31 March 2020, due to the timing of its investment needs and its past profile of investment, but that this would not be captured in Ofwat's benchmarking models. It seemed difficult to deal with such cases well through Ofwat's special cost factor process.

Implications for our approach to cost assessment

31. Ofwat's submissions provided further information on its approach in cases where its cost assessment had produced a higher figure than the company's forecasts. However, we did not find Ofwat's response sufficient to address our concerns that the combination of top-down econometric models and Ofwat's special cost factor adjustments could lead to cost allowances there were too high.

32. Our focus was on the cost assessment for Bristol Water, and we have not sought to examine Ofwat's cost assessment for other companies in any detail. In the case of Bristol Water, we have adopted an approach to cost assessment that provided some further protection against the risks of a cost allowance that is too high, and which also recognises that the special cost factor process used by Ofwat may not have taken full account of Bristol Water's circumstances.

33. Our cost assessment work has included a review of aspects of Bristol Water's business plan expenditure forecasts. This helped to inform our assessment of whether an appropriate allowance would be made for Bristol Water's needs and circumstances. This also allowed us to better understand the risk that the outcome of benchmarking analysis for Bristol Water, plus special cost factors, would tend to overstate Bristol Water's expenditure requirements.

34. For enhancement expenditure, we were particularly concerned about the scale of special cost factors and the risks of asymmetry if applied as a series of upward adjustment to the results from benchmarking analysis. We decided that, overall, it was better to take enhancement expenditure separately and start with Bristol Water's business plan forecasts.

35. We have not automatically accepted any of the special cost factors that Ofwat allowed for Bristol Water as part of its final determinations. We also considered the case for possible negative special cost factor adjustments for Bristol Water.

Review of Ofwat's top-down econometric models

Introduction

1. This appendix provides our review of Ofwat's top-down econometric models. It is structured as follows:

   (a) We describe Ofwat's top-down econometric models.

   (b) We present the estimated coefficients from Ofwat's models that formed part of its triangulation process.

   (c) We provide analysis of the relationships between expenditure and the cost drivers that feature in Ofwat's models, some of which we found to be counter-intuitive.

   (d) We provide a review of a number of other issues with Ofwat's econometric models.

The econometric models used by Ofwat

2. The econometric models that Ofwat used for its PR14 cost assessment were developed using input from Ofwat's consultants, CEPA. The model selection process, and the detailed specification of the final set of models, are described in two reports produced by CEPA and published by Ofwat.[1] In our description below, we refer to CEPA's approach and CEPA's views in places as our review is based on the information in CEPA's published report. However, we recognise that the model development process also involved input from Ofwat and that the final decisions on model selection were made by Ofwat.

3. CEPA recognised that, given the data limitations and different estimation techniques available, there is not a single model (nor a single estimation procedure) that reflects accurately all companies' characteristics and their impact on costs. CEPA therefore considered a range of different models.

4. CEPA used evaluation criteria to select a short list of five models that it recommended to Ofwat. Ofwat decided to use these five models for its PR14 cost assessment.

[1] CEPA *Cost assessment – advanced econometric model*, March 2014 and CEPA Cost assessment, January 2013.

5. CEPA's model development process considered models that varied in a number of dimensions:

(a) The specification of the dependent variable in the model and, in particular, whether this focused on base expenditure (which Ofwat referred to as 'botex') or included base expenditure and enhancement expenditure (totex).

(b) Whether the model employed a Cobb-Douglas or translog functional form.

(c) The explanatory variables included in the model and in particular whether the model should include, as explanatory variables, all the theoretical cost drivers identified by CEPA or whether it should be a refined model that only includes a subset of those cost drivers.

(d) The econometric estimation technique used (eg whether to estimate the model using the OLS technique, a panel data random effects approach or to use a form of stochastic frontier analysis).

6. We provide an overview of the model development below. We first describe the data source used. We then take each of the four elements of model design and estimation listed above and summarise CEPA's approach. Finally, we summarise the selection process that CEPA used.

7. CEPA's final model selection reflected its view that there was not a single correct model to use. CEPA and Ofwat used the term 'triangulation' to refer to the process and calculations used to weight and combine results from different models and other forms of benchmarking analysis to make an overall assessment for each company. CEPA developed an approach to triangulation that Ofwat subsequently used. This combined the output of the five econometric models recommended by CEPA with results from other cost modelling work that Ofwat developed for enhancement expenditure.

The data set used by CEPA

8. CEPA used a panel data set that had a sample size of 90 observations, which comprised:

(a) 18 water companies in England and Wales, including Bristol Water; and

(b) five years of data spanning the period 2008/09 to 2012/13.

9. The data set consisted of measures of costs and data on each of the explanatory variables used in the models, for each company and each year in the sample period.

10. The sample included all the water companies regulated by Ofwat, apart from a few small water companies that are subject to a different type of economic regulation.

11. The sample of companies included both WoCs and WaSCs. The cost data used for the models concerned the costs reported for (or allocated to) wholesale water activities only.

The dependent variable: totex models versus base expenditure model

12. One of the initial choices in specifying an econometric model is the choice of the dependent variable. What is it that we want to compare across companies and explain, in part, by the various explanatory variables in the model?

13. CEPA considered models that used two alternative expenditure measures for the dependent variable:

    (a) measures of ‘totex’; and

    (b) measures of ‘base expenditure’.

14. The totex (or total expenditure) measure captured most of the expenditure of the wholesale water service, but excluded some specific items of spend that Ofwat did not want to include in its benchmarking analysis (eg business rates and pension deficit repair contributions).

15. The base expenditure measure is the part of the totex measure that excludes capex allocated to enhancement projects (eg projects that add to the capacity of the system or achieve quality of service improvements).

16. In each case, the dependent variable in the models was the natural logarithm of the expenditure measure used.

17. The measure of totex for a given year was the sum of opex in that year and a measure of the average capex over the previous five years. CEPA used this approach in order to smooth the ‘lumpy’ pattern of observed capex (ie to reduce fluctuations in the capex measure across time). Similarly, the base expenditure measure was the sum of opexp plus the average base capex in the last five years.

18. Ofwat carried out separate analysis of enhancement expenditure which it combined with the results from the base expenditure models as part of its approach to triangulation (see Appendix 2.3).

Cobb-Douglas versus translog models

19. CEPA's decisions on model specification placed emphasis on a choice between two types of models, which it referred to as 'Cobb-Douglas' models and 'translog' models.

20. The type of model that CEPA referred to as Cobb-Douglas is a relatively straightforward type of model specification in which the dependent variable of expenditure is expressed in logs (using the natural logarithm) and all explanatory variables are also in logs.

21. CEPA described the Cobb-Douglas model as 'a standard functional form used in cost assessment literature', under which estimated coefficients can be interpreted as the elasticity of cost with respect to the corresponding cost driver.[2] An interpretation of this type of model is that a 1% increase in a cost driver included in the model (eg total length of water mains) would imply an X% increase in expenditure, where X is to be estimated from the model.

22. CEPA described the translog model as follows:[3]

> The translog model is one of the so-called flexible functional forms and is used routinely in the academic literature. In the current context one of its particular advantages is that it allows the degree of returns to scale to vary with firm size. The Cobb-Douglas is nested within the translog so it is possible to test the Cobb-Douglas restriction.

23. CEPA treated the translog model as an extension of the Cobb-Douglas model which allows for varying economies of scale across companies by introducing interactions and quadratic terms for the explanatory variables.[4]

24. CEPA considered that the translog model allows for more flexibility as it introduces the possibility of substitution between inputs (through the interaction terms) and for economies of scale (through the square terms). However, the translog model requires the estimation of more parameters and the interaction and quadratic terms are more difficult to interpret.

25. The specific implementation of the translog model used by CEPA does not fully implement the standard translog cost function from economic theory. For

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[2] CEPA (March 2014), *Cost assessment – advanced econometric model*, p7.
[3] ibid, piv.
[4] To provide an example of the translog approach, a possible simple cost function would be one that says that cost (C) is a function of two inputs A and B. The Cobb-Douglas form that CEPA considered would involve a model specification as follows (where the β terms are coefficients to be estimated by the model and 'ln' denotes the natural logarithm): ln(C) = constant + β1*ln(A) + β2*ln(A). The corresponding model specification for the translog model would be: ln(C) = constant + β1*ln(A) + β2*ln(A) + β3*ln(A)2 + β4*ln(A)*ln(B) + β5*ln(B).

example, the interaction and square terms applied were only applied to a small subset of the identified cost drivers. In this section, we use the term ‘translog’ to refer to this aspect of model specification used by CEPA and Ofwat but recognise that this may differ from other translog models.

Choice of explanatory variables: full model versus refined model

26. CEPA said that the first step in its model selection process was to identify the ‘theoretical cost drivers’, which it incorporated as explanatory variables in its models.[5]

27. Table 1 below shows explanatory variables that CEPA considered in its modelling. The table also indicates whether these explanatory variables featured in the final models that CEPA recommended to Ofwat, which it described as the ‘full’ model and the ‘refined’ models (Ofwat ultimately used several different refined models but the set of explanatory variables was the same in each of these). In the table, the first column briefly describes the explanatory variable and the second column provides the short-form names that CEPA gave to the explanatory variable, where this is significantly different or not self-explanatory.

28. CEPA implemented the translog function using the square and cross-product terms of a small subset of the cost drivers it had identified: ln(length of mains), ln(number of properties divided by length of mains) and ln(water delivered per customer). This explains the terms such as ‘Length^2’ and ‘Length * density’ in the table. CEPA’s initial set of models also included models that excluded these translog elements.

29. CEPA reported that its full totex model for water included all the variables considered to be theoretical drivers of costs, with the exception of the variable for the regional construction price index, which it considered to be correlated with the regional wage measure.[6] CEPA reported that the refined model specification included only the variables which it found to be statistically significant or were important cost drivers from a theoretical perspective.[7]

[5] CEPA (March 2014), *Cost assessment – advanced econometric model*, pvii.
[6] ibid, p33.
[7] ibid, pviii.

Table 1: Explanatory variables used by CEPA

Summary of explanatory variable	*Short name*	*Inclusion in full model*	*Inclusion in refined model*
Constant term		✓	✓
Ln (total length of mains)	Length	✓	✓
Ln (number of connected properties / length of main)	Density	✓	✓
Ln (potable water delivered / number of connected properties)	Usage	✓	
[Ln (total length of mains (km)] ^ 2	Length^2	✓	✓
[Ln (number of connected properties / length of main (properties/km)] ^ 2	Density^2	✓	✓
[Ln (potable water delivered / number of connected properties (Ml/d per property)] ^ 2	Usage^2	✓	
Ln (total length of mains) * Ln (number of connected properties / length of main)	Length * density	✓	✓
Ln (total length of mains) * Ln (potable water delivered / number of connected properties)	Length * usage	✓	
Ln (number of connected properties / length of main) *Ln (potable water delivered / number of connected properties)	Density * usage	✓	
Time trend		✓	✓
Ln (average regional wage measure)		✓	✓
Ln (regional construction price index)			
Ln (population supplied / number of connected properties)	Population density	✓	✓
Ln (proportion of properties that are metered)		✓	
Ln (total number of sources / total water input to distribution system)		✓	
Ln (average pumping head * total water input to distribution system)		✓	
Ln (proportion of water input from river abstractions)		✓	✓
Ln (proportion of water input from reservoirs)		✓	✓
Ln (number of new meters installed in year as a proportion of metered customers)		✓	
Ln (length of new mains laid in year / total length of mains at year end)		✓	
Ln (length of mains relined and renewed / total length of mains at year end)		✓	
Ln (number of properties below reference pressure level/total properties connected)		✓	
Ln (volume of leakage / total water input to distribution system)		✓	
Ln (number of properties affected by unplanned interruptions > 3 hrs / total properties connected)		✓	
Ln (number of properties affected by planned interruptions > 3 hrs / total properties connected)		✓	
Ln (potable water delivered to billed metered households / total potable water delivered)		✓	
Ln (potable water delivered to billed metered non-households / total potable water delivered)		✓	

Source: CMA analysis of CEPA (March 2014), *Cost assessment – advanced econometric model*.

Estimation technique and specification of the error term

30. Having specified the dependent variable, functional form and explanatory variables, CEPA faced some further decisions on model specification and estimation.

31. CEPA used two different approaches:

(a) The pooled OLS estimation technique (CEPA used the term 'corrected OLS',[8] or COLS).

(b) A random effects model, which it estimated through the generalised least squares technique (GLS).

32. As an approximate explanation, the OLS technique is based on the idea of a line of best fit across the data in the sample. Unlike a best fit line drawn in two dimensions on a piece of paper, which may capture a relationship between two variables, the OLS technique can construct a line of best fit but in multiple dimensions (the estimated regression line) which can capture a relationship between more than two variables. In more technical terms, the OLS technique produces a set of estimated coefficients (one for each explanatory variable in the model) that, taken together, are calculated so as to minimise the square of the distance between each data point in the data set and the corresponding point on the estimated regression line. The smaller those differences are, the better the estimated model fits the data.

33. Applying pooled OLS to the data set treats all 90 observations in the same way, as if they are independent observations (ie no explicit account is taken of the fact that there are five observations from each company, which may have correlations between them over time).

34. The GLS (random effects) approach involves a more complex model specification and estimation process than OLS. Under this approach, the estimation is made under the assumption that there are additional factors (random effects) that affect or explain each company's costs in each year of the time period which are not captured by the explanatory variables in the model. These additional factors are assumed to have the same impact on the company's costs in each of the five years of the data period (ie they are time-invariant). Furthermore, these factors are assumed to be distributed across companies according to a normal probability distribution. CEPA and Ofwat treated the estimated random effect for each company as part of the overall

[8] This is essentially OLS as far as model specification and estimation is concerned, but with an adjustment to the predicted level of expenditure derived from the model to apply what Ofwat treated as an upper quartile efficiency adjustment.

residual for each company and attributed to potential relative efficiency differences between companies rather than company-specific cost drivers. Because CEPA treated the time-invariant random effects as part of relative efficiency, CEPA preferred to use a short data period (five years) instead of a longer panel (eg ten years) for the GLS (random effects) approach.

35. CEPA also discussed the use of a fixed-effects estimation technique. Under this approach, there would be a company-specific explanatory variable (or fixed effect) for all but one company. Compared with the random effects approach, the fixed-effects approach involves no assumption that the company-specific effects are distributed across companies according to a normal probability distribution. Instead, the company-specific effect is a separate estimated coefficient for each company.

36. CEPA stated that the 'true distinction between fixed and random effects is whether the effects are correlated with the other regressors [explanatory variable] or not' and that 'in the case of random effects the effects are assumed to be uncorrelated with the regressors, whereas in fixed effects the effects are permitted to be correlated with the regressors'.[9]

37. CEPA preferred the random effects approach to the fixed-effects approach. CEPA reported that it used the Hausman test to choose between GLS (random effects) and fixed effects models. CEPA considered that results from the Hausman test indicated that the assumption of the random effects model, that there is no correlation between the random effect and the explanatory variables in the model, was reasonable.[10]

38. Neither the OLS, random effects nor fixed effects model specifications produce results that decompose the estimated residuals from the model between efficiency and 'noise' (eg modelling or measurement error).

39. An alternative approach that purports to decompose the estimated residuals from the model between efficiency and noise is stochastic frontier analysis (SFA). CEPA considered several different SFA approaches as candidates for its model estimation, but decided against these. CEPA considered that its OLS and GLS (random effects) models produced more stable and robust results than the SFA models it tried; it also found that some of the SFA models were not possible to estimate for technical reasons.[11] Furthermore CEPA was concerned about the ability of the SFA models to reliably achieve what they were purported to do: split the error term between efficiency and

[9] CEPA (March 2014), *Cost assessment – advanced econometric model*, piii.
[10] ibid, p24.
[11] ibid, pp10–11.

noise. CEPA considered the theoretical assumptions about the probability distribution of inefficiency and noise, on which the SFA models rested, and stated that these assumptions may be considered arbitrary.[12] CEPA preferred alternative approaches (ie OLS and GLS (random effects)) which do not rely on those assumptions.

CEPA's model selection process

40. CEPA applied a model selection process to identify preferred models from its initial long list. CEPA reported that it used five evaluation criteria:

(a) theoretical correctness;

(b) statistical performance;

(c) practical implementation issues;

(d) robustness testing; and

(e) regulatory best practice.

41. Having obtained an initial long list of ten models, CEPA applied a 'traffic light' approach to evaluate these ten models, in light of both model specification and estimation results. Under this approach, green indicated a good model; amber a model that was acceptable but with a few issues; and red a model that CEPA considered flawed. CEPA applied its traffic light approach to three of its evaluation criteria: theoretical correctness, statistical performance, and robustness checks.

42. CEPA attended first to both the statistical performance and the robustness checks. In each case where these criteria were met (at least amber or green) CEPA looked at the theoretical correctness. When one of the ten candidate models received a red (only for statistical performance or robustness check) it was not taken further. The table below summarises aspects of the traffic light approach that CEPA applied to the ten models.

[12] CEPA (March 2014), *Cost assessment – advanced econometric model*, p102.

Table 2: Summary of CEPA's traffic light model selection approach

	Theoretical correctness	*Statistical performance*	*Robustness check*
RED	N/A	The estimated coefficients for the subset of explanatory variables that CEPA considered 'core' were substantially outside CEPA's ex ante expectations	Overall range of efficiency scores and predictions is not plausible. Pooling tests suggest significant and material differences in coefficients for key variables in different time periods
AMBER/ GREEN	1. CEPA prefer translog over CD functional form (based on theory and statistical analysis) 2. Are all core theoretical drivers included? If not, given amber	1. Coefficient estimates largely in line with CEPA's expectations and elasticities relatively sensible. If not, given amber. 2. How refined is the model? (Statistically significant parameter estimates while including as much of the value chain drivers as possible.) Is N-K >5 for RE? The most refined models given green. 3. Statistical results: goodness of fit/ statistical preference for GLS random effect over fixed effects. If fixed effects preferred, given amber.	1. Sensitivity to dropping observations/ variables. If efficiency scores or predictions are sensitive, given amber. 2. Are model rankings outliers with respect to other CEPA models at same level of expenditure and value chain disaggregation? If so, given amber.

Source: CMA analysis of CEPA Cost assessment – advanced econometric model, March 2014.

43. Of the ten estimated models, CEPA recommended five models to Ofwat. CEPA grouped these into three categories:

(a) One full totex model (model WM3) with all candidate explanatory variables included except the BCIS variable.

(b) Two 'refined' totex models (model WM5 and model WM6) for which some of the variables from the full totex model were dropped. These two models are the same except one is pooled OLS and the other GLS random effects.

(c) Two refined base expenditure models (model WM9 and model WM10). These two models are the same except one is pooled OLS and the other GLS random effects.

44. CEPA described its refined models as including only the explanatory variables which it found to be statistically significant or were important cost drivers from a theoretical perspective.[13]

45. These five models were used as part of Ofwat's overall cost assessment for its final determinations.

[13] ibid, pviii.

Estimated coefficients from Ofwat's econometric models

46. This section sets out and briefly comments on the estimated coefficients from Ofwat's econometric models. These are the general results from the models that are applied to all companies.

47. CEPA estimated the coefficients for the explanatory variables in each of its five selected models, using its historical data set spanning five years.

48. In its published report, CEPA reported estimated coefficients for models that used 'normalised' versions of the explanatory variables for the various translog terms of these models. It applied normalisation to its three scale variables (total length of mains, density and usage) and, in turn, the explanatory variables based on these terms. The normalised variables were calculated by dividing the variable by its sample mean. CEPA considered that the normalisation process made it easier to understand the magnitude of the implied effect of each explanatory variable on estimated expenditure. For example, CEPA used the normalised results to examine whether the estimated coefficients were in line with its initial hypotheses. CEPA said that for the explanatory variables other than the translog terms, the estimated coefficients should be the same for the normalised and non-normalised versions.[14]

49. Table 3 presents the estimated coefficients for the five models, estimated for the normalised explanatory variables. The list of explanatory variables in the first column of the table uses CEPA's short-form variable names (see Table 2 above). Ofwat told us that the standard errors that were used for the measures of statistical significance of estimate coefficients, which are indicated in Table 3, were estimated using the cluster robust approach to estimation of the standard errors in the case of the OLS models and that unadjusted standard errors were used for the GLS random effects models.

[14] ibid, p110.

Table 3: Estimation results: estimation results of models WM3, WM5, WM6, WM9 and WM10

MODEL	WM3: translog; OLS	WM5: translog; OLS	WM6: translog; GLS (RE)	WM9: translog; OLS	WM10: translog; GLS (RE)
	Full totex	Refined totex	Refined totex	Refined base expenditure	Refined base expenditure
Dependent variable	**Log totex**	**Log totex**	**Log totex**	**Log base expenditure**	**Log base expenditure**
Independent variables	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
Constant	–0.96128	2.88752*	2.51229†	2.9165	1.71338*
Length of mains	0.90456‡	1.07182‡	1.07838‡	1.03714‡	1.03225‡
Density	–0.27601	0.21036	0.28066	0.27499	0.40509†
Usage	–0.03222	-	-	-	-
Length^2	–0.03077	–0.02259	–0.01917	0.01439	0.01912
Density^2	1.15405‡	1.06674†	0.94174*	0.23994	0.35379
Usage^2	–0.24695	-	-	-	-
Length x Density	0.64729‡	0.51222‡	0.55717‡	0.35875*	0.44863‡
Length x Usage	-0.00603	-	-	-	-
Density x Usage	-0.06318	-	-	-	-
Time trend	0.01193	–0.00675	–0.00319	-0.00077	0.00941*
Average regional wage	1.49168‡	0.71957	0.95771‡	0.28008	0.90116‡
Population density	–0.56056	0.98924	0.49497	2.03158†	1.05336†
Proportion of metered properties	–0.77579	-	-	-	-
Sources	–.29272‡	-	-	-	-
Pumping head	0.12203	-	-	-	-
Proportion of water input from river abstractions	0.00224	0.02014‡	0.01182	0.00477	0.00388
Proportion of water input from reservoirs	–0.01501	–0.01397	–0.01229	–0.00654	0.00214
Proportion of new meters	0.02846	-	-	-	-
Proportion of new mains	–0.03075†	-	-	-	-
Proportion of mains restored/renovated	0.02901†	0.06502‡	0.05565‡	0.05994†	0.03764‡
Properties below reference pressure level	0.00295	-	-	-	-
Leakage volume	–0.20009	-	-	-	-
Properties affected by unplanned interruptions > 3 hrs	0.008	-	-	-	-
Properties affected by planned interruptions > 3 hrs	0.02661	-	-	-	-
Proportion of usage by metered household properties	0.5006	-	-	-	-
Proportion of usage by metered non-household properties	–0.17073	-	-	-	-
Adjusted R2	0.9955	0.9894	0.9886	0.9878	0.9856
N	90	90	90	90	90

Source: CEPA (March 2014), *Cost assessment – advanced econometric model*.
*Significance at 10% level.
†Significance at 5% level.
‡Significance at 1% level.

50. The estimated coefficients can be interpreted as elasticities. A 1% increase in the explanatory variable would imply a percentage change in costs given by the estimated coefficient. For instance, a change on the length of mains by 1% would imply that totex in model WM3 increases by 0.905%, whereas in model WM6 the 1% increase would lead to a 1.0784% increase in totex.

51. The explanatory variables that, across all five models, CEPA found to be both statistically significant and to have a relatively large coefficient, are the length of mains and length*density variable. This shows that, in these models at least, the effects of mains network size and the number of connected properties are very important in determining total estimated expenditure.

52. A number of other explanatory variables that are common across the five models show significant variations in the magnitude of the estimated coefficients and sometimes even changes in sign between models (eg see the results for population density). These other variables might not be driving costs significantly and it is possible that the relationship implied by the estimated coefficients might be spurious.

53. Many of the estimated coefficients for the explanatory variables were not consistent with what CEPA had expected from a theoretical or economic perspective. For example, in the full totex model WM3: *(a)* the estimated coefficient on usage (defined as average potable water delivered per connected property) was negative and not significant; and *(b)* the estimated coefficient on the proportion of new mains laid in the year was found to be statistically significant but to be negative rather than positive.

54. The impact of some of the other explanatory variables is difficult to interpret from the estimated coefficients. This is the case for the translog terms (eg ‘length*usage’).

55. We consider the results implied by Ofwat’s models in more detail in the next section.

Analysis of cost relationships implied by Ofwat’s models

56. Bristol Water argued that some of the estimated cost relationships implied by Ofwat’s models were unexpected and contrary to engineering judgment. In addition, our own review further model of Ofwat’s approach to model specification identified risks that the estimated coefficients from Ofwat’s models may be spurious, because of the large number of explanatory variables relative to the sample size (see paragraphs 203 to 215).

57. In the first part of this section, we consider the counter-intuitive results for estimated coefficients that Bristol Water identified in its SoC and Ofwat’s response to these issues. We also highlight some further results that are unexpected in terms of the estimated coefficients.

58. In the remainder of the section, we provide our own analysis of the relationships implied between costs and the explanatory variables in Ofwat’s refined base expenditure model (OLS version). This analysis involves estimates of the level of expenditure that this model would imply for a hypothetical industry average company, which we use as a reference point to examine how changes in explanatory variables (or changes across several factors) affect estimated expenditure. This provides further insight on the cost relationships implied by Ofwat’s models.

Counter-intuitive results for estimated coefficients

59. Bristol Water identified several cases where the estimated results from Ofwat's models seem counter-intuitive. These are cases where the relationship between costs and an explanatory variable go in the opposite way to what it would have expected. Bristol Water provided several examples of what it considered to be the unexpected cost relations from the models.

60. Ofwat told us that Bristol Water's view that the translog coefficients had the wrong sign for Bristol Water but not for other companies was not fully correct. Ofwat said that Bristol Water benefited from the translog model as it had an elasticity of costs with respect to length of mains greater than one in all models and also a positive elasticity of usage in the full model.

61. We identified some further issues beyond those highlighted by Bristol Water. One example of particular significance is the regional wage measure.

62. Ofwat's full totex model (WM3) includes the logarithm of the regional wage measure as an explanatory variable. The estimated coefficient is around 1.5. The economic interpretation of this is that a 1% difference in the regional wage rate between two companies would lead to a 1.5% difference in costs. Our starting point would be an expectation that the coefficient would be less than one. This is because wages are only part of a company's costs, and we would expect other significant costs (eg materials costs) to vary less (if at all) between regions than wages. Similarly CEPA reported an expectation that this coefficient would be 'relatively high and positive, circa 0.6-0.7, but below 1.0'.[15]

63. It is possible that there is an economic explanation for this aspect of the results from Ofwat's full totex model (eg perhaps there is more acute variation between regions in the wages/salaries of water company employees than there is variation in the wider categories of occupations covered by the regional wage measure used in Ofwat's models). But it is also possible that the results reflect other correlations in the data and therefore do not provide a reliable estimate of the extent to which differences in wage rates between regions lead to differences in companies' expenditure requirements.

64. We note that the estimated coefficient for regional wages varied substantially across Ofwat's models, which mitigates the effect from WM3, but it also serves to highlight the potential inaccuracy in these types of models.

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[15] ibid, p20.

65. In its response to Bristol Water's SoC, Ofwat said that it was important to focus on 'overall model performance and robustness' and highlighted a number of arguments, in particular:[16]

(a) Ofwat argued that an 'un-intuitive' sign of a single coefficient estimate need not undermine the credibility of a model's prediction. Ofwat said that its estimates were based on the OLS and random effects estimators, both of which were unbiased and consistent under certain conditions (notably, that the errors were uncorrelated with the explanatory variables). Ofwat identified that multi-collinearity between two explanatory variables may harm the accuracy of estimated coefficients for these factors but that jointly these factors would remain unbiased.

(b) Ofwat said that the accuracy of a model depended on the collective set of estimated coefficients across the full set of explanatory variables in the model. Ofwat argued that, in its view, it was not particularly insightful to argue that an increase in a single variable was forecasted to reduce costs because this was not how Ofwat used these models in forecasting – Ofwat moved all the variables together.

66. CEPA had made similar arguments in its explanation of multi-collinearity:[17]

> An exact linear relationship between two or more explanatory variables characterises the extreme case of perfect collinearity (approximate linear relationships between variables are more common in practice). In the former case (perfect collinearity) the OLS procedure cannot be implemented. The latter case (approximate linear relationships) results in high standard errors. Whilst the parameter estimates and estimates of the standard errors are not biased as such, the problem is that it will be hard to draw conclusions on the impact of individual variables on the dependent variable. The overall predictive power of the model is not reduced (only the ability to use the coefficients individually).

67. Similarly, CEPA stated that:[18] 'The unexpected results for statistical significance and size/signs of the parameters may be due to multi-collinearity, which would not pose issues for the overall predictive power of the model.'

68. Ofwat's references to statistical concepts of 'unbiased' and 'consistent' estimators do not address the concern that the specific estimates which formed part of the models used by Ofwat may have been too inaccurate to

[16] Ofwat response, pp58–59.
[17] Ofwat response, pii.
[18] Ofwat response, p33.

use for the purposes of Ofwat's cost assessment. It is not sufficient that an estimator has the statistical property of being unbiased 'under certain assumptions', particularly where estimated coefficients have high estimated standard errors, are sensitive to model specification or imply surprising results. Furthermore, the concept of consistency in an estimate is that, as the sample size tends to infinity, the probability of the estimate being accurate converges to one. CEPA's sample size is 90 and therefore the asymptotic properties of estimators seem to be of limited relevance.

69. Ofwat identified multi-collinearity between its explanatory variables as a possible reason for the unexpected estimates for specific coefficients (though it is not the only reason). We note it is possible that, where inaccuracy in estimated coefficients stems from correlations between them, the inaccuracy in the overall model prediction may be lower than the inaccuracy suggested by looking at any of them in isolation (the effects may offset each other to some degree). Nonetheless, any inaccuracy in estimated coefficients that arises from multi-collinearity between explanatory variables may still be a material problem. The estimated expenditure requirements for any particular company could be distorted by counter-intuitive estimated coefficients that are affected by multi-collinearity.

70. We did not accept Ofwat's argument that it was not particularly insightful to argue that an increase in a single variable is forecasted to reduce costs because this not how Ofwat used these models in forecasting. We did not consider that this argument could address the concern that the expenditure estimate for any particular company is adversely affected by counter-intuitive estimated coefficients that are affected by multi-collinearity. Furthermore, Ofwat's approach did not move all the variables together as Ofwat had suggested. Ofwat's estimated expenditure requirements for each company are based on a series of forecast explanatory variables for that company. The forecasted explanatory variables are not the same as those from the historical data set and the overall correlations across Ofwat's data set will not be the same as the correlations between explanatory variables for any one company.

71. It was not clear what CEPA meant by the 'overall predictive power of the model'. However, we would disagree with the proposition that multi-collinearity does not raise concerns about the accuracy of predictions of the expenditure of any single company – or for the accuracy of Ofwat's cost assessment.

72. We note that CEPA had identified that its results differed from what it had expected, in terms of both the sign (positive or negative) and magnitude of many of the estimated coefficients.

Further analysis of Ofwat's refined base expenditure OLS model

73. In the remainder of this section, we examine the results from Ofwat's modelling in more detail.

74. For this further analysis, we have focused on Ofwat's refined base expenditure modelling. The refined base expenditure models seem the most important element of Ofwat's three econometric modelling workstreams in terms of their impact on Ofwat's overall cost assessment for Bristol Water. This is because *(a)* Ofwat effectively disregarded the results from the refined totex models in the case of Bristol Water, and *(b)* Ofwat's review and interpretation of the results from its full totex model for Bristol Water was dependent on the results it had obtained for Bristol Water from the refined base expenditure model (which Ofwat used to split the results from the full totex model between base and enhancements).

75. For Bristol Water, the differences in Ofwat's model results between pooled OLS and GLS (random effects) are relatively small and we have focused our analysis on the refined OLS model. However, we recognise that the analysis below may not be representative of the results for the random effects version of the refined base expenditure model.

76. One way to seek to examine and interpret the results from Ofwat's econometric models is to assess whether the estimated coefficients from these models seem reasonable from an engineering and economic perspective.

77. If both the dependent variable and a cost driver are expressed as a natural logarithm, a 1% increase in the cost driver (holding all other explanatory variables constant) would imply a percentage change in expenditure given by the estimated coefficient for that cost driver.

78. We identified issues in seeking to review the estimated coefficients for each of the explanatory variables in the models used by Ofwat. The coefficient on an explanatory variable might be interpreted as an indication of the effect on expenditure of a change in that explanatory variable, holding all other explanatory variables constant. However, the translog functional form used in Ofwat's models makes it difficult to interpret the coefficients on some explanatory variables in this way, because there are relationships between them. It is not possible to consider the impact of one explanatory variable whilst holding other explanatory variables constant if these are mathematically related.

79. For example, we might be interested in what the model implies for the relationship between mains length and expenditure. However, this is

complicated because mains length features in several different explanatory variables (eg the explanatory variables in the refined base expenditure models include: *(a)* the natural logarithm of mains length; *(b)* the square of the natural logarithm of mains length and *(c)* the product of (i) the natural logarithm of mains length and (ii) the natural logarithm of the number of customers divided by mains length).

80. In addition, since the dependent variable in Ofwat's models is the natural logarithm of expenditure, the estimated coefficients for the explanatory variables are estimates of the proportionate effect of each explanatory variable on expenditure. This in itself creates interdependencies between explanatory variables as the effect in £ million of a given change in one explanatory variable will depend on the other explanatory variables.

81. We identified an alternative approach. We defined a hypothetical average water company as a point of comparison. This is a hypothetical company that has characteristics and outputs which are the simple averages across the companies in our data sample. More specifically, we have taken each of the explanatory variables used in our econometric models and calculated the average value over the 18 companies over the five-year period from 2008/09 to 2012/13. Table 4 shows the assumed characteristics for our hypothetical average company.

82. We are then in a position to examine the relationships between expenditure and the explanatory variables implied by Ofwat's refined OLS model by examining the effect on the estimated annual expenditure requirements of varying specific characteristics of the hypothetical average company, whilst holding others constant.

Table 4: Specification of hypothetical average company

Explanatory variable or characteristic	*Hypothetical average company*
Total number of connected properties (million)	1.38
Total mains length (km)	18,870
Total connected properties divided by total mains length (persons per km)	73
Average consumption per property (m^3/year)	176
Population supplied in winter (million persons)	3.08
Total population supplied divided by total connected property	2.24
Regional wage measure (2012/2013)	16.3
Average pumping head (m.hd)	135
Distribution input (average across year) (Ml/day)	804
Proportion of distribution input from rivers	37%
Proportion of distribution input from reservoirs	22%
Proportion of distribution input from boreholes	41%
Mains length relined or renewed (km)	108
Mains length relined or renewed as proportion total mains length	0.57%

Source: CMA analysis.

83. By combining the assumed features of the hypothetical average company with the estimated coefficients from Ofwat's refined base expenditure OLS model

(WM9) we obtain an estimated base expenditure for the hypothetical company in 2015/16 of £156.5 million or £109 per connected property.

84. We can compare this figure with simple averages of base expenditure per connected property. Our calculations using the Ofwat data set indicate that, over the five-year sample period and across the 18 water companies used by Ofwat, the average base expenditure per property (in 2012/13 prices) was £111 if we use Ofwat's smoothed measures of capex or £113 if we do not smooth capex. Ofwat's model WM9 implies that a company with industry average characteristics would have a slightly lower expenditure per customer than the simple average of past spend across companies over the data period.

85. The figure of £109 is an estimate for an averagely efficient hypothetical average company. If we apply the same 6.53% downward adjustment for upper quartile efficiency as Ofwat, we obtain an estimate of the efficient base expenditure requirements for our hypothetical average company of £102 per property.[19]

86. We used the estimate after adjustment for upper quartile efficiency (£102 per property) as a baseline.[20] We then examined a number of scenarios for how a hypothetical company may differ to that hypothetical average company and used Ofwat's estimated coefficients to calculate the implied efficient base expenditure requirements for each of these scenarios.

Summary of results from analysis based on hypothetical average company

87. Table 5 shows the results from the exercise described above. The rows in the table show the estimated efficient base expenditure requirements for each scenario. In each case the estimates apply to a company that is identical to the average hypothetical company except for the specific differences specified in the scenario column. The table shows both the estimated efficient base expenditure for the hypothetical company and the estimated efficient expenditure per customer (connected property).

[19] Ofwat's approach to cost assessment was based on estimates for a company which had 6.53% lower costs than an averagely efficient hypothetical company. Ofwat had found that a company at the upper quartile in efficiency performance would have costs that were 6.53% lower than an averagely-efficient hypothetical company.
[20] In this exercise we did not include the 'alpha adjustment' used by Ofwat and CEPA. This has a small effect.

Table 5: Efficient costs implied by model WM9 for hypothetical companies

Scenario	*Estimated efficient base expenditure (£ million, 2012/13 prices)*	*Estimated efficient base expenditure per customer (£ 2012/13 prices)*	*Difference in base expenditure per customer compared to hypothetical average company*
Hypothetical industry average company	140.69	102.13	N/A
1. Company with twice the number of customers, twice the population and twice the total length of mains	290.51	105.44	3.2% higher
2. Company with half the number of customers, half the population and half the length of mains	69.08	100.30	1.8% lower
3. Company with 10% greater population	170.75	123.95	21.4% higher
4. Company with 10% less mains in total	129.68	94.13	7.8% lower
5. Company with 10% greater average pumping head	140.69	102.13	No change (Pumping head not in refined models)
6. Company that takes 10% less of its total distribution input from rivers and 10% more from boreholes than the hypothetical company	140.48	101.97	0.2% lower
7. Company that takes 10% less of its total distribution input from impounding reservoirs and 10% more from boreholes than the hypothetical average company	141.25	102.54	0.4% higher
8. Company with 10% higher value for regional wage measure than the hypothetical average company	144.50	104.89	2.7% greater
9. Company with rate of mains replacement and relining (per km of main) that is 50 cent greater than the hypothetical average company	144.15	£104.64	2.5% greater

Source: CMA analysis.

88. This analysis raises some issues. We highlight below four aspects of the results from the table above:

(a) Estimated coefficients that, taken together, imply a form of diseconomies of scale with respect to the number of connected properties and population that a company supplies (taking length of mains per property and other explanatory variables as constant).

(b) The implied relationship between population density (population supplied divided by number of connected properties) and expenditure was of an unexpectedly high magnitude.

(c) The implied relationship between length of mains and expenditure (holding customer numbers constant) and expenditure was of an unexpectedly high magnitude.

(d) The model seems to imply limited effect of variations in a company's use of different raw water sources (eg rivers, reservoirs and boreholes) on costs.

89. We take these issues in turn. Overall, we consider that this analysis provides evidence of the limitations and inaccuracies arising from Ofwat's models. This is relevant to our views on the extent to which Ofwat's models (and other models of this nature) are likely to provide accurate estimates of water companies' efficient expenditure requirements.

Diseconomies of scale with respect to company size

90. The refined base expenditure model implies a form of diseconomies of scale that we do not consider plausible. A company that is twice the size of our hypothetical average company, in terms of number of connections, population and total length of mains, would have an expenditure per property served that is 3.2% higher than our hypothetical average company (see result for scenario (1) in Table 5). Similarly, a company that is half the size of our hypothetical average company, in terms of number of connections, population and length of mains, would have a cost per property served that is 1.8% lower than our hypothetical average company (scenario (2)).

91. This would suggest that simply taking a water company and breaking it up into two separate companies would reduce the total costs across the two companies. Repeating the process would further reduce total costs across these companies.

92. For example, if we had a company that was double the size of the hypothetical average company and we separated it into two companies of equal size, the model results suggest that (excluding divestment costs), across the two companies, base expenditure would reduce by around £10 million per year.[21] This is a counter-intuitive result.

93. This aspect of the model results seems indicative of spurious results. We have not identified a reason why it would be appropriate to use an econometric model to estimate water companies' efficient expenditure

[21] This is calculated as (£105.44–£102.13)*(2*1,377,589 properties), using data from Tables 4 and 5.

requirements that involves an assumption of this type of diseconomies of scale.

94. Ofwat provided some comments in response to our analysis on the potential implication of diseconomies of scale in the refined base expenditure OLS model.

95. Ofwat said that there were valid reasons for diseconomies of scale to exist, such as sourcing sufficient water for a large number of customers or establishing sufficient capacity for growth which may not yet be fully utilised. We did not consider these to be valid explanations for the feature of Ofwat's models that we were concerned with. We did not understand why companies that supply a large number of customers would face higher costs because of the need to source sufficient water for them. This might be an issue for companies that have a relatively high number of customers relative to the geographic area that they supply, but that is a separate matter relating to population density. Similarly, we did not understand why establishing capacity for growth would mean that larger companies that supply more customers will have higher costs: both large and small companies may face increased costs to accommodate growth in customer numbers and consumption levels.

96. Ofwat also said that it thought that Bristol Water benefited from the diseconomies of scale with 1.15 elasticity of cost to length in the refined base expenditure OLS model and did not consider that the model's economies of scale specification adversely affect Bristol Water. The view that Bristol Water benefited did not seem correct (though the complexity of Ofwat's models make it difficult to interpret them precisely). We used a similar type of analysis to that above and found that the refined base expenditure OLS model predicted lower costs for a company with Bristol Water's size and length of mains relative to customer numbers and population, than for the hypothetical average company.

Counter-intuitive results for effect of variations in population density

97. The results for scenario (3) above indicate that a company that supplies the same number of properties as the hypothetical average company, and has the same length of mains, but serves a population that is 10% higher, would have a level of efficient base expenditure that is 21.4% greater than the hypothetical average company (all else equal).

98. We can see this as an implied relationship between population density (average number of persons per property supplied) and expenditure. We have assumed an industry-average company that has an average population density of 2.24 persons per property supplied. We found that Ofwat's refined

model implied that such a company would have an efficient base expenditure of £102.13, whereas a company with a population density of 2.46 would have an efficient base expenditure of £123.95.

99. We consider a 21% increase in base expenditure for a 10% increase in population (all else equal) to be unlikely.

100. The population density is a potential driver of the expenditure requirements per property supplied. This is especially relevant if there is no measure of average consumption per property (usage in Ofwat's terminology) in the model, as is the case for Ofwat's refined base expenditure models. If a company supplies a larger population relative to the number of connected properties, then it seems likely that the volume of water that it is required to abstract, treat, produce and distribute will be greater (all else equal) which would increase its costs. However, if the relationship between population density and expenditure requirements was driven by variations in average consumption per property we would not expect such a large effect. For instance, if all costs were proportionate to the volume of water produced and distributed, we would expect an effect in this scenario of around 10%.

101. CEPA's explanation of the inclusion of the population density explanatory variable in the models was that it: 'Approximates average consumer size (domestic vs. I&C) and can be used to take some of the variation away from usage'.[22] We did not understand this and did not consider that it explained the result above.

102. In its report, CEPA singled out the estimated coefficient on population density from its model WM9 as a reason to give the model an amber rather than a green rating under its statistical performance criterion. CEPA stated that the coefficient for population density was 'slightly high, possibly due to multi-collinearity'.[23]

103. It is conceivable that the population density explanatory variable is picking up some more subtle underlying relationship. For example, some of the areas of England and Wales that have a relatively high population relative to the number of connected properties may also be areas that require greater use of relatively high-cost water resources, as the lower cost resources are insufficient to meet demand. This would tend to increase the average expenditure requirements per customer. However, it is also possible that the estimated coefficient on the population density variable is reflecting spurious

[22] CEPA (March 2014), *Cost assessment – advanced econometric model*, p45.
[23] ibid, p78.

correlations or perhaps some relationship in the data between companies' efficiency or inefficiency and their population density.

104. Ofwat told us that the population density issue was an isolated case in the base expenditure OLS model, and that the base expenditure random effects models had a lower coefficient for population density (10.5%) and that since Ofwat's approach included triangulation, it did not consider this to be an issue overall. Furthermore, it said that Bristol Water was an average company in terms of population density and was not adversely affected. We recognise that the population density issue seems more acute for the OLS base expenditure model and that this issue may not have adversely affected Bristol Water. Nonetheless, we consider our analysis of the population density effects in the OLS base expenditure model to be relevant to our wider review of Ofwat's models.

Counter-intuitive results for effect of variations in mains length

105. The results from scenario (4) above are that a company that has 10% less mains in total than the hypothetical average company would have 7.8% lower costs per connected property.

106. The positive relationship between length of mains and expenditure requirements (holding all else equal) seems plausible. If a company's customers are relatively diversely spread across the geographic area that it serves, such that it requires a relatively large amount of water mains to serve them, we would expect, all else equal, its costs to be greater than those of a company that can serve the same customer base with less water mains infrastructure.

107. However, the scale of the effect seems high. This is for two reasons:

(a) Whilst the length of a water company's distribution mains seems a relevant cost driver for the costs of parts of its water distribution system, there is a substantial part of its assets and activities for which we would not expect the length of mains to be an important cost driver (eg water abstraction and treatment processes or service reservoirs). We would expect the overall or average effects of mains length on base expenditure to be diluted by the areas of base expenditure for which mains length has limited effect on expenditure.

(b) Even in areas where mains length affects costs, there may be partially offsetting factors. For example, as the length of mains per connected property increases then, all else equal, we would expect smaller volumes of water flowing through these mains, on average. This would tend to allow for smaller diameter pipes as mains length increases, and doubling

mains length would not necessarily double the total costs associated with water mains. The PR09 cost base (a database of unit cost estimates for water industry capex projects) indicates that the diameter of water mains has a material effect on the costs of laying or rehabilitating (through pipe insertion) water mains, with higher diameter mains being associated with higher costs per metre.

108. To illustrate the first point, suppose a water company's costs were made up of two parts, A and B, and that these were of equal size in terms of costs. Suppose that there was a proportionate relationship between total mains length and the costs of part A such that doubling mains length doubled costs, and no relationship between total mains length and the costs of part B. In this example, we would expect to find that a 10% increase in mains length would increase costs by only 5%.

109. Bristol Water's regulatory accounts indicate that treated water distribution is approximately half of its total wholesale costs.[24] Of the treated water distribution costs, a significant part will be for assets and activities not driven by mains length. In this context, a 7.8% increase in costs for a 10% increase in mains length seems high.

Limited effect from variations in raw water inputs

110. Two explanatory variables of CEPA's refined base expenditure model concern the raw water inputs that companies draw on:

(a) The proportion of distribution input from rivers (expressed as a natural logarithm).

(b) The proportion of distribution input from impounding reservoirs (expressed as a natural logarithm).

111. Our analysis of the hypothetical company above indicates that these factors may have a relatively limited effect on the estimated level of efficient costs for each company.

112. In scenario (6) we considered a company that takes 10% less of its total distribution input from rivers and 10% more from boreholes than the hypothetical average company. We found that its base expenditure would be 0.2% lower than those of the hypothetical average company. This translated as 15 pence per customer per year.

[24] CMA analysis of Bristol Water's regulatory accounts 2014.

113. We carried out some further calculations using information on the industry average company and found that the implied cost difference between river water and water from sources other than rivers and impounding reservoirs (eg borehole abstraction) worked out at around 0.7 pence per cubic metre.[25]

114. Bristol Water's view was that this figure of 0.7 pence per cubic metre was not reasonable and far too low, and referred to estimates from Ofwat's PR09 opex econometric models which Bristol Water considered to predict a difference between surface water and groundwater of 8.3 pence per cubic metre in terms of opex (2007/08 prices).

115. In addition, the results from our scenario (7) implied that taking a greater proportion of water from reservoirs rather than boreholes would slightly increase costs. This would run counter to a view that reservoir water is more costly. CEPA stated that 'water from reservoirs is expected to lead to higher costs than water from boreholes'.[26] However the effect is quite small.

Review of Ofwat's modelling approach

116. This section provides a review of a number of elements of the top-down econometric models used by Ofwat. We identify a number of significant concerns, which raise further questions about the accuracy of these models, in addition to those from our review of the model estimation results in the previous section.

117. The fact that we have identified concerns with Ofwat's models does not, on its own, dictate whether or not these models should be used for cost assessment. No benchmarking analysis will be perfect and there will always be vulnerabilities and limitations in any approach. The appropriate approach overall should be considered in the light of the potential contribution and limitations of the various approaches that are feasible.

118. Furthermore, the development of econometric models of the nature that Ofwat used for its cost assessment involves (or reflects) choices over a great many aspects of model specification and estimation. It is not practical to take every conceivable aspect and dimension of model specification and critically examine all reasonable options and alternatives. As a consequence any model development and selection process will be affected by judgement on which aspects of model characteristics and performance are most important. It is perhaps inevitable that the models resulting from such a process will

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[25] We obtained this figure by taking the difference in costs per customer (£0.15), multiplying by the number of customers of the hypothetical average company, and dividing by 10% of the total annual volume of distribution of the hypothetical average company.
[26] CEPA (March 2014), *Cost assessment – advanced econometric model*, p21.

overlook or give insufficient weight to issues that other parties may consider important.

119. Our discussion below focuses on the econometric models themselves. We recognise that Ofwat's special cost factor process provided companies with opportunities to mitigate, to some degree, the effect on them of possible limitations or inaccuracies in Ofwat's econometric models. The special cost factor process was an important part of Ofwat's overall approach to cost assessment, but is not covered in this appendix.

120. We organise our discussion and review of Ofwat's models into three broad areas:

(a) the use of totex models

(b) model specification; and

(c) statistical and model estimation issues.

121. These areas are interrelated (eg the statistical issues we identify have implications for model specification), but we have sought to give some structure to the discussion that follows.

The use of totex models

122. The subsections below discuss four aspects of Ofwat's use of totex models:

(a) No account for the timing of investment needs.

(b) The inclusion of enhancement expenditure.

(c) No disaggregation of models into parts of the value chain below wholesale water.

(d) Lack of more granular benchmarking analysis.

No account for the timing of investment needs

123. Ofwat's models involve comparisons across companies and over time of measures of companies' totex, covering both opex and capex. This reflects Ofwat's decision to take a totex approach to cost assessment and other parts of its price control framework.

124. Making comparisons across companies of totex raises an immediate problem. Capex concerns investment and companies' investment requirements will vary over time. Differences between companies in their level of total cash

expenditure, in a given year or five-year period, may be reflective of differences in their investment requirements at a point in time and not indicative of their relative efficiency. For example, two different companies may have the same level of efficiency but different expenditure if they are at different points in their asset replacement cycles.

125. Accounting practice has long recognised that looking at a company's costs in a given year on a cash basis may provide a misleading indication of its financial position or performance. Companies' profit and loss statements do not report revenues minus totex as a measure of profit. Instead, capex enters the profit and loss statement through depreciation charges or amortisation. Ofwat's models do not use any measures of depreciation or amortisation: comparisons between companies and over time are on a cash basis.

126. Furthermore, Ofwat's econometric models did not include any explanatory variables that measure differences between companies, or over time, in companies' investment needs or the condition or quality of companies' capital stock.[27] Ofwat told us that including variables relating to the condition or quality of capital stock would create perverse incentives to reward companies with poor quality asset stock and that companies had ongoing responsibilities for serviceability. We agree that there may be such a risk to incentives (though this depends on other aspects of the price control framework), but this does not detract from the concerns about the accuracy of model results: the estimated expenditure from Ofwat's models may be too high for some companies and too low for others because they fail to account for the relative condition or quality of companies' capital stock and the timing of investment needs.

127. There are two risks to accuracy of the model results:

(a) The estimates derived from totex models for a particular company may provide an inaccurate guide to its expenditure requirements over a five-year period because they may take insufficient account of the extent to which its investment requirements in that period differ from those that applied on average across all companies in the historical data period used for these models. The timing of a company's investment needs may mean that it has relatively high expenditure requirements in the next five-year period compared with the results implied by the modelling, and vice versa.

[27] Each of the five models used by Ofwat included a measure of the volume of mains replaced and relined as an explanatory variable. In addition, the full totex model included explanatory variables for the proportion of new meters installed and the proportion of new mains laid in the year. However, these measures of companies' levels of activity are not necessarily indicative of their investment requirements; the activity levels reflect management choices and working practices and do not cover all aspects of water companies' investment requirements (they focus on water mains and metering assets).

(b) Variations over time and between companies in capex, which are driven by variations in investment needs, may give rise to spurious correlations in the data that distort the estimated coefficients from the econometric model and worsen the accuracy of the estimated expenditure for each company that is derived from the model. This is because variations in capex may, by chance, be correlated in the historical data with one or more of the explanatory variables in the model. This would tend to distort the estimates of the coefficient for these explanatory variables.

128. Ofwat told us that dealing with different investment needs was an issue in any comparative assessment and that it considered that its approach of smoothing capex in the econometric models and its broader approach involving special cost factor claims mitigated this issue. On special cost factors, Ofwat said that where companies considered that Ofwat's modelling results did not capture their large capital investment project they could submit a special cost factor claim for consideration.

129. We agreed that smoothing capex helps to reduce the problem above, but we had no reason to think that smoothing over five years was sufficient to address this issue given the much longer asset lives in the water industry.

130. We reviewed the special cost factor adjustments that Ofwat made for base expenditure across all companies and did not consider that Ofwat had developed a reliable method for taking full account of differences between companies in the timing of investment needs. The issue might not be a single 'large capital investment' project. It could instead be the cumulative effect, across many different assets, which means that one company's investment needs are significantly higher or lower than the industry average. It seems difficult to assess the case for special cost factor adjustments relating to the timing of investment needs for a specific company without looking at expenditure requirements across the whole of its wholesale business.

131. We recognised that Ofwat's decision to develop and use totex models for cost assessment reflected concerns that the previously regulatory framework provided companies with an undue bias towards capex and distorted their decisions away from finding ways to deliver services to customers at least cost (without compromising quality). The Gray review of Ofwat and consumer representation in the water sector (2011) had found the evidence of a bias towards capital investment to be convincing.[28] The assessment of the Gray review team was that the bias towards capital investment was both real and

[28] Defra (2011), *Review of Ofwat and consumer representation in the water sector*, p42.

important and that the approach set out in Ofgem's RIIO framework for energy network companies appeared to have considerable attractions.[29]

132. Ofwat's specific implementation of a totex approach is not the same as that used by Ofgem. Ofwat's approach to cost assessment for PR14 placed more weight on top-down benchmarking of totex than implied by Ofgem's RIIO framework and by Ofgem's subsequent implementation of that framework for electricity and gas distribution network companies. The specific aspects of Ofgem's approach that the Gray review identified as a potential means to address the capital investment bias concerned equalising marginal incentive rates across operating and capex and capitalising a fixed percentage of totex for the purposes of calculating the RCV.[30] The Gray review did not comment explicitly on the totex approach to benchmarking analysis or cost assessment.

Inclusion of enhancement expenditure

133. Ofwat's totex models include base service and enhancement expenditure. There are likely to be substantial differences between companies (and over time) in their enhancement expenditure requirements. For example, enhancement will reflect whether increases in (forecast) demand for water can be met through existing capacity or require new capacity to be built (eg some companies may have excess capacity in water resources and water treatment at a particular point in time, reflecting historical investment decisions and changes in population and industry over time in their regions).

134. Furthermore, where companies need to increase water resource capacity, the costs of doing so may vary substantially between companies depending on local and regional ecological and environmental factors that determine the feasible options for additional water resources. Enhancement requirements may also be driven by environmental concerns, such as over-abstraction from particular sources, which will vary across different companies' regions.

135. Despite the number of explanatory variables in Ofwat's models, the models seem limited in the explanatory variables that take account of differences between companies in their enhancement expenditure requirements.

136. We consider that this reflects a general difficulty in seeking to include enhancement expenditure in the econometric models, rather than omissions in the explanatory variables selected for Ofwat's models. We could not identify

[29] ibid, p43.
[30] ibid, p43.

a set of alternative explanatory variables that seemed likely to capture the material differences between companies in their enhancement needs.

137. We recognise that there are potential benefits of including enhancement expenditure in the econometric models. In particular, the split between enhancements and base expenditure is not clear-cut and separate analyses for base and enhancements are vulnerable to risks from imperfect and inconsistent cost allocations. But these cost allocation issues do not detract from the problems arising from the inclusion of enhancement expenditure in Ofwat's totex models.

No disaggregation of models into parts of the value chain below wholesale water

138. Compared with its previous approach to price control reviews, Ofwat has moved towards more aggregated and high-level forms of benchmarking analysis. In addition to the aggregation of opex and capex into single models, Ofwat's approach took the whole of wholesale water supply together, without considering different parts of the value chain or different wholesale water activities separately.

139. Ofwat's models specified the dependent variable as the logarithm of measures of totex, or base expenditure, across companies' wholesale activities. This is one reasonable type of model specification to consider.

140. However, Ofwat could also have considered models that take different parts of the value chain separately. Ofwat could still have taken opex and capex together, but used separate models for different parts of the value chain. For example, Ofwat's previous price control reviews adopted the principle of using separate models for different parts of the water value chain and suggests separates models for:

(a) raw water abstraction, transportation, storage and treatment; and

(b) treated water distribution (perhaps with expenditure attributed to pumping activities separated out in to a further model).

141. This could allow for more accurate estimates of the relationships between costs and cost drivers. This is for two main reasons:

(a) Models that focus on specific parts of the value chain may allow the set of explanatory factors to be tailored to each model, reducing risks of inaccuracy in estimated coefficients from the small sample size (and limited variation within the sample) relative to the number of cost drivers that are material for wholesale water supply. For example, a model of treated water distribution expenditure might benefit from the exclusion of

variables relating to raw water quality and a focus on explanatory variables that are more important to treated water distribution costs.

(b) Under Ofwat's approach there are risks that the estimated coefficients for some cost drivers are adversely affected by spurious correlations between the cost driver and variations in expenditure in parts of the value chain that are not significantly affected by the cost driver. In contrast, a disaggregated approach allows a greater focus on the areas of expenditure that specific cost drivers relate to.

142. There are potential downsides from such models (eg vulnerabilities to differences between companies in cost allocation) but these do not seem so great as to override the contribution that such models could make to the estimation of coefficients on explanatory variables in the model.

143. Ofwat told us that consideration of the different sections of the value chain for wholesale water supply reinforced rather than undermined the advantages of totex modelling because of the complex trade-offs and interactions between activities in the value chain. It set out the following set of argument:

> A company may choose a water source further from the main area of demand because it has low treatment costs, which it uses to offset some of the extra transport costs of raw or treated water. Alternately it may choose multiple sources of raw water closer to centres of demand that are more expensive to treat but reduce its water transport costs. The investment in transport and treatment capacity can also impact on distribution costs by reducing the need for investment in the local storage of treated water. Taken together these issues significantly undermine the case for disaggregated benchmarking and would create substantial difficulty in implementing such a scheme.

144. We agreed with the first part of the extract above, which relates to *(a)* the possible choices a water company may face as to how to organise its water supply to customers, and *(b)* potential differences between companies in the extent to which they use different activities and asset types within the overall value chain. However, we disagreed with the inference that these features of the industry undermine the case for disaggregated benchmarking or create substantial difficulties. Whilst there are risks with the development and use of disaggregated models (as there are with totex models) we do not believe that a well-designed disaggregated benchmarking approach would be undermined by these features.

145. For example, a bad approach to disaggregated benchmarking would involve running a series of separate models for different parts of the value chain, calculating an upper quartile efficiency benchmark for each model, and then producing an upper quartile efficiency benchmark for wholesale water as the sum of these separate upper quartile benchmarks from each model. This would be vulnerable to the criticism that it provides an unrealistic and unachievable cost benchmark by ignoring the interactions and trade-offs across different parts of the value chain. This problem can be addressed by summing the estimated costs (or cost per customer) across different disaggregated models before calculating any efficiency benchmark.

146. Ofwat also said that partitioning the value chain also exposed any benchmarking analysis to the distortions caused by cost allocation and attribution issues. We recognise that there are risks to the accuracy from costs allocation issues but these risks did not seem so great as to provide a reason for excluding disaggregated models from the assessment, particularly where they may bring benefits in terms of the estimation of relationships between expenditure requirements and the cost drivers.

Lack of more granular benchmarking analysis

147. Besides the possibility of benchmarking models that take different parts of the water supply value chain separately (eg separating water treated from treated water distribution), another approach is to carry out relatively granular or disaggregated forms of benchmarking analysis. This could provide an additional perspective, to complement more aggregated benchmarking models.

148. In its regulation of electricity distribution companies in Great Britain, Ofgem has complemented relatively aggregated top-down benchmarking analysis with far more granular benchmarking analysis. Ofgem's final approach in its most recent review of the price controls for the electricity distribution companies gave a 50% weight to totex modelling and a 50% weight to disaggregated modelling. The disaggregated modelling was built up from many different streams of benchmarking analysis at the level of individual activities that companies carry out (eg tree-cutting, or inspections and maintenance) or for specific categories of investment (eg 33kV transformers). Ofgem explained as follows:[31]

> Totex models internalise operational expenditure (opex) and capital expenditure (capex) trade-offs and are relatively immune

[31] Ofgem RIIO-ED1: Final determinations for the slow-track electricity distribution companies: business plan expenditure assessment, 28 November 2014, p28.

to cost categorisation issues. They give an aggregate view of efficiency. The bottom-up, activity-level analysis has activity drivers that can more closely match the costs being considered.

149. We recognise that there are differences between the water companies in England and Wales and the regional electricity distribution companies regulated by Ofwat (eg there is a larger sample of independent water companies in water industry). However, we see merit in Ofgem's view that there are significant benefits to more granular benchmarking analysis despite the existence of trade-offs between opex and capex and cost allocation issues.[32]

150. The Competition Commission's 2014 price control determination for Northern Ireland Electricity Ltd (NIE) drew on more granular forms of benchmarking than used by Ofwat. The Competition Commission made extensive use of the detailed data sets that Ofgem had collected for electricity distribution network operators (DNOs) in Great Britain. This data fed into the Competition Commission's analysis of NIE's network investment plan and also the benchmarking of NIE's 'indirect' costs.[33]

151. More granular benchmarking analysis would require more detailed data than Ofwat used for its totex and base expenditure models. The data collected by Ofwat for the PR14 price control review, and its approach to benchmarking analysis and cost assessment, reflects, in part, the outcome of the Gray review.[34] That review was critical of the data burden that Ofwat placed on companies and the review's recommendations included for Ofwat to 'set clear targets and timescales for a reduction in the burden of the price control and compliance processes'.

Model specification

152. We take the following aspects of model specification in turn:

   (a) Difficulty in interpreting the models.

   (b) The use of the translog functional form.

   (c) The assumed relationship between expenditure and the cost drivers.

[32] Ofgem has developed a very detailed set of regulatory reporting arrangements for annual data submissions from regulated electricity distribution companies. Ofgem provides detailed definitions of activities and assets to reduce risks that companies report on an inconsistent basis.
[33] Northern Ireland Electricity Limited price determination (2014).
[34] D Gray (2011), Review of Ofwat and consumer representation in the water sector, p28.

(d) Inclusion of inputs in the explanatory variables.

(e) Potential missing cost drivers.

Difficulty in interpreting the models

153. We found it difficult to understand the intuition for Ofwat's model specifications and were concerned that aspects of Ofwat's models did not seem to make sense from an economic and engineering perspective.

154. These issues arise from a number of features of Ofwat's models, including:

(a) the translog approach (discussed separately below);

(b) the use of aggregate expenditure in the dependent variable, rather than expenditure per customer, which can provide for more intuitive comparisons between companies;

(c) the use of various ratios and proportions for some explanatory variables and aggregate figures for other explanatory variables; and

(d) the indiscriminate use of explanatory variables expressed in logarithms (even logarithms applied to proportions).

155. We provide an example below to illustrate our more general concerns about the intuitive basis for the models. In short, we consider that a measure of the number of customers supplied is a natural and logical variable to take account of in making benchmarking comparisons between water companies. However, it only features in Ofwat's models in an indirect way.

156. Ofwat's econometric models make comparisons of measures of expenditure between companies. The dependent variable in the econometric model is a measure of expenditure. CEPA identified what it termed three 'scale' variables which, alongside a time trend, it treated as the 'core' explanatory variables. These are: *(a)* length of mains; *(b)* number of connected properties divided by length of main (termed property density); *(c)* total potable water consumption divided by number of connected properties (usage) and *(d)* what CEPA called a time trend. CEPA said that these 'scale variables should be the main drivers of costs'.[35]

157. This seems to give little weight to differences in the number of customers supplied (or, perhaps more precisely, the number of customer sites that the company provides a water service to), which is likely to be an important

[35] CEPA (March 2014), *Cost assessment – advanced econometric model*, p20.

reason for variations in expenditure between companies. Furthermore, the 'usage' variable used by CEPA is not a direct measure of scale, but rather the intensity of consumption at the individual customer level.

158. In benchmarking the costs of different companies that provide a service to customers, we would naturally want to take account of the number of customers served by the company and/or another measure of the total volume of the service supplied. Neither of these forms part of CEPA's core scale variables. Taking account of differences in customer numbers seems particularly important given the scale of variation between companies in Ofwat's sample. Over the period of Ofwat's data, the companies range from serving around 120,000 properties (Dee Valley) to serving around 3.6 million properties (Thames).

159. While Ofwat's models left out the number of connected properties as an explanatory variable, they included other measures of the scale of companies' operations that seem less directly relevant and more difficult to interpret. These are, for example:

(a) The natural logarithm of mains length. While mains length may be a driver of distribution network costs it may not be particularly important to water resource and treatment costs.

(b) The natural logarithm of the square of the mains length (ie the logarithm of mains length*mains length). We found this variable difficult to rationalise and interpret.

(c) The natural logarithm of mains length multiplied by the natural logarithm of the number of connected properties / length of mains length. We found this variable difficult to rationalise and interpret.

The use of the translog functional form

160. For the purposes of our assessment, we did not focus on the general question of whether a translog functional form is a useful model for econometric analysis of costs or efficiency. Instead, our focus is on the specific translog implementation used in Ofwat's models, within the specific context of our determination for Bristol Water.

161. As stated above, we found it difficult to rationalise and interpret the specific explanatory variables that Ofwat included in its econometric models for the purposes of implementing the translog approach (eg the natural logarithm of the square of the mains length; the natural logarithm of mains length multiplied by the natural logarithm of the number of connected properties divided by the total length of mains).

162. In explaining its use of the translog form, CEPA stated as follows:[36]

> We tested both [Cobb-Douglas and translog] functional forms in our modelling as previous literature indicated that there is evidence of varying economies of scale in the water and sewerage industry. For example, work commissioned and published by Ofwat (Stone and Webster 2004) suggested the presence of variable returns in the water industry, with evidence of diseconomies of scale for water and sewerage companies (WaSCs), but possible economies of scale for WoCs. Although, Stone and Webster could not reject the presence of constant returns to scale for water-only companies (WoCs). In addition, Saal et al (2011) found that, for WoCs, the average sample firm was subject to diseconomies of scale. However, it concluded that vertically integrated firms gained significant benefits from economies of scope and scale. We discussed the theoretical implications of the translog with Ofwat staff and we agreed with them that a translog form was viable.

163. It seems that CEPA and Ofwat used the translog function form because they thought that there may be significant economies or diseconomies of scale across our sample of water companies. CEPA's reports did not, however, explain why, from an economic or engineering perspective, there would be such economies or diseconomies of scale.

164. We did not consider that CEPA had fully explained the use of models that allowed for economies or diseconomies of scale through its references to past studies. Any statistical analysis is vulnerable to potential unreliable results or inaccurate inferences. For instance, any study that seeks to draw conclusions about the presence of economies or diseconomies of scale by considering the statistical significance of estimated coefficients may be vulnerable to challenge on further review.

165. We have seen from both Ofwat's models and our own work on alternative models, that the estimated coefficients from econometric models of the expenditure of English and Welsh water companies can be highly sensitive to model specification, and relatively minor changes to aspects of a model may change the estimated coefficients. Furthermore, the standard errors may be underestimated (eg if the estimation of standard errors ignores possible correlations over time in companies' costs), and hence the significance of estimated coefficients can be overstated. These are things that we would

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[36] CEPA (March 2014), *Cost assessment – advanced econometric model*, p7.

need to investigate before giving weight to the results from the studies referred to by Ofwat and CEPA.

166. In the context of a small sample size relative to the number of explanatory variables in the econometric model, we consider that it may be unsafe to rely on statistical analysis to reveal how the econometric models should be specified. There are risks of spurious results. Our analysis above of Ofwat's refined base expenditure model (OLS), which features a translog functional form, found that this implied diseconomies of scale. We consider that this may be indicative of spurious results because we could not think of an economic or engineering reason why the cost per connected property should be higher simply because a company supplies a greater number of connected properties (assuming what CEPA terms the density and usage remain constant).

167. If a statistical analysis suggested some form of economies of scale or diseconomies of scale, we would not necessarily consider it appropriate to take account of this in the models used for cost assessment for Bristol Water's price control. Even if it was the case that smaller companies had lower costs than larger companies, on the basis of cost per customer or cost per cubic metre supplied, it does not follow that we would want to provide for relatively higher expenditure allowances (eg per customer) for the larger companies and lower allowances for smaller companies. The relationship in the data could be due to non-causal factors. For example:

(a) A correlation between company size and unit cost measures could be driven by correlations in efficiency: small companies may happen to have had more efficient working practices (on average) over the sample period. This would not necessarily mean that all small companies would be lower cost in the future.

(b) It could be due to factors that enable some of the smaller companies to operate at lower cost, or that raise some of the larger companies' costs, which are not captured by the explanatory variables in the model and which do not necessarily apply to all small companies.

168. Because statistical analysis on a small sample cannot be entirely accurate, we would consider it important to have an explanation of the rationale for treating diseconomies of scale as a causal factor that the regulatory cost assessment should allow for, if such models are to be used.

169. In response to our initial comments on Ofwat's use of the translog models, Ofwat said that there were a number of economic and engineering reasons why the cost per connected property could be higher because a company

supplied a greater number of connected properties. Ofwat said that the company may have needed to build a new treatment plant which was not running at capacity or the treatment of raw water could be more complex given the greater number of properties.

170. We did not accept these attempts by Ofwat to rationalise the form of diseconomies of scale that we had expressed doubts over:

(a) The extent to which a company is making use of the capacity of its assets, rather than having a high degree of asset underutilisation, could affect the calculated cost per property. However, there seems to be no reason to expect that companies that serve a relatively high number of customers would suffer from a larger degree of asset underutilisation than companies that serve a relatively low number of customers.

(b) The point made by Ofwat on raw water quality seems to confuse differences between companies in the total number of customers with differences in the density of customers within the area they serve. It seems possible that a company that serves a geographic area with a high density of customers may have higher costs per customer because, to meet water demand in its area, it needs to use some relatively inferior water resources that have higher water treatment costs. This would be an argument for including measures of customer density in the models (eg relating to the geographic area supplied relative to customer numbers, though this might be well proxied by the variables for mains length relative to connected properties). However, our concern is not about customer density but about the idea that, holding the density of customers constant, suppling a greater number of customers will increase costs.

The assumed relationship between expenditure and the cost drivers

171. We have reviewed the way that Ofwat's models incorporated potential cost drivers into the specification of explanatory variables. We found that, in some cases, the models impose assumptions on the relationship between expenditure and cost drivers that did not seem to make sense.

172. The first issue that we discuss is the use of logarithms for the specification of explanatory variables that are calculated as proportions. An example concerns the explanatory variables relating to the nature of each company's water resources, which feature in model WM3. These variables are: *(a)* the natural logarithm of the proportion of distribution input from rivers; and *(b)* the natural logarithm of the proportion of distribution input from impounding reservoirs.

173. We do not consider it sensible to take the logarithm of this proportion for the specification of the explanatory variable. Doing so would assume that a 10% increase in the proportion would lead to an X% increase in costs. This would imply, for example, that the effect on a company's costs of moving from 5% river water abstraction to 10% river water abstraction (a 100% increase in the proportion) would be the same in £ million as if that company moved from 40% to 80% river water abstraction (similarly, a 100% increase in the proportion).

174. This aspect of Ofwat's model specification follows from a general policy of the dependent variable and all explanatory variables being calculated as natural logarithms. The approach of expressing costs and cost drivers has support from the Cobb-Douglas functional forms (of which the translog form is an extension) used in some academic literature. However, this does not in itself justify taking the natural logarithm of a cost driver in the special case where that cost driver is expressed as a proportion. The classic Cobb-Douglas production function in the academic literature has inputs of capital and labour, neither of which are expressed as proportions.

175. There are further problems, beyond the use of explanatory variables of logarithms of variables that are proportions. These concern the use of explanatory variables that are defined as proportions or as one cost driver divided by another variable.

176. As an example of this second issue, we considered the explanatory variable for 'proportion of new meters'. This is defined as the number of new meters installed by the company in a year as a proportion of the number of the company's customers that are metered. CEPA identified this as a driver of enhancement costs. CEPA stated that, for the coefficient on this explanatory variable it 'would expect a low positive number as the installation of new meters should drive up capital costs'.[37]

177. We agree that variations between companies in the number of new meters installed is a relevant cost driver to consider (at least if the expenditure measure includes enhancements). However, the exact specification of the explanatory variable used in Ofwat's models raised some questions. The explanatory variable in Ofwat's full totex model does not consider variations in the total volume of meters installed between companies, but rather variations in new meters expressed as a proportion of the existing base of metered customers. This model would assume that two companies would have the

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[37] CEPA (March 2014), *Cost assessment – advanced econometric model*, p21.

same costs of installing new meters, as a percentage of their totex, only if this proportion is the same. This did not seem to make sense.

178. We illustrate this by reference to an illustrative example in Table 6. In this example, we assume that companies A, B and C are the same in all ways except the factors in the table relating to metering. Companies A and B have a different existing base of metered customers and install a different number of meters, but the number of new meters as a proportion of existing metered customers is the same.

Table 6: Illustration of the problem with CEPA specification of proportion of new meters variable

	Total number of metered customers	*Number of new meters installed*	*Number of new meters as proportion of metered customers*
Company A	100,000	4,000	0.04
Company B	150,000	6,000	0.04
Company C	150,000	4,000	0.027

Source: CMA analysis.

179. The model specification used by Ofwat would make the same allowance for totex associated with new meters for companies A and B even though company B installs 50% more meters. Furthermore, if the model identifies a positive coefficient for this explanatory variable, the allowance for totex associated with new meters would be greater for company A than company C, even though they install the same number of meters.

180. This specification is not explained in CEPA's reports. We did not identify any reason to think, as Ofwat's model specification implies, that the marginal costs of installing meters is best represented as a function of the number of customers that already have meters.

181. A more plausible approximation, for the purposes of model specification, would be that the cost per meter is the same across companies. All econometric model specifications can only provide imperfect approximations of relationships between costs and cost drivers. But it seems more reasonable to assume that, in this example, companies A and C have similar meter installation costs and company B has higher meter installation costs, than to assume that companies A and B have similar meter installation costs and company C has low meter installation costs.

182. A similar problem arises with Ofwat's treatment of the data relating to the following cost drivers:[38]

[38] There may also be endogeneity problems with these variables, but this is not the focus of the discussion here.

(a) **Length of water mains renewed or relined**. Ofwat's model specification is an explanatory variable defined as (the logarithm of) the total length of mains that is relined or renewed by the company in a year divided by the company's total length of mains at the end of that year.

(b) **New water mains installed in the year**: Ofwat's model specification is an explanatory variable defined as the (logarithm of) the length of new mains installed by the company in the year divided by the company's total length of mains at the end of that year.

183. By expressing the explanatory variable as a proportion, Ofwat's model specification implies that the impact on totex of variations in the amount of new mains or in mains relining or renewal is contingent on the company's total length of mains.

Inclusion of inputs in the explanatory variables

184. CEPA's and Ofwat's interpretation of the model results rests on the assumption that the estimated residuals from the econometric models – ie the cost differences between companies that are not explained by the estimated coefficients for the explanatory variables in the model – are a measure of efficiency differences between companies. If the explanatory variables themselves capture features of companies that reflect their efficiency in delivering services this may distort the results (in statistical terms, there may be a problem of endogeneity).

185. To take an extreme example, an econometric comparison of costs could be specified to include number of employees (both own staff and contractors' staff) as an explanatory variable. The model might find this to be correlated with costs – that variations in levels of staff between companies have explanatory power (further to other variables in the model) in explaining differences in costs between companies. But we should not expect estimated residuals from such a model to be a good guide to efficiency differences.

186. A number of the explanatory variables in Ofwat's models seem to relate to the inputs used by water companies to provide services to customers, over which companies have at least some degree of control. For example:

(a) the length of mains;

(b) the proportion of water abstracted from rivers;

(c) the proportion of water abstracted from reservoirs;

(d) the proportion of properties that are metered;

(e) the length of new mains laid in year divided by total length of mains;

(f) the length of mains relined and mains renewed divided by the total length of mains at year end; and

(g) the estimated volume of leakage divided by total water input to distribution system.

187. For several of these explanatory variables, it seems possible to argue that they are used to make an allowance in the model for an important underlying feature of companies' operating environment that has a significant effect on its expenditure requirements (if it operates efficiently) and which is not possible to capture directly.

188. For example, a water company will have some flexibility in both day-to-day operations and longer-term planning on the proportion of its water that it takes from different sources. However, the options and opportunities for raw water available will vary considerably across companies, due to both local environmental factors and investment decisions made in the past by the company or its predecessors (perhaps many years ago). Including explanatory variables for the proportion of water abstracted from rivers and reservoirs can make an allowance for these differences in the water sources available to a company, which reflect local environmental factors and historical decisions. This may be beneficial to the modelling even if there is a risk that the model overlooks or even distorts a company's efficiency in optimising across the different raw water options available to it.

189. Similarly, whilst a water company will face some asset management and system development choices that affect its length of mains, it faces duties to serve customers in its appointed area. Variations between companies in the dispersion of customers across that area will give rise to cost differences. Furthermore, a company's network design and infrastructure will be influenced by the pattern of customer demand that arose over time.

190. Our view is that, in some cases at least, including explanatory variables that are inputs and under management control may be better than a strict approach of excluding such factors. In principle, there would be merit in using alternative explanatory variables or data sources that could capture the same underlying factors with less of a link to a company's inputs and asset management approach, but such data sources may not be available.

191. There seems to be a different issue relating to leakage. CEPA's modelling treats leakage as an aspect of quality. This reflects more general aspects of Ofwat's regulation of the water industry which treats companies' reported

leakage as a relevant measure of performance (eg with incentive schemes attached to leakage measures).

192. An alternative view is that leakage is not, in itself, a measure of quality or performance, and reflects instead the inputs to the production processes used to meet customer demand for water supplies. As part of their approach to asset management, companies will face cost trade-offs that relate to leakage (eg greater pipe replacement activity might reduce leakage and, in turn, the costs relating to water abstraction, treatment and pumping but these should be set against the costs of more pipe replacement work).

193. Including leakage as an explanatory variable in a model might increase the extent to which the model explains differences in costs between companies but may reduce the extent to which the model captures differences between companies in their efficiency of providing water services to customers. In particular, the model may predict higher levels of efficient costs for companies that have achieved lower levels of leakage, but this may overlook the possibility that maintaining lower levels of leakage may turn out to be more expensive overall for customers. There are wider environmental concerns relating to leakage which may be relevant to the determination of wholesale price controls, but these would tend to vary across different geographic areas.

194. Ofwat's view was that the potential concerns about endogeneity relate only to the full totex model (which includes leakage and quality variables) as the variables in the refined models such as network length cannot be substantially influenced by management in the short term and that, while inclusion of leakage in the full model may mean Ofwat understated the inefficiency of Bristol Water, there is no evidence that this has caused wider problems with its suite of models.

Potential missing cost drivers

195. CEPA's report presents its full totex model as covering all theoretical cost drivers. However, we were not persuaded that this was the case.

196. For example:

(a) We have identified above that the number of connected properties seems a relevant cost driver, but it was not included in Ofwat's models directly as an explanatory factor.

(b) Another potentially relevant cost driver concerns peak demand or measures of the variance between peak demand and average demand.

(c) The nature and quality of raw water sources seems an important cost driver, and it may not be adequately captured by the explanatory variables used by Ofwat relating to the proportion of water taken from river and reservoir sources. Bristol Water argued that a measure of the complexity of treatment processes required by companies was a relevant cost driver and we considering this issue in Section 4 of our provisional findings.

197. In respect of the second point, the costs of providing a water service are, in large part, costs required to provide and maintain the capacity needed to accommodate the demand for water services from customers. Demand is uncertain and varies both within the day (eg more consumption in the morning and evening and less in the middle of the night) and over the year (eg more consumption during hot summer periods).

198. The capacity that companies need to provide are not driven predominantly by average levels of consumption, but by the ‘peakiness’ of consumption patterns. For instance, the capacity needed for water treatment might be driven by estimates of peak daily demand during a period of very high consumption during the summer. Similarly, the capacity needed for treated water distribution infrastructure may reflect not only the total volume of water distributed but also the extent to which consumption peaks at particular times of the day (eg this may affect the costs of service reservoirs and also pipe capacity).

199. If there are significant differences between companies in the peakiness of their customer’s demand, this could lead to significant differences in costs. Whilst Ofwat’s econometric models include an explanatory variable for usage (a measure of water consumption per property) they do not include any variables which capture the peakiness of consumption: ie potential differences between companies in consumption at times of peak and average consumption.

200. Ofwat told us that it did not consider that the peak demand relative to average demand was an important consideration in the water econometric models because treated water could be stored in various parts of the network. We did not find this argument persuasive. Companies do deal with the peaks through different forms of storage, but storage itself carries costs.

201. Overall, we were not confident that Ofwat’s models included all relevant theoretical cost drivers.

Statistical and model estimation issues

202. The subsections below take the following issues in turn:

(a) Number of explanatory variables relative to sample size and variation.

(b) Relatively short data period.

(c) Pre-modelling adjustments as alternative to statistical estimation.

Number of explanatory variables relative to sample size and variation

203. We were concerned that the models used by Ofwat model might be 'over fitted' for a sample size of 90 observations (ie they include too many explanatory variables relative to the number of data points).

204. It is ambitious to take a data set spanning 18 companies over five years and to attempt to use an econometric model to produce estimates that quantify the relationship between expenditure and up to 27 different explanatory variables.

205. Econometric models have limitations. To the extent that they can identify and estimate meaningful and usable estimates of the relationships between cost and the explanatory variables, this must come from inferences drawn from the correlations in the data sample. At a high level, there are two related problems to be aware of:

(a) There may be correlations in the data sample between the expenditure measure used for the dependent variable and an explanatory variable which are not reflective of causality (how cost drivers affect expenditure requirements). This would tend to distort the accuracy of the estimated coefficient for that explanatory variable, at least for the purposes of treating the coefficient as an approximation of the causal relationship between that factor and companies' expenditure requirements.

(b) Where two explanatory variables are highly correlated, it may be difficult for the econometric model to isolate the causal effect of any one of them on costs. This could result in inaccurate estimates of the way that these two factors would, on their own, affect costs.

206. The second issue relates to the statistical concept of 'multi-collinearity'. Ofwat has argued that multi-collinearity may explain some of the estimated coefficients from its models which, taken in isolation, look counter-intuitive. Ofwat and CEPA did not seem to treat multi-collinearity as a problem for the cost assessment that draws on the econometric modelling, but we have concerns. See the discussion in the subsection above on 'Ofwat's response to unexpected coefficients'.

207. The two problems above are a greater concern the smaller the sample size is and also where there is limited variation in the explanatory variables within a

small sample. A smaller sample size presents greater risks of spurious (ie non-causal) correlations and less opportunity for the model to withstand correlations between explanatory variables.

208. Ofwat’s data sample has 90 observations. We consider this insufficient to avoid the two problems above. Furthermore, the sample cannot be seen as 90 independent observations. Some of the explanatory variables explaining costs do not vary much across time (ie they are stable over time for each company) and the model estimation may, in effect, be relying on the variation across the 18 observations (18 companies) to estimate coefficients for these explanatory variables.

209. The R-squared in Ofwat’s models are all very close to one (at least equal to 0.985) which is an indication that the model is over-fitted.

210. The greater the number of explanatory variables the higher is the risk of spurious relationships between the costs and the explanatory variables (rather than causality). The probability of spurious effects is greater when the sample size is small compared to the number of parameters.[39] Moreover, multivariate methods are problematic in this respect because such data are often high-dimensional and have an inherent complex structure which is the case for many of the explanatory variables in the cost equation used by Ofwat (eg interaction terms or variables that are ratios of other parameters).[40]

211. Whether the model is over fitted is intrinsically related to lack of degrees of freedom (constraints on one variable after controlling for the rest of the parameters in the model). Furthermore, the relatively limited variation over time for some of the explanatory variables might reduce the effective sample size.

212. The very high correlations between some of the explanatory variables (eg correlation of 0.92 between proportion of usage by metered household properties and proportion of metered properties) might be an indication of more than a single variable capturing very similar effects on costs. This is related to the multi-collinearity problem that increases the standard errors of

[39] Freedman, DA. (1983) ‘A note on screening regression equations.’ *The American Statistician*, 37, 152–155.
Stauffer, DF, Garton, EO and Steinhorst, RK (1985) ‘A comparison of principal component from real and random data’. *Ecology*, 66, pp1693–1698.
Flack, VF and Chang PC (1987), ‘Frequency of selecting noise variables in subset regression’. *The American Statistician*, 41, pp84–86.
[40] Rextad, EA, Miller, DD, Flather, CH, Anderson, EM, Hupp, JW, and ANDERSON, DR (1988). ‘Questionable multivariate statistical inference in wildlife habitat and community studies’. *Journal of Wildlife Management* 52, pp794–798.

the estimators, making them less precise and potentially unreliable. The multi-colinearity problem seems particularly high in the full totex model.

213. Ofwat told us that, in relation to our comments on the number of explanatory variables, it considered that its refined models struck a reasonable balance between sample size and number of explanatory variables and were similar in this respect to some alternative models that we had proposed (see the alternative models in Section 4 of our provisional findings). Ofwat also said that it recognised the limitations of the full model but considered that the benefits of including one such a model in its triangulation (the model being less likely to suffer from omitted variable bias) outweighed the risks from over specification.

214. We agreed with Ofwat that the issue of the number of explanatory variables is more problematic for the full totex models than for the refined totex models. We were not persuaded that the full model brought net benefits. The ability of the full model to reduce risks of omitted variable bias is limited by the small sample size relative to the number of explanatory variables and several of the estimated coefficients were counter to what CEPA had expected.

215. We still had concerns about the number of explanatory variables in the refined model, especially given the lack of variation over time in many of the explanatory variables in the sample.

216. The alternative models that we had proposed include a similar number of explanatory variables to Ofwat’s refined models if each time dummy variable is counted as an explanatory variable. However, we considered that the time dummy variables posed less of a problem than the other explanatory variables and that our approach was less vulnerable to concerns about the number of explanatory variables relative to the sample size. For instance, the concern about multi-collinearity between explanatory variables does not seem as likely to be as much of an issue for the time dummy variables, given the existence of variation in each explanatory variable across the 18 companies in any given year.

Relatively short data period

217. Running the econometric models over a longer time period would increase the sample size and may allow for a more accurate analysis of the extent to which each explanatory variable affects costs. This would depend on the extent to which data is reported on a reasonably consistent basis over time and also whether the model specification is vulnerable to any significant changes in the relationship between an explanatory variable and costs over the sample period.

218. The final models recommended by CEPA and used by Ofwat for the water service used a panel data set covering 18 companies over the five-year period from 2008/09 to 2012/13. Ofwat's dependent variables, totex and base expenditure, are both constructed using a smoothed measure of capex, which took a moving average of capex over the last five years. As a result, Ofwat's models drew on capex data over a nine-year period from 2004/2005 to 2012/13 and opex data for the five-year period 2008/09 to 2012/13.

219. CEPA's earlier report for Ofwat in January 2013 had referred to a data set available for use in the econometric modelling that covered the five-year period from 2001/02. Ofwat told us that there were a number of differences between CEPA's initial data set and the final data set used by CEPA to produce the final models:

(a) They cover different time periods. The initial data set used by CEPA actually covered the period 1996/97 to 2010/11, whereas the final data set covered 2008/09 to 2012/13.

(b) The initial data set included more potential explanatory variables (ie explanatory variables that CEPA did not use for its final models).

(c) The initial data set 'included relatively crude assumptions' to split opex between wholesale and retail. Ofwat said that it was able to use a more sophisticated approach for the final data set.

220. CEPA did not provide a full explanation of its decision to use a sample period of five years only for the water service. It highlighted the constraints of the random effects approach which it considered better to run using a short time period. This is because the assumption used by CEPA and Ofwat that the time-invariant random effect was attributable to relative efficiency would be less plausible the longer the time period over which the random effect model was run (we would not expect relative efficiency differences to persist unchanged over a lengthy period of time). That assumption would not be relevant to the OLS models (three of CEPA's final five models were OLS models).

221. CEPA said the following on the effects of using different time periods:[41]

> In general the long panel estimates were very similar to the short panel estimates. Where the model parameters were dissimilar,

[41] CEPA (March 2014), *Cost assessment – advanced econometric model*, p12.

the long-panel estimates were within the short-panel confidence intervals.

222. We cannot be sure from this statement that the effects of using a longer data period would be immaterial for Bristol Water. The confidence intervals for the estimated coefficients in Ofwat's models are often wide, so CEPA's statement above does not mean that there would be no effect on the cost assessment for each company if a longer data period had been used.

223. The relatively short data period used by Ofwat is a potential concern. We recognise that using a longer time period would increase the risks of inaccuracy arising from the need to make an approximate split between wholesale and retail activities in the period before Ofwat's data reporting requirements provided for such a split. However, since retail costs are a small proportion of overall costs, the inaccuracy from cost allocation does not seem sufficiently large to rule out a longer time period. A longer period could bring benefits overall by increasing the accuracy of the estimated coefficients on explanatory variables.

224. Ofwat's view was that simply increasing the length of the data set may not improve the robustness of the model estimates due to limited variation in some of the explanatory variables. We did not consider this to be strong point. Even if explanatory variables do not vary over time, the level of expenditure may do and a longer time period may reduce risks that the results are affected by short-term non-causal correlations between expenditure and explanatory variables.

Pre-modelling adjustments as alternative to statistical estimation

225. Where we identify differences between companies' operating environment and circumstances, besides relative efficiency, that are likely to affect their costs, we can seek to take account of them through the benchmarking analysis. One way to do so is to include an explanatory variable in the econometric model that captures these differences and allows the econometric model to make an estimate of the extent to which that factor affects costs. This is the approach that Ofwat and CEPA took to the modelling.

226. There is an alternative approach which is to make a non-econometric adjustment to the cost data to take account of that factor before running the econometric analysis (eg to normalise the cost data for assumed regional wage differentials between companies) and then to apply a corresponding adjustment for that factor to the cost estimates for each company (eg to re-introduce the assumed regional wage differences). This second approach

requires an assumption on the extent to which the factor (eg regional wage differences) affects costs.

227. Where the sample size is small, there are significant risks that an econometric estimate of the extent to which a factor affects costs will be inaccurate, or that correlations between that factor and other parts of the model will be detrimental to the overall assessment. The pre-modelling adjustment approach may be an improvement in cases where we can form a reasonable view on the extent to which a factor affects costs, outside of the model.

228. This approach has previously been used to make adjustments to costs for differences in regional wage rates, drawing on regional wage data and estimates of the proportion of costs that is likely to reflect regional wage differences. This is the approach that Ofgem has taken in its price control cost assessment for electricity distribution companies, most recently for RIIO-ED1.[42] The CC also adopted this approach in its final determination for Northern Ireland Electricity Limited in 2014.

229. Besides wages, another area where pre-modelling adjustments might have a role, rather than econometric estimation, as a means to account for differences between companies is for differences in service levels. Differences in elements of the quality of service provided by companies may affect their costs, but the scale of effect on costs may be quite small as a proportion of totex and it may be difficult for the econometric models to make an accurate estimate of the relationship. It may be possible to use other data sources and information to make adjustments to 'normalise' costs of companies on aspects of service quality before the econometric modelling.

230. Ofwat's approach to cost assessment did not seem to consider alternative methods that involved this type of pre-modelling adjustment or to provide an evaluation of its relative merits in the context of the small sample size.

231. Ofwat told us that it did not believe that Ofgem's approach of making pre-modelling adjustments for wages offered clear benefits over Ofwat's econometric treatment of wages and Ofwat believed that Ofgem's approach was driven by the smaller sample size (number of companies) available to Ofgem.

232. Bristol Water said that it considered it preferable to use pre-modelling adjustments to adjust for factors such as regional wages, because there was a risk that the regional wage term was correlated with other variables in some

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[42] Ofgem (28 November 2014), *RIIO-ED1: Final determinations for the slow-track electricity distribution companies*, p41.

of the models and therefore capturing more than the regional wage impact. Bristol Water said that that using a pre-modelling adjustment would address this issue.

233. Overall, we consider that pre-modelling adjustments provide a potentially useful alternative to econometric estimation.

Supporting information on alternative econometric models

Introduction

1. This appendix considers the specification of alternative top-down econometric models for the purposes of our cost assessment for Bristol Water. We sought to identify possible alternative models that could help mitigate some of the limitations of Ofwat's econometric models.

2. Our development of alternative models focused on models of base expenditure. We did not seek to identify alternative models of totex, which included enhancement expenditure, because we were particularly concerned about the difficulties of capturing differences in companies' enhancement requirements in the models.

3. This appendix is organised as follows:

   (a) The first section concerns the specification of the dependent variable, which is the measure of expenditure that the model compares across companies and over time.

   (b) The second section concerns the specification of the explanatory variables in the model. For our development of alternative models, we took the explanatory variables used by Ofwat as a starting point, reflecting the extensive work done by Ofwat and its consultant CEPA and the data readily available for the purposes of our inquiry, and reviewed the use of these variables. We also consider alternative explanatory variables that feature in the models that Bristol Water's consultant Oxera developed, and consider the implications of these for our specification of alternative models.

   (c) The third section concerns the model estimation approach and, in particular, the choice between the pooled OLS and GLS random effects approaches used for Ofwat's models, as well as the potential use of stochastic frontier analysis (SFA) proposed by Bristol Water.

   (d) The final section presents model estimation results for the 18 models presented in Section 4 of our provisional findings.

Specification of the dependent variable

4. This section considers the specification of the dependent variable. We take three aspects of this specification in turn:

(a) Aggregate expenditure versus average expenditure per customer.

(b) Smoothed versus unsmoothed treatment of capex.

(c) Logarithmic versus non-logarithmic expenditure measures.

Aggregate expenditure versus average expenditure per customer

5. Ofwat's econometric models use measures of totex and aggregate base expenditure as the dependent variables.

6. As an alternative, we have explored models which make comparisons between companies of measures of expenditure per customer. More specifically, we have used a measure of expenditure per connected property as the dependent variable in the econometric model.

7. Arguably, making benchmarking comparisons between companies in measures of expenditure per property supplied seems more natural than comparing measures of companies' totex. This is particularly important given the scale of variation between companies in Ofwat's sample. Over the period of Ofwat's data, the companies range from serving around 120,000 properties (Dee Valley) to serving around 3.6 million properties (Thames).

8. Using expenditure per connected property as the dependent variable also brings three benefits:

(a) There are correlations between many of the variables that we would consider cost drivers for totex (eg total length of mains, number of customers, total water delivered). These correlations reflect underlying differences between companies in the scale of their activities and services. Such correlations may make it difficult for the econometric estimation to produce reasonable estimates of the relationship between an explanatory variable and costs, because it will be difficult to isolate the effect of that factor on costs from the effect of other correlated factors. By expressing the dependent variable as expenditure per property, we can normalise both the left hand side and the right hand side of the regression equation for a measure of companies' scale and thereby define explanatory variables that are less likely to be correlated with each other.

(b) Making comparisons of expenditure per connected property allows for an intuitive understanding of the economics of the model, including the implied relationships between the explanatory variables and costs. We found it difficult to interpret Ofwat's models, which combined a dependent variable of totex with a series of explanatory variables, some of which

were based on aggregate figures (eg total length of mains) and some of which were proportions or ratios.

(c) Our unit cost models can help to reduce problems relating to the small size of the data sample (and limited variation over time for some variables). A unit cost model of the type we have used requires one less explanatory variable than aggregate expenditure models used by Ofwat.

9. The first two issues are, to some degree, related. We identify below that for a number of potential cost drivers, a linear or non-logarithmic relationship with expenditure seems more reasonable from an intuitive or theoretical perspective than a logarithmic relationship. The expenditure per connected property model structure that we use provides a way to specify models with linear relationships between cost drivers and expenditure (provided both the dependent variable and explanatory variable are normalised in a consistent way). Whilst it would be possible to specify a linear model with aggregate expenditure (rather than expenditure per customer) as the dependent variable, the explanatory variables that would be needed for such a model are likely to suffer from multi-collinearity.

10. One possible objection to specification of expenditure per customer as the dependent variable is that it might imply an assumption that there are constant returns to scale in the relationship between expenditure and the number of customers. However using cost per customer as the dependent variable does not, by itself, mean that the model must preclude allowances for economies of scale. The assumptions of the model specification in relation to economies of scale with respect to the number of customers depend on both the dependent variable and the explanatory variables. It would be possible to allow for economies of scale in a unit cost model by adding an additional explanatory variable to the model that relates to the number of connected properties. For instance, the additional explanatory variable might be the number of connected properties or perhaps the inverse of this. In each case, this would allow the model estimation to identify potential relationships between the number of connected properties a company has and its average expenditure per connected property.

11. Nonetheless, we did not include an explanatory variable for economies of scale in our unit cost models. We did not identify a good reason why a greater number of connected properties should, on its own, materially decrease expenditure requirements per connected property.

12. We recognise, instead, that having more customers located within a network of a given size (length) or geographic area may help to reduce costs per

customer. We allow for this by using an explanatory variable of length of network divided by connected properties.

13. Furthermore, even if there was some degree of economies of scale, there is still an argument in favour of unit cost models in that these require one less explanatory variable and, in a small sample size, may allow other more important cost drivers to be captured in the model.

14. Whilst we see value in unit cost models that compare measures of expenditure per property supplied between companies, we did not restrict our analysis to these unit cost models. We also used models that compare aggregate expenditure between companies, which is in line with the approach taken by Ofwat.

Smoothed versus unsmoothed treatment of capital expenditure

15. Ofwat’s models specify the dependent variable, for each year, as a measure of opex plus a measure of capex that is an average of capex over a five-year period: that year and the previous four years. Ofwat described this approach as smoothed capex. This can also be described as a moving average treatment of capex.

16. Variations in capex between companies, and over time, are driven, in part, by differences in the timing of companies’ investment requirements and may also be significantly affected by companies’ strategic decisions within the context of a five-year price control period. Such variations over time and between companies may distort the estimated relationship between expenditure and the explanatory variables in the model. In this context there are also risks of drawing misleading inferences about efficiency differences between companies at a point in time from benchmarking analysis of totex.

17. The approach of using average capex over a five-year period might reduce these problems by averaging out fluctuations over a five-year period. In particular, if there tends to be a five-year cycle in investment due to the price control period, the approach would reduce (or remove) the effect of the cycle on the dependent variable. However, the approach seems unlikely to eliminate the more general problem that companies’ capex will show variations due to differences in their investment needs at a given point in time: a five-year average appears to be too short to address this concern.

18. The smoothed approach also has other effects:

(a) It reduces the time period of the sample. If the measure of totex is defined to include capex from the past five years, then a nine year period of raw data will only allow for a five year period of data to use for estimation of

the econometric model. Using a smaller sample period might lose useful information that could otherwise help improve the reliability of estimated relationships between expenditure and the explanatory variables.

(b) It introduces inconsistency between the period of time covered by the dependent variable and the period of time covered by the explanatory variables. For instance, the observation in the data set for a particular company in 2009/10 will reflect that company's expenditure over the period 2005/06 to 2009/10 but the explanatory variable data (eg average consumption per property or the regional wage measure) will apply only to 2009/10. This inconsistency could distort model estimation results and makes the interpretation of coefficients more difficult.

(c) It is not entirely consistent with the objective of carrying out benchmarking analysis on the basis of totex. The dependent variable for Ofwat's models is not, strictly speaking, a measure of a company's totex in a year, but rather a measure of the company's opex in the year plus average capex over the past five years. This introduces a different treatment of opex and capex into the benchmarking analysis, which may cause distortions to results.

19. For this reason, we explored two types of models:

(a) Following Ofwat's approach, using capex averaged over five years (the smoothed approach).

(b) Models that use the sum of opex and capex in a year for the expenditure measure, without averaging, and which make use of the longer period of available data for estimation.

20. The main data set that Ofwat provided to us used seven years of data, from 2006/07 to 2012/13. That data set is consistent with that which Ofwat used for its econometric analysis, and has undergone some quality assurance processes by Ofwat. We used this seven-year data set for the unsmoothed approach under (b) above. Whilst we could see benefits in exploring a longer data period than seven years, neither Ofwat nor Bristol Water provided a comprehensive data set that could be used directly for our analysis.

21. Bristol Water said that it considered the unsmoothed approach superior to Ofwat's smoothed approach. It agreed that the unsmoothed approach has disadvantages in terms of: (a) reducing the time period for the assessment; (b) introducing an inconsistency between the time period of the dependent variable and the time period of the explanatory variable; and (c) giving rise to distortions in the results between opex and capex. Bristol Water highlighted that, whilst the unsmoothed approach has limitations, the smoothed approach

suffers because the cost driver information in a particular year will not relate in a meaningful way to the capital maintenance expenditure over the previous five-year period.

22. We had initially considered both a five-year and seven-year versions of the unsmoothed approach, and shared the results of some initial models on this basis with Bristol Water and Ofwat. Bristol Water argued in favour of the five-year unsmoothed approach. It said that for the purpose of providing an accurate assessment of its future expenditure needs it is important that the models are not influenced by the unrepresentative AMP4 period and that given the trend in investment expenditure between AMP4 and AMP5 there is a real risk that the results for Bristol Water would be distorted under both the smoothed approach and the seven-year unsmoothed approach.

23. In the initial analysis we had carried out the results had been similar between the seven-year and five-year unsmoothed models, with an average difference of around 1% (the five-year smoothed model being higher) across two sets of comparable model specifications. Given the scale of this difference, and to keep the number of models under consideration manageable, we did not proceed with both versions of the unsmoothed model. We saw merit in the longer sample period of the seven-year version. We did not agree with Bristol Water's arguments that we should use the five-year unsmoothed models. Bristol Water did not explain why we should give more weight to the more recent data, across the industry, for AMP5 than the data from AMP4. Bristol Water considered that the AMP4 data was unrepresentative but did not explain why this was so.

Logarithmic versus non-logarithmic expenditure measures

24. A further decision on the dependent variable to take is whether or not to specify the dependent variable as a natural logarithm of the expenditure measure.

25. CEPA said that a model specification in which both costs and explanatory variables are expressed as a natural logarithm 'is deemed superior to a linear model in the cost modelling literature as it does not require marginal costs to be constant as in the linear model'.[1] Ofwat also argued in favour of models that use natural logarithms for the dependent variable, stating that the use of log-transformed equations in efficiency studies is the norm rather than the exception and that any deviation from this norm should be well justified.[2]

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[1] CEPA (March 2014), *Cost assessment – advanced econometric model*, pi.
[2] Ofwat response to alternative models put-back paper.

26. We recognise that there can be good reasons for a logarithmic specification. However, the application of cost modelling to the price controls for water and sewerage companies in England and Wales, and the specific types of explanatory variables used, seem sufficiently different to cost modelling in other economic literature that we did not consider it safe to rely on general inferences and views about normal practice.

27. In its model development for Ofwat, CEPA seems to have addressed the question of log versus linear models by focusing on the restrictive assumption of a linear model: that marginal costs (the impact on costs of a small change in the cost driver) are taken to be constant across companies. CEPA seemed showed limited attention to the restrictive assumption involved in the type of logarithmic models favoured by CEPA and Ofwat.

28. A model in which the dependent variable is expressed as the logarithm of expenditure implies that each cost driver has a proportionate effect on expenditure. In some cases, this assumption makes sense. However, this assumption may be problematic in other cases, especially for the type of totex model that Ofwat used. For example:

(a) Ofwat's models cover the whole wholesale water service, yet a number of the cost drivers used by Ofwat relate only to costs in a specific activity or part of the value chain. The logarithmic models used by Ofwat imply that each cost driver has a proportionate effect on totex. This creates problems. For instance, differences between companies in pumping head are assumed in Ofwat's full totex model to have a proportionate effect on costs (ie a 1% greater pumping head would increase totex by X%, where X is taken to be the same across companies and over time). However, the relationship between pumping costs (both energy costs and capital maintenance of pumping stations) seem unlikely to be proportionate to totex. Pumping head will affect only part of the treated water distribution costs, which is only part of totex. If a company has higher totex because it requires relatively complex water treatment processes, we would not expect this to affect the relationship between average pumping head and its pumping costs. There seems no reason why the impact on totex (in £ million) of an increase in pumping head would be proportionate to totex.

(b) For some of the cost drivers, the relationship with costs seems poorly approximated by a logarithmic relationship and a linear approximation makes more sense. For instance, if we had a model with the logarithm of water resource and treatment costs as the dependent variable (to avoid problem (a) above), which included the logarithm of the proportion of water from rivers as an explanatory variable (as Ofwat's models use), this would imply that the impact of a given increase in water from rivers, in

Ml/day, would be proportionate to the company's total resource and treatment costs. A positive coefficient would imply that the impact on costs, in £m, of taking an additional 5 Ml/day of water from rivers would be greater for a company that is taking a lot of water from other sources (and hence the proportion of water abstracted from rivers is low) than for a company that takes little water from other sources (and hence the proportion of water abstracted from rivers is high). Thus, the unit cost (£ per cubic metre) of abstracting more water from rivers is contingent on how much water the company takes from sources other than rivers. We have not identified a good basis for assuming such inter-dependencies in the model specification. A better approximation, which is available from a linear unit cost model, is that water from river sources has, on average across the industry, an additional cost of X pence per cubic metre than water from other (eg borehole) sources.

29. It is possible that the translog functional form favoured by Ofwat could, in some circumstances, mitigate the issues above to some degree by taking greater account of interactions between different cost drivers in explaining cost differences between companies. However, if this were the case, the problem would remain unresolved for almost all of the cost drivers used by Ofwat. This is because Ofwat's models only applied its translog functional form to a subset of three cost drivers. More generally, we doubt that with a small sample size the estimation of coefficients on any translog terms will be sufficiently accurate to mitigate the issues above.

30. The choice of functional form of the model is not a choice between a functional form that involves a restrictive assumption on the relationship between costs and cost drivers and one that does not. The choice is between alternative functional forms that each involve different restrictive assumptions on these relationships. From this perspective, there is sense in considering which is the least bad restrictive assumption:

(a) **Non-logarithmic unit cost**. The restrictive assumption that the impact on totex (per property), from a given change in the cost driver, is the same in £ across all companies and over time (holding other cost drivers constant).

(b) **Logarithmic unit costs**. The restrictive assumption that the impact on totex (per property), from a given change in the cost driver, is the same as a percentage of totex (per property), across companies and over time.

31. We have considered the balance between (a) and (b) for a set of cost drivers we have identified for inclusion in our alternative set of models. Table 1 below presents our high-level assessment. Since both types of assumptions will be

gross simplifications of the underlying factors that affect costs, it is difficult to make this assessment and it should be treated with caution (we add a question mark to denote areas that we were particularly uncertain about). Nonetheless, we found this to be a useful exercise, which raised questions about the logarithmic specification when applied to totex and base expenditure models.

Table 1: High-level assessment of functional form for dependent variable

Potential cost driver	*Assumption of non-logarithmic unit cost least bad*	*Assumption of logarithmic unit cost least bad*
Proportion of raw water from rivers	✓	
Proportion of raw water from reservoirs	✓	
Proportion of raw water subject to W3/W4 treatment	✓	
Regional wage measure (or proportionate change in wage measure)		✓
Average pumping head	✓	
Total length of mains divided by total properties supplied	✓ **(?)**	
Average water delivered per property	✓	
Proportion of consumption by metered non-household customers		✓ **(?)**

Source: CMA analysis.

32. The implication from the table above is that, at least for a model in which the dependent variable is expenditure per connected property, the non-logarithmic specification of the dependent variable seems preferable for a number of cost drivers.

33. In the light of thus, we have taken the following approach:

(a) We have estimated models that follow Ofwat's approach of specifying the dependent variable as a logarithm of expenditure.

(b) We have also estimated linear models that use expenditure per property as the dependent variable, without conversion to logs.

34. Neither is entirely satisfactory: it seems that some cost drivers would call for approach *(a)* and others would call for approach *(b)*. It may be possible to develop an alternative approach that addresses this issue through a more complex two-step estimation strategy, but this was not a priority for our model development.

35. For the purposes of our alternative model development, we have considered both functional forms (both of which seem imperfect).

36. This approach has implications for the way that explanatory variables are specified. Because we use logarithmic and non-logarithmic models, we specify the explanatory variables slightly differently for each type. If the dependent variable is expressed as a logarithm, this may fit better with an explanatory variable that is also in the form of a logarithm. However, this is not always so. We consider a case-by-case review appropriate for each explanatory variable.

37. Note that if the dependent variable is an aggregate expenditure measure, rather than a unit cost measure, it does not make sense to use the non-logarithmic model. We use only the logarithmic approach to the dependent variable for our aggregate expenditure models.

38. Finally, and importantly, we did not consider that we should make the decision on which functional form to use based on statistical results alone. We disagreed with the approach of Ofwat and CEPA on this issue. CEPA stated that with respect to the functional form of model, 'the choice is about how good a fit the form provides'.[3]

39. We consider goodness of fit relevant, particularly where we cannot find an economic basis to prefer one model structure to another. However, we did not agree that the choice of functional form can be reduced to goodness of fit alone. There is no reason to believe that the functional form that provides the best fit of the data in statistical terms is necessarily the most reliable model for the purpose of estimating companies' future (efficient) expenditure requirements or comparing the relative efficiency of companies in the past. Such a model might do well at attributing variations in costs between companies and over time to the explanatory variables in the model, but that does not mean that the estimated coefficients are the most accurate or reliable estimates of the causal relationships between cost drivers and companies' efficient expenditure requirements. This is particularly so in a small data sample which shows limited variation over time in some explanatory variables.

Specification of explanatory variables

40. This section considers the explanatory variables that can be included in the model specification. It takes the following in turn:

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[3] CEPA (March 2014), *Cost assessment – advanced econometric model*, p7.

(a) Use of Ofwat's explanatory variables as a starting point.

(b) Assessment of explanatory variables that did not seem likely to contribute positively.

(c) Refinement of explanatory variables to better reflect cost drivers.

(d) Discussion of each of Ofwat's explanatory variables.

(e) Bristol Water's alternative explanatory variables.

(f) Measures of correlation across the explanatory variables that we used.

Use of Ofwat's explanatory variables as a starting point

41. We have taken Ofwat's econometric models as a starting point for specification of explanatory variables for our alternative models. This reflected the extensive work done by CEPA and Ofwat and the data readily available for the purposes our inquiry.

42. We have reviewed Ofwat's explanatory variables, with emphasis on two issues:

(a) Whether the explanatory variable featured a cost driver that was likely to contribute positively to the model estimation, in the context of a small sample size.

(b) Whether the way that the explanatory variable incorporated this cost driver was appropriate (eg whether the cost driver was expressed in absolute terms or as a proportion and whether it was in logs). In considering this second issue, it was relevant that in some cases our dependent variable is a measure of expenditure per customer, which differed from Ofwat's dependent variable.

43. We discuss these two issues below, before presenting our treatment of the various explanatory variables used by Ofwat.

Explanatory variables that did not seem likely to contribute positively

44. We were concerned that the inclusion of some potential explanatory variables used by Ofwat could worsen the reliability or accuracy of the model, and excluded them on this basis. For example, we excluded explanatory variables where we had concerns that CEPA's reports for Ofwat did not provide a good explanation of the economic (rather than statistical) case for including them (where it was not otherwise obvious), and also where we had concerns that

the factor would be misleading for our intended purposes because of an ambiguous relationship with costs.

45. In an ideal world, with a large data set, it might be possible to include a large number of potential – or experimental – cost drivers as explanatory variables and take the view that if the cost driver is important it will show up in the estimated results. We did not consider this safe for our analysis.

46. With a small sample, every additional explanatory variable we add raises a new risk of spurious correlation(s) in the estimation results and thereby worsening the accuracy of the cost estimates based on those results. To justify including an explanatory variable, we decided that we should have grounds to believe that it will benefit the overall analysis.

47. To take an extreme example, if there was a variable that we knew affected companies' costs but that had a maximum impact of 0.1% of totex, it would add no material benefit to estimation results. But if the variable happened, by chance, to be strongly correlated with companies' relative efficiency – or with the other explanatory variables – it could worsen the accuracy of the model estimation results overall.

48. There are serious risks of spurious results in seeking to estimate coefficients for a model with a large number of explanatory variables relative to the sample size. We thought that these risks would be compounded by the limited variation over time in some potential explanatory variables. We considered the counter-intuitive estimation results from Ofwat's full totex model to be indicative of these risks.

49. We considered it preferable to use a smaller set of explanatory variables, which captured what seemed to be the most important cost drivers available from the data set.

50. In addition, we were concerned that some cost drivers would have an ambiguous effect on costs, which reflects in part the endogeneity in the explanatory variables. For instance, a measure of low quality service might be indicative of relatively low expenditure (lower costs are incurred in providing a lower quality service) or indicative of relatively high expenditure (higher expenditure is needed to address problems with service quality). In the absence of a way to disentangle these opposing effects, we were concerned that any coefficient estimated for that explanatory variable would not make a reliable contribution to the estimation of a particular company's future efficient expenditure requirements.

51. As part of our work, we asked Bristol Water which (if any) of the explanatory variables from Ofwat's econometric models it considered – from an economic,

engineering or business perspective – to be immaterial to differences in base expenditure between companies. We defined 1% of base expenditure as the materiality threshold. Bristol Water's response took each of the explanatory variables in Ofwat's models in turn, and considered both whether these were appropriate and whether they were material. Bristol Water identified the following subset of the variables used by Ofwat as both appropriate and material (we leave aside variables that are only relevant to models including enhancement expenditure):

(a) Length of mains.

(b) Regional wage.

(c) The number of connected properties.

(d) Proportion of usage by metered non-household properties.

(e) Pumping head.

52. In many cases, Bristol Water's views were consistent with our own initial view of Ofwat's explanatory variables, but this was not always the case and we avoided placing undue reliance on Bristol Water's submissions.

Refinement of explanatory variables to better reflect cost drivers

53. We also reviewed the way that Ofwat's models incorporated potential cost drivers into the specification of explanatory variables.

54. We found that these models imposed assumptions on the relationship between expenditure and cost drivers that did not seem to make sense. See the discussion on the assumed relationship between expenditure and the cost drivers in our review of Ofwat's models in Appendix 4.1.

55. As an example, we considered that the proportion of raw water from river sources was a relevant cost driver to consider. But, on further analysis, it did not seem reasonable to incorporate this cost driver in any of our models by including an explanatory variable defined as the natural logarithm of the proportion of raw water from river sources.

Discussion of each of Ofwat's explanatory variables

56. The sub-sections below take each of the explanatory variables used by Ofwat and summarise whether and how we have used these in our alternative models.

57. For each explanatory variable, there is a question of whether it should be expressed as a logarithm or not. This depends in part on whether the dependent variable is expressed as a logarithm, but it is not always appropriate to specify the explanatory variable as a logarithm just because the dependent variable is a logarithm. This may be the case, for example, where the explanatory variable is a proportion. We identify a few issues such as this below.

Ofwat variable: ln (total length of mains)

58. For the aggregate expenditure models, we include the natural logarithm of the total length of mains as an explanatory variable, following Ofwat's approach.

59. For models that use cost per connected property as the dependent variable it makes sense to include length of mains divided by number of connected properties as an explanatory variable.

Ofwat variable: ln (number of connected properties / length of main)

60. For the aggregate expenditure models, we include the natural logarithm of the total number of connected properties divided by the total length of mains as an explanatory variable, following Ofwat's approach.

61. This variable is the inverse of the total length of mains divided by number of connected properties, which is included as above. For the unit cost models, there does not seem a case for including this as a variable in our models in addition to the length of mains divided by number of connected properties; they capture the same thing.

Ofwat variable: ln (potable water delivered / number of connected properties)

62. Potable water delivered divided by number of connected properties is a measure of average water consumption per property and seemed a potentially important cost driver. We included this cost driver in our models.

Ofwat translog variables:

63. The following variables were included in Ofwat's models for the purposes of its translog specification:

   (a) [ln (total length of mains (km)]^2.

   (b) [ln(number of connected properties/length of main (properties/km)]^2.

   (c) [Ln(potable water delivered/number of connected properties)]^2.

(d) ln (total length of mains) * ln (number of connected properties / length of main).

(e) ln (total length of mains) * ln (potable water delivered / number of connected properties).

(f) ln (number of connected properties / length of main) * ln (potable water delivered / number of connected properties).

64. These variables are not included in our set of alternative models which focus on a simpler model structure.

Ofwat variable: time trend

65. We considered that a series of time dummy variables for each year (time dummies) would be better, especially over a short sample period.

66. There may be year-to-year fluctuations in costs across the industry, associated with the price control periods or input price movements, which do not fit well with an upward or downward time trend and which may be better accommodated through a model specification using time dummies. However, we did carry out sensitivity analysis for the alternative approach of using a time trend.

Ofwat variable: ln (average regional wage)

67. We included this as a potentially important explanatory variable.

68. We identified possible concerns about the regional wage data used as an input to the econometric model. For instance, the wage measure for Bristol Water is a measure covering a large part of the South West of England, which may not be representative of Bristol Water's area.

Ofwat candidate variable: ln (regional construction price index)

69. We recognise the problems Ofwat faced due to correlations between this variable and the regional wage measure, which led to its exclusion from Ofwat's models. We did not include it in our alternative models. We thought that there might be ways to incorporate this variable whilst limiting the risks from multi-collinearity (eg by taking the ratio of the construction index to the wage measure) but we did not consider this to be a priority for our modelling.

Ofwat variable: ln (population supplied / number of connected properties)

70. We have not included this variable in our alternative models.

71. We did not identify an economic or engineering basis for this variable being included, in addition to average water delivered per connected property.

72. CEPA stated that this variable 'Approximates average consumer size (domestic vs. I&C) and can be used to take some of the variation away from usage'.[4] We did not understand this statement. This variable seems to take no account of the level of consumption by non-household customers so we did not identify how it could approximate average customer size. The alternative measure of average water delivered per connected property seems a better measure of average customers size.

Ofwat variable: ln (proportion of properties that are metered)

73. We have not included this variable in our alternative models.

74. Wholesale costs exclude meter reading. There will be some incremental wholesale base expenditure costs associated with metered customers, as meters will require replacement from time to time (or perhaps repair). We would expect these costs to be a relatively small element of (wholesale) base expenditure. These did not seem material for inclusion in the models. Bristol Water told us that, for a 20% difference in meter penetration between companies, it would expect the costs to periodically replace meters, and maintain the meter space, to account for less than a 0.5% difference in base costs between companies.

75. The number of metered customers is positively correlated with consumption per property and presents risks of spurious correlations if the former is an important cost driver.

Ofwat variable: ln (potable water delivered to billed metered households / total potable water delivered)

76. We have not included this variable in our analysis. The two CEPA reports for Ofwat did not seem to provide an explanation for including this variable, which is highly correlated with the proportion of properties that are metered.

77. We did not identify a reason to include this variable, for similar reasons as above for the explanatory variable based on the proportion of properties that are metered.

[4] CEPA (January 2013), Cost assessment, p11.

Ofwat variable: ln (potable water delivered to billed metered non-households / total potable water delivered)

78. We included this variable in our analysis as a potentially relevant explanatory variable to consider, particularly when used in a model that also includes the average consumption per property as the dependent variable.

79. Bristol Water told us that it considered this variable to be an appropriate and material cost driver. It explained that:

> Larger non-household customers tend to be supplied from larger mains and therefore avoid costs associated with the smaller diameter mains that make up the majority of the network. These lower costs are reflected in lower tariffs. Consequently, a higher proportion of water delivered to non-household customers would be expected to reduce costs.

80. It is also possible that a greater usage from non-households would lead to less peaky water consumption patterns across the year, which would tend to reduce costs.

81. We included this variable in some of our alternative models.

Ofwat variable: ln (total number of sources / total water input to distribution system)

82. We have not included this variable in our alternative models.

83. CEPA stated that 'It is a safe assumption that there are economies of scale in the resource and raw water distribution part of the business',[5] but did not provide any information to back up this view.

84. Without any explanation, we are unsure why there should necessarily be a strong relationship between the size of water resources and costs.

85. Even if there were economies of scale in relation to the average size of a company's water sources, it is problematic to include this variable. There is a negative correlation between average size of a company's water source and the proportion of its water from other sources (besides rivers and reservoirs) such as boreholes, which may tend to be significantly lower-cost than river and reservoir sources. Companies that take a relatively large proportion of their water from other sources tend to have a relatively small size of each source.

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[5] CEPA (March 2014), *Cost assessment – advanced econometric model*, p46.

86. The results from Ofwat’s full totex model showed a negative coefficient for this explanatory variable, which implied that producing a given amount of input from a greater number of sources reduced costs. This result runs counter to the theory of economies of scale that CEPA had identified as a safe assumption. It could be explained by the correlation between the number of sources and the usage of water from boreholes, in a context where borehole sources tend to be cheaper than reservoirs and rivers.

87. With a large enough sample of companies and years, it might be possible to disentangle the effects above. However, for our analysis, we did not include this variable, given the absence of a good explanation from CEPA’s reports of the economies of scale argument for including the variable in the first place, and the risks to estimation results from correlations between the number of sources and the proportion of water from boreholes.

*Ofwat variable: ln (average pumping head * total water input to distribution system)*

88. We included average pumping head as a potentially important cost driver.

89. To limit risks of multi-collinearity, we used average pumping head rather than average pumping head multiplied by total water input to distribution system.

90. We considered average pumping head multiplied by distribution input per property for the non-logarithmic unit cost model (since greater consumption per customer would tend to increase pumping costs).

Ofwat variable: ln (proportion of water input from river abstractions)

91. We included a measure of the amount or proportion of water input from river abstractions as a potentially important cost driver.

92. We did not consider it sensible to take the logarithm of this proportion for the specification of the explanatory variable, even if our dependent variable is the logarithm of an expenditure measure. Doing so would assume that a 10% increase in the proportion would lead to an X% increase in costs. This would imply, for example, that the effect on a company’s costs of moving from 5% to 10% river water abstraction (a 100% increase in the proportion) would be the same in £ million as if the company moved from 40% to 80% river water abstraction (similarly, a 100% increase in the proportion).

93. For the logarithmic unit cost models and the logarithmic aggregate cost models, we considered that a more reasonable approximation was to use the proportion of water from rivers without taking a logarithm. This would imply that a change in the proportion of water from rivers from 5% to 10% would

have the same proportionate effect on base expenditure as a change in the proportion of water from rivers from 10% to 15%, or similarly from 75% to 80%.

94. For the linear unit cost model, we did not use the proportion of water from rivers. Instead, we used a measure of the volume of water produced from river raw water sources divided by the number of properties supplied. This alternative variable can be calculated as the proportion of water from river sources multiplied by distribution input per property. For the linear unit cost model, we considered this alternative variable more appropriate than the variable expressed as a proportion, since the total incremental costs of river water abstraction will depend not only on differences between companies in the proportion of river water used but also on the amount used.

95. We recognised that it might be possible to also use this alternative variable for the logarithmic unit cost models and the logarithmic aggregate cost models, but for our development of these logarithmic models we had started from the type of variables used by Ofwat and the case for an alternative variable was less strong for these models.

Ofwat variable: ln (proportion of water input from reservoirs)

96. We considered that the amount or proportion of water input from reservoir abstraction was a potentially important cost driver. See comments for river abstraction above for discussion of how we specified explanatory variables to incorporate this type of cost driver into the models.

Ofwat variable: ln (number of new meters installed in year as a proportion of metered customers)

97. The number of new meters is a potentially relevant cost driver for enhancement expenditure. Our alternative models focused on base expenditure so we did not include this variable.

Ofwat variable: ln (length of new mains laid in year / total length of mains at year end)

98. The length of new mains is a potentially relevant cost driver for enhancement expenditure. Our alternative models focused on base expenditure so we did not include this variable.

Ofwat variable: ln (length of mains relined and mains renewed / total length of mains at year end)

99. We considered the length of mains relined and mains renewed as a potentially relevant cost driver but have not included it in our alternative models. A top-down econometric model that seeks to explain totex by reference to the volume of investment that a company has chosen to carry out carries risks of misinterpreting efficiency differences between companies that reflect asset management choices about how much mains to renew. Furthermore, the length of mains renewed seems a narrow aspect of capital maintenance to focus on.

Ofwat variable: ln (number of properties below reference pressure level/total properties connected)

100. We did not include this variable.

101. CEPA explained this variable as follows: 'Quality measure: the lower the proportion of properties with inadequate water pressure, the higher the costs because companies have spent or are spending money to improve quality but relationship is unclear in the models.'[6]

102. A major concern with this variable is that it has an ambiguous relationship with costs:

   (a) A company that performs relatively well on this quality measure will, all else equal, have higher costs than a company that performs relatively badly, since it will (all else equal) cost more to provide a higher quality service.

   (b) A company that performs relatively badly on this quality measure at a given point in time may have higher costs because it needs to take action (including investment) to address the quality problem.

103. These two effects are distinct. Including this variable in the regression analysis will, at best, produce a coefficient that reflects which of these two forces dominates across the industry on average over the sample period (at worst the estimated coefficient will simply be spurious due to the small sample size).

104. Furthermore, differences between companies in their performance against this quality measure may reflect wider differences between companies in the

[6] CEPA (March 2014), *Cost assessment – advanced econometric model*, p46.

quality of management which also affect relative efficiency. There is a risk that the model estimation would suffer from endogeneity problems between the level of expenditure and the level of quality.

105. Given these issues, it seemed safer to exclude this variable altogether than to include it in the econometric analysis.

106. If there were some way to distinguish between the two effects above (eg by disentangling costs due to changes in quality over time from costs due to the level of quality at a point in time) there may be a case for including this aspect of quality in the models. Ofwat's modelling approach did not provide such a method.

Ofwat variable: ln (volume of leakage / total water input to distribution system)

107. We did not include this variable.

108. Ofwat and CEPA treated leakage as a measure of quality of service.

109. The same concerns apply as above for the variable related to the number of properties below reference pressure level.

110. In addition, there is an argument that leakage is not itself a measure of quality or output of the water company, but rather a factor that reflects asset management decisions that companies face in providing a water service to customers (eg trade-offs between pipe replacement and maintenance to reduce leakage and the costs of abstracting and treating the water lost through leakage). The optimal level of leakage could vary substantially across companies.

111. Including leakage as an explanatory variable in a model might increase the extent to which the model 'explains' differences in costs between companies but may reduce the extent to which the model captures differences between companies in their efficiency of providing water services to customers. In particular, the model may predict higher levels of efficient costs for companies that have achieved lower levels of leakage, but this may overlook the possibility that maintaining lower levels of leakage may turn out to be more expensive overall for customers.

112. We were not persuaded of the need to adjust the estimate of a company's (efficient) expenditure requirements over the price control period according to whether its leakage is relatively high or low compared to other companies.

Ofwat variable: ln (number of properties affected by unplanned interruptions > 3 hrs / total properties connected)

113. We did not include this variable. The same concerns apply as above for the variable related to the number of properties below reference pressure level.

Ofwat variable: ln (number of properties affected by planned interruptions > 3 hrs / total properties connected)

114. We did not include this variable.

115. We had similar concerns as for other quality variables.

116. CEPA described this variable as follows: 'Service quality measure: the more interruptions, the lower the quality; thus if interruptions decrease, this might be associated with service enhancement and thus higher costs; planned interruptions however may be correlated with maintenance works and may result in positive sign'.[7]

117. We have not identified a way to disentangle the following effects:

(a) A company that has relatively few planned interruptions greater than 3 hours may have higher costs because it provides a better service (eg it may incur costs to make arrangements that restore supplies, or allow supplies to be continued, while work on the system is carried out).

(b) A company that carries out a relatively large amount of capex may have a high level of planned interruptions, to enable work on the system to be done.

118. The second effect means that there are risks that the econometric model suffers from endogeneity, seeking to explain expenditure by a variable that reflects a company's chosen level of expenditure. In turn, there are risks that companies with inefficiently high expenditure are perceived as efficient (and that efficient companies with low interruptions are perceived as inefficient).

119. CEPA's reports did not provide any evidence that the first effect above has a sufficiently material effect to warrant the risks from the second effect.

Bristol Water's additional explanatory variables

120. Our work on alternative models was based primarily on refinement of the explanatory variables used in Ofwat's models. In addition, Bristol Water

[7] CEPA (March 2014), *Cost assessment – advanced econometric model*, pp46–47.

provided analysis by its consultants Oxera. Oxera's model specifications included some additional explanatory variables that had not been used by Ofwat. We consider these in the sub-sections below.

Bristol Water variable: proportion of distribution input from W3 or W4 treatment works

121. We can see the logic for this explanatory variable, which is a measure of treatment complexity.

122. It is a potential complement or substitute for the explanatory variables relating to the proportion of raw water from rivers and reservoirs which may affect differences in companies' water resource and treatment costs.

123. Bristol Water argued that the proportion of raw water from rivers and reservoirs is not a good measure of treatment complexity and hence water treatment costs. It said that there is wide variability between different river sources, or between different reservoir sources, in the quality of raw water. It said that other variables that capture treatment works complexity more directly are likely to be better explanatory variables for differences in costs than the proportion from rivers.

124. Ofwat raised concerns about the treatment complexity data that Oxera used for this explanatory variable (it has not been updated recently and may be out of date).

125. The data on this variable provided to us by Bristol Water used companies' regulatory reporting up to 2008/09. There was no reported data from 2009/10 onwards. The Bristol Water data series for the W3/W4 variable involved an assumption that the proportion of water subject to the W3/W4 treatment processes was the same from 2009/10 onwards as it had been from 2008/09.

126. From the data provided by Bristol Water, we could see that the data for the W3/W4 variable tended to be similar over time, and where there were changes these were more often increases over time than decreases. The assumption that it was the same from 2009/10 onwards as it had been from 2008/09 made some sense. However, the data limitations mean that there are significant risks of inaccuracy.

127. We note that Ofwat used the results from models that included this variable in its special cost factor adjustment for Bristol Water's treatment complexity.

128. Overall, we considered the rationale for this variable sufficiently strong to contribute to the analysis, despite the concerns with the data, but did not think that this variable could be relied on exclusively.

Bristol Water variable: proportion of GMEAV of water distribution infrastructure in condition 4 or 5

129. We did not include this in our alternative models.

130. We could see some logic for an explanatory variable of this nature being included as a cost driver. A limitation of Ofwat's models of totex (and our alternative models) is that they do not allow for asset condition at the start of the period as a relevant driver of (capital) expenditure in that period.

131. However, the data Bristol Water used, and provided, for this variable was based on Ofwat data from 1997/98, which had not been updated. We would not expect differences in asset condition between companies to be stable over such a long period of time. We were concerned about the data for this variable being out of date and potentially unreliable.

Bristol Water variable: proportion of upstream assets by GMEAV

132. We did not include this variable in our alternative models. We did not understand the logic for a greater proportion of upstream assets by GMEAV leading to increased expenditure required. For instance, some upstream assets may have a high GMEAV, but have long asset lives and lower maintenance costs as a percentage of GMEAV than other assets. Also, a high proportion of upstream assets by GMEAV may be indicative of a company having a low-cost distribution system, rather than higher-than-average upstream costs. We were also concerned that the GMEAV data may be vulnerable to significant estimation error, especially for infrastructure assets.

Bristol Water variable: measure of average age of water mains

133. We considered the use of a measure of the average age of water mains as an explanatory variable in our alternative models, but ultimately decided against this approach. We discuss this matter in Section 4 of our provisional findings (paragraphs 4.132 to 4.138).

Measures of correlation across explanatory variables

134. Our modelling approach, given the relative small sample size of the data, has favoured more parsimonious model specifications to avoid problems associated to over fitting the model. In small samples, one of the implications of using many explanatory drivers is that it is more likely to find high (spurious) correlations between some of the explanatory variables.

135. We have taken further steps to reduce risks associated with multi-collinearity, including the use of unit cost models and specifying explanatory variables in a way that is likely to reduce correlations between variables (eg correlations to the influence of companies' scale on cost drivers).

136. As a further check, the Table 2 below presents the correlation coefficients between pairs of variables that have been used in our alternative models. It provides a guide to the degree of correlation between the explanatory variables which might cause problems in the inference and prediction performance of our models. The greater the correlation between variables, the closer the correlation coefficient will be one (in the case of positive correlations) or minus one (in the case of negative correlations). The variables shown in the table are either variables used directly in the models or variables which are used in the models after being expressed as a natural logarithm (for reasons of space the table does not show the logarithms as well).

Table 2: Correlation matrix

Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*
Mains length (1)	1.00													
Mains length per property (2)	0.05	1.00												
Average consumption per property (3)	(0.34)	(0.23)	1.00											
Number of customers divided by total length of mains (4)	(0.02)	(0.96)	0.28	1.00										
Regional wage measure (5)	(0.15)	(0.57)	0.40	0.63	1.00									
Proportion of distribution input from rivers (6)	(0.06)	(0.17)	0.35	0.20	(0.13)	1.00								
Proportion of distribution input from reservoirs (7)	0.47	0.47	(0.46)	(0.48)	(0.68)	(0.10)	1.00							
Volume of water abstracted from rivers per property (8)	(0.06)	(0.22)	0.53	0.27	(0.03)	0.97	(0.17)	1.00						
Volume of water abstracted from reservoirs per property (9)	0.47	0.48	(0.43)	(0.48)	(0.67)	(0.11)	1.00	(0.17)	1.00					
Average pumping head (10)	(0.18)	0.28	(0.17)	(0.31)	(0.01)	(0.27)	(0.02)	(0.28)	(0.02)	1.00				
Average pumping head multiplied by distribution input per property (11)	(0.21)	0.21	0.24	(0.21)	0.13	(0.11)	(0.14)	(0.04)	(0.13)	0.90	1.00			
Proportion of distribution input subject to W3 or W4 treatment (12)	0.25	(0.19)	(0.06)	0.14	(0.12)	0.62	0.27	0.55	0.26	0.10	0.08	1.00		
Total distribution input subject to W3 or W4 treatment divided by number of properties (13)	0.19	(0.29)	0.44	0.30	0.09	0.74	0.06	0.78	0.07	(0.05)	0.17	0.84	1.00	
Proportion of water consumption by metered non-household customers (14)	(0.14)	0.25	0.51	(0.27)	(0.34)	0.50	0.01	0.58	0.01	(0.23)	(0.00)	0.02	0.28	1.00

Source: CMA analysis.

Model estimation and assumptions on the error term

137. Ofwat's analysis used two different approaches to model estimation:

(a) The pooled ordinary least squares (OLS) technique.

(b) The use of the generalised least squares (GLS) technique to estimate a model with an assumed random effects error term.

138. In addition, Bristol Water has suggested the stochastic frontier analysis (SFA) approach used by its consultants, Oxera.

139. For our development of alternative models, we have focused on the pooled OLS technique. We explain why below.

Random effects models

140. We did not consider there to be a clear-cut case in favour of the GLS random effects approach, which is more complicated and for which model estimation (at least for estimated coefficients if not for estimated standard errors) requires more restrictive assumptions than the pooled OLS technique.

141. The results from Ofwat's models suggested that, for Bristol Water at least, the choice between OLS and GLS random effects had a small effect on the estimated efficient level of expenditure from the models. Whilst this result may not necessarily hold for all alternative models it suggested that this was not one of the most important aspects of model specification that we should prioritise for our development of alternative models.

142. One difference between the GLS random effects approach and pooled OLS is that the random effects model specification includes some allowance for correlations over time, for each company, in the element of expenditure that is not explained by the explanatory variables in the model. We recognised that such correlations may be significant and sought to allow for them under the OLS approach using the 'cluster robust' estimates of standard errors.

143. For our development of alternative models, which was a constrained exercise in the context of our inquiry, we considered it more important to examine other aspects of model specification than the choice between random effects and OLS models, and focused on the simpler OLS approach.

Stochastic frontier analysis

144. Oxera used a form of stochastic frontier analysis (SFA) for some of its econometric analysis for Bristol Water. This approach seeks to decompose the 'error' term in the model (ie the element of expenditure not explained by the explanatory variables) between *(a)* random noise (eg modelling and measurement error) and *(b)* inefficiency.

145. In order to achieve the decomposition between noise and inefficiency, the SFA model requires an assumption that the probability distribution (across companies) for the noise element is significantly different to the probability distribution (across companies) of the efficiency/inefficiency element. This is a major assumption of the SFA approach.

146. Oxera's SFA approach made an assumption that the probability distribution (across companies and over time) for the noise element is a normal distribution while the probability distribution (across companies) for inefficiency is a half-normal distribution. Bristol Water told us that Oxera's models were 'based on a half-normal form for inefficiency as it is a relatively simple distribution and one that is commonly employed in the literature'.

147. Bristol Water provided a note from its consultants, Oxera, which expanded on the assumption of the half-normal distribution for inefficiency:

> 'For the inefficiency component, the distribution has to be one-sided, by definition (ie, u ≥ 0 for a cost function model). This is because a company is either fully efficient (ie on the cost frontier) or it is inefficient, in which case the inefficiency term, u, is positive, so that the company's costs are higher, all other things being equal. Thus, u cannot be normal because the normal distribution cannot preclude negative values. To progress any further, a decision needs to be made with respect to what one-sided distribution to use for the inefficiency component.'

148. We did not consider there to be obvious *a priori* reasons for expecting a high proportion of companies to be operating just below the 'efficiency frontier', as assumed if the half normal distribution is adopted. For example, in the context of a regulated industry that targets (for example) upper quartile performance, it might be reasonable to expect that a few companies would be at the frontier, most companies would have a moderate level of inefficiency and a small number of companies would be more inefficient.

149. We note that Ofwat's consultant CEPA considered the theoretical assumptions for the probability distribution of inefficiency and noise that are required for SFA models and stated that these assumptions may be arbitrary.[8]

150. Bristol Water provided some analysis of the distribution of operating cost efficiency as assessed by Ofwat at PR04 and PR09. Bristol Water said that this appeared to give some empirical support for a higher density of companies being closer to the frontier as would be expected in the case for a half-normal distribution. Bristol Water said that this showed that a half-normal distribution for opex efficiency is plausible. However, Ofwat's approach to selection of the frontier company at PR04 and P409 meant that some companies were more efficient than the frontier company and Bristol Water's calculations did not seem to take this into account. We did not consider Bristol Water's analysis to provide strong evidence in favour of adopting the half normal distribution for inefficiency.

151. In light of the issues above, and in the absence of evidence to indicate an appropriate assumption for the distribution of inefficiency, we decided not to prioritise investigation of the potential use of SFA analysis in our development of alternative models.

Estimation results for alternative models

152. This section sets out results from our estimation of the alternative models described.

153. We first comment on the issue of estimated standard errors which is material to the results we present. We used the statistical software package Stata for our analysis. Stata provides functionality that seeks to control for heteroskedasticity and autocorrelation of the error terms in the estimation of the standard errors.[9] We used the 'vce (cluster robust)' command in Stata to take account of both the possible heteroskedasticity and possible autocorrelation in the estimation of the standard errors. We clustered by

[8] CEPA (March 2014), *Cost assessment – advanced econometric model*, p102.
[9] Heteroskedasticity exists where the variance of the error term is not constant across the observations of the sample. When heteroskedasticity is not tackled and it is instead assumed that the error terms are homoskedastic (constant variance), the estimated standard errors for the coefficients on the explanatory variables in the model may be inaccurate. This imposes risks in determining the relevance we should give to each explanatory variable. An additional problem that also affects the size of standard errors for the estimated coefficients emerges when the error terms in the model are correlated for different observations (eg over time). This means that the covariance between the error terms for different observations is not equal to zero. Particularly in models using panel data, it is more likely that this problem arises since the error terms for the study period and corresponding to each specific 'entity' (in our case each water company) possibly exhibit similar patterns (eg over time). If this issue is not taken into account in the estimation of standard errors, these again could be inaccurate.

company as there may be correlations, for each company, over time in the modelled error term.

Table 3: Estimated coefficients from logarithmic unit cost models

	Base expenditure smoothed (5-year data sample)			*Base expenditure unsmoothed (7-year data sample)*		
Explanatory variables groups	*EV1*	*EV2*	*EV3*	*EV1*	*EV2*	*EV3*
Ln (water delivered per property)	0.06745	0.40857	0.55917*	0.08432	0.55357*	0.7052**
Ln (regional wage measure)	1.1877	0.613	0.05398	1.1912	0.45485	(0.14187)
Ln (mains length per property)	0.32298	0.39959	0.42931**	0.28906	0.38489	0.40785*
Proportion of DI from rivers	0.27698	0.33325*		0.27453	0.35037	
Proportion of DI from reservoirs	0.37497*	0.272		0.41259	0.28872	
Ln (average pumping head)	0.28984**	0.24867*	0.13771	0.30337**	0.24656*	0.13916
Prop. consumption by metered NHHs		(0.99791)	(0.82419)*		(1.3926)**	(1.2114)**
Proportion of DI subject to W3/W4 treatment			0.44088			0.45225
Time dummy variable (2006/07)				(0.07072)	(0.05535)	(0.03467
Time dummy variable (2007/08)				(0.08586)	(0.05367)	(0.03723)
Time dummy variable (2008/09)	(0.0418)	(0.0226)	(0.0149)	(0.10634)*	(0.08226)	(0.07293)
Time dummy variable (2009/10)	(0.02615)	(0.00786)	0.00745	(0.15337)*	(0.13075)*	(0.11362)*
Time dummy variable (2010/11)	(0.03007)	(0.01795)	(0.00583)	(0.13751)*	(0.12299)*	(0.10944)*
Time dummy variable (2011/12)	(0.00101)	(0.01382)	(0.01946)	(0.01543)	(0.03276)	(0.03867)
Constant	(7.9009)***	(5.7924)**	(3.9092)**	(7.8086)**	(5.0302)*	(3.0432)
Number of observations	90	90	90	126	126	126

Source: CMA analysis.
Note: Statistical significance indicated at *10%, ** 5%, ***1% levels, based on cluster robust standard errors.

Table 4: Estimated coefficients from linear unit cost models

	Base expenditure smoothed (5-year data sample)			*Base expenditure unsmoothed (7-year data sample)*		
Explanatory variables groups	*EV1*	*EV2*	*EV3*	*EV1*	*EV2*	*EV3*
Water delivered per property	(0.06832)	0.02271	0.02477	(0.07087)	0.04692	0.04938
Regional wage measure	0.00729*	0.00274	0.00114	0.00765	0.00212	0.00042
Mains length per property	0.0029*	0.00356*	0.00393**	0.00286	0.00363*	0.00397**
Volume of water from rivers per property	0.04431	0.05744*		0.04425	0.06085	
Volume of water from reservoirs per property	0.05621	0.03465		0.06038	0.036	
Average pumping head * DI per property	0.00039*	0.00033	0.00018	0.00038*	0.00029	0.00015
Prop. consumption by metered NHHs		(0.13298)*	(0.10073)*		(0.17724)**	(0.14223)**
DI subject to W3/W4 treatment per property			0.08299*			0.0852
Time dummy variable (2006/07)				(0.00835)	(0.00564)	(0.00516)
Time dummy variable (2007/08)				(0.00902)	(0.00435)	(0.00469)
Time dummy variable (2008/09)	(0.00454)	(0.00163)	(0.00242)	(0.01291)**	(0.00937)	(0.01019)
Time dummy variable (2009/10)	(0.00254)	0.00014	0.000066	(0.01779)**	(0.01455)**	(0.01465)**
Time dummy variable (2010/11)	(0.00353)	(0.00155)	(0.00172)	(0.01641)**	(0.01405)**	(0.01428)**
Time dummy variable (2011/12)	(0.00007)	(0.00145)	(0.00176)	(0.00136)	(0.0031)	(0.00349)
Constant	(0.06027)	(0.00097)	(0.00198)	(0.0545)	0.01929	0.01826
Number of observations	90	90	90	126	126	126

Source: CMA analysis.
Note: Statistical significance indicated at *10%, ** 5%, ***1% levels, based on cluster robust standard errors.

Table 5: Estimated coefficients from logarithmic aggregate cost models

	Base expenditure smoothed (5-year data sample)			*Base expenditure unsmoothed (7-year data sample)*		
Explanatory variables groups	*EV1*	*EV2*	*EV3*	*EV1*	*EV2*	*EV3*
Ln (number of properties / total mains)	0.67683***	0.60064**	0.58735***	0.71568***	0.61957**	0.61173***
Ln (water delivered per property)	0.10373	0.44092	0.57812*	0.1148	0.57526*	0.7287**
Ln (regional wage measure)	1.0734	0.50839	0.05825	1.0817	0.3708	–0.14799
Ln (total mains length)	1.0153***	1.0144***	1.0152***	1.0137***	1.0111***	1.016***
Proportion of DI from rivers	0.27511	0.33119*		0.2707	0.34677	
Proportion of DI from reservoirs	0.31586	0.21687		0.3595	0.24645	
Ln (average pumping head)	0.29508**	0.25383*	0.1527	0.30785**	0.25057*	0.15569
Prop. consumption by metered NHHs		(0.99255)	(0.74272)		(1.3836)**	(1.132)**
Proportion of DI subject to W3/W4 treatment			0.42041			0.43038
Time dummy variable (2006/07)				(0.06984)	(0.05473)	(0.03825)
Time dummy variable (2007/08)				(0.08226)	(0.05096)	(0.04033)
Time dummy variable (2008/09)	(0.03794)	(0.01907)	(0.01663)	(0.10242)*	(0.07923)	(0.07434)
Time dummy variable (2009/10)	(0.02234)	(0.00437)	0.00573	(0.14943)**	(0.1277)*	(0.11499)*
Time dummy variable (2010/11)	(0.02757)	(0.01567)	(0.00788)	(0.1348)**	(0.12089)*	(0.11128)*
Time dummy variable (2011/12)	(0.00333)	(0.01593)	(0.02076)	(0.0174)	(0.03424)	(0.04019)
Constant	(7.7151)***	(5.6288)**	(4.0833)*	(7.6089)**	(4.8862)*	(3.1908)
Number of observations	90	90	90	126	126	126

Source: CMA analysis.
Note: Statistical significance indicated at *10%, ** 5%, ***1% levels, based on cluster robust standard errors.

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Base case analysis

1. This appendix includes additional analysis and considerations that we made in arriving at our assessment of Bristol Water's planned base expenditure and a summary of the Bristol Water and Ofwat responses to our working papers.

Opex (wholesale water)

2. In this section we provide additional background on:

   (a) CC10 determination and comparison to AMP5 and AMP6;

   (b) Bristol Water and Ofwat's views on the appropriate business planning process for opex;

   (c) AMP6 additional opex; and

   (d) CMA sensitivity analysis.

CC10 determination and actual performance for AMP5

3. In CC10, Bristol Water challenged seven different areas of opex allowance, and the CC agreed to make adjustments where it considered costs to be beyond management control.

4. The CC10 decision allowed an additional £6.9 million base opex for Bristol Water (2007/08 prices) compared to the Ofwat allowance. The changes related to bad debts (£3.3 million), abstraction charges (£1.9 million); and pensions (£1.7 million).

5. The CC also allowed additional opex associated with enhancement capex that Bristol Water was allowed within AMP5, including £0.5 million for supply demand balance and £1.8 million for water quality compared to the Ofwat allowance.

6. During AMP5, Bristol Water underspent the allowance in years 1 to 3 (noting that year 1 contains £1.5 million of CC referral costs) by £7.8 million as shown in Table 1. Consistent with the regulatory framework for AMP5, these opex costs include retail costs.

Table 1: Bristol Water actual opex and allowances for AMP5 (both retail and wholesale)

				£m (2012/13 prices)
	2010/11	*2011/12*	*2012/13*	*2013/14*
Allowed	55.2	54.9	55.3	55.5
Actual	54.5	51.1	52.1	55.6
Difference	0.7	3.9	3.2	0.0

Source: CMA analysis of Bristol Water SoC, Figure 21.

Bristol Water forecasts and views

7. Bristol Water is seeking a small overall increase in total wholesale opex from AMP5 to AMP6 of £3 million (1%). Comparable figures for AMP4 are not available. The AMP5 actual expenditure (£225 million) contains many one-off items (eg CC10 and reorganisation costs) that complicate a like-for-like comparison.

8. Bristol Water has created an opex forecast by starting from a base year and then making adjustments for future changes in costs.

9. Using this approach, Bristol Water has based its opex submission on a base year of 2013/14. Bristol Water told us that it was an appropriate year to use as:

   (a) it is the most recent actual data available;

   (b) actual expenditure in 2013/14 is in line with the CC10 allowance for that year; and

   (c) the level of operating expenditure allowed for in AMP5 was based on factors that will continue in AMP6.'[1]

10. In addition, Bristol Water said that:

> '2014-15 operating costs are forecast to be above the CC10 allowance and include the increased impact of additional operating expenditure related to capital investments allowed at PR09 in addition to some one-off costs that we would expect to reverse (eg increased rechargeable work, external input into our business efficiency project, an enforced change of banking supplier due to the RBS downgrade, set-up costs to prepare for the opening of the retail market).'[2]

[1] Bristol Water SoC, paragraph 894.
[2] Bristol Water SoC, paragraph 350.

11. Bristol Water has included an opex efficiency challenge which it indicates will reduce AMP6 opex by a cumulative £8.5 million[3] as shown in Table 2, equivalent to £2.5 million lower opex in the final year. This represents a total efficiency target of £14 million offset by price inflation (above RPI) of £6 million. We refer to these as Real Price Effects (RPEs).

Table 2: Bristol Water wholesale opex efficiency in final business plan

	%						*£m (2012/13 prices)*
	Annual	*2015-16*	*2016-17*	*2017-18*	*2018-19*	*2019-20*	*AMP6 impact*
Wholesale input price inflation (relative to RPI)	0.6	0.6	0.8	1.1	1.4	1.7	5.6
Frontier productivity growth	-1.0	-1.0	-1.4	-1.9	-2.3	-2.8	-9.4
Relative efficiency	-0.5	-0.5	-0.7	-0.9	-1.2	-1.4	-4.7
Total efficiency	-1.5	-1.4	-2.1	-2.8	-3.5	-4.2	-14.0
Overall effect	-0.9	-0.9	-1.3	-1.7	-2.1	-2.5	-8.5

Source: Bristol Water Analysis (Bristol Water SoC, Table 56).

12. Bristol Water told us that the proposed wholesale operating costs in 2019/20 represented a 0.3% increase on the base operating costs from 2013/14.'[4]

13. The 0.3% is the increase from the chosen base year (£45.5 million) to 2019/20 (£45.7 million) and reflects the impact of the overall effect of efficiency (£2.5 million in 2019/20) offset by additional costs for enhancement (around £2.7 million).

Ofwat's view

14. In its response to the Bristol Water SoC, Ofwat does not specifically address the level of opex, since its econometric modelling is based on totex. However, Ofwat does state that it has increased Bristol Water's base cost allowance in respect of certain categories of opex, in particular:

> 'Where special cost factor claims and modelling adjustments are concerned we have given Bristol Water the benefit of the doubt in a number of areas (for instance in relation to the Cheddar water treatment works and traffic congestion costs). We have also made significant adjustments to our modelled allowances for both base (in relation to water treatment costs) and enhancement expenditure (by increasing the allowance in the refined totex modelling stream).'[5]

15. Ofwat also has suggested that Bristol Water has a relatively high cost plan:

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[3] Bristol Water SoC, Table 56.
[4] Bristol Water SoC, paragraph 897.
[5] Ofwat response, paragraph 23.

‘Bearing in mind the above and the significant adjustments we have already made to our modelling results suggests that the remaining differences indicate Bristol Water has a relatively high cost plan and the scope to make very significant efficiency savings.’[6]

CMA analysis

Opex efficiency

Increase from base year

16. Bristol Water has used 2013/14 as the base year for its wholesale water opex in its submission, for the reasons stated in paragraph 9.

17. However, while there may be specific recurring upward cost drivers in the year, 2013/14 does not appear representative of actual Bristol Water opex since 2010/11 as shown in Table 3 below.[7]

Table 3: Actual wholesale opex

£m (2012/13 prices)

	2010/11	2011/12	2012/13	2013/14	2014/15
Opex	44.0	42.8	43.3	45.5	49.1*
Change year on year		-2.7%	1.1%	5.5%	7.7%
Cumulative change		-2.7%	-1.7	3.7%	11.7%

Source: CMA analysis.
*Provisional figure.
Note this table refers to wholesale opex – table 1 refers to total opex.

18. The opex in 2011 includes £1.5 million relating to the CC referral (wholesale element 2012/13 prices). Excluding this item, 2013/14 was 7.3% above the 2010/11 cost and 6.3% above the average for the first three years. The 2014/15 year also contains some non-recurring items (around £3.6 million) including CMA referral and company restructuring costs.

19. Bristol Water incurs a range of opex costs. Our analysis has indicated the following:

    (a) The 2013/14 year costs were £2.4 million (5.5%) higher than 2012/13 (in real terms). This was driven mainly by:

[6] Ofwat response, paragraph 51.
[7] Note that at a very late stage in our process Bristol Water submitted some revised operating costs for 2014/15 which contained some small amendments to the figures. Given the lateness and the generally small amendments to the figures we have not revised our assessment to take account of the changes at this point.

(i) staff costs (that element not recharged to capex) increased by £0.3 million. There was a 2.5% pay rise to all staff. This followed a 3.75% rise for staff in 2012/13;[8]

(ii) increased energy costs of £0.4 million and rates of £0.1 million;

(iii) a £1.6 million increase in ‘other’ costs. Bristol Water has identified additional regulatory costs (PR14 work) £0.6 million; and additional contracting services due to large bursts £0.8 million; additional costs due to new DWI sampling requirements £0.2 million; and

(iv) a £0.3 million increase in rechargeable costs (which is ultimately recovered from third parties);

(v) a £0.3 million increase in regular cash pension contributions; and

(vi) an offsetting £0.6 million reduction due to the application of PR14 specific cost allocation guidance.

(b) Bristol Water has said that in calculating the base year, it has removed significant one-off events. This is not apparent from the information it has supplied, which shows actual costs for 2013/14 (deflated to 2012/13 prices) agreeing to the base starting position shown in the statement of case.[9]

(c) Bristol Water has also said that 2013/14 benefitted from favourable operating conditions compared to historic averages (although less favourable when compared to 2012/13. We considered that this suggested that costs could be higher.

(d) The three previous years’ opex were around £2.5 million lower yearly[10] (see Table 3). Relative to this level, the Bristol Water AMP6 plan (£228 million) represents on average a 5.5% increase (compared with the 0.3% that Bristol Water calculated as the average increase relative to a base year of 2013/14 (see paragraph 12)).[11]

(e) Within the allowance for opex, both Ofwat and the CC at PR09 allowed some additional costs associated with enhancement capital spend (for example the opex associated with optional metering).The AMP5 enhancement opex costs included in the Bristol Water business plan are

[8] Bristol Water regulatory accounts 2014.
[9] Bristol Water told us that from the 2013/14 base year it removed the one-off costs for responding to an Ofwat investigation into charges for self-lay developers. These costs were allocated to retail non-household, and so did not result in any reductions to wholesale opex.
[10] Ignoring CC costs in 2010/11 of £1.7 million.
[11] Bristol Water SoC, paragraph 897.

based on what the CC determined rather than an actual forecast.[12] This results in an uplift of £1.1 million to reflect the additional costs that would not be reflected in the 2013/14 base year. We would have expected that a real forecast (ie taking into account actual AMP5 experience) would have been used, rather than using the CC10 allowance that does not take into account developments in the intervening three years. In its draft 2014/15 variance explanation, Bristol Water said that this expenditure is included in the total of 'other' expenditure of £0.2 million, and so might be assumed to be less than £0.1 million.

20. In response to further questions on this forecast, Bristol Water provided an analysis of the schemes where the opex impact had not fully impacted on AMP5. This analysis estimated the element of allowed costs that had not been reflected in AMP5 actual costs. We found that this reliance on forecast costs from some five to six years ago to evidence expected increases to be seriously flawed. We would not expect the actual design and construction of engineering solutions to perfectly follow the original outline (which some five years before would be less certain). Engineering techniques and approaches change and the final solution could be much different and a better fit for purpose. This suggests that the opex might be higher or lower than originally envisaged but it would be strange for it to be perfectly the same.

Labour costs

21. From information in the regulatory accounts, the number of staff employed by Bristol Water has risen consistently over the past five years (2009 to 2014). Excluding staff employed on non-appointed activity, the full-time equivalents figure was 452 in 2014 having risen by 15% since 2009 but with support services rising by 15% and administration staff by 95% (whilst this may be down to classification, the consequence is that more than a third of the staff now appear to be of an administration/ support nature).[13] This is illustrated in Table 4 below.

Table 4: Bristol Water reported full-time equivalents excluding non- appointed activity

Full-time equivalents excl. non-appointed	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Water treatment and distribution	262	269	272	271	262	273
Support services	91	82	78	85	93	105
Administration	38	46	47	58	72	74
Total	391	397	397	414	427	452

Source: CMA analysis.

[12] Bristol Water SoC, paragraph 904.
[13] Over the same period, Bournemouth Water staff rose from 191 to 196. The split between Administration and Other cannot be readily tested against other companies.

22. Bristol Water told us that:

> 'Our headcount has been slowly increasing, which reflects the growing size and complexity of the business. In particular, it reflects the impact on the business of the size of the capital programme for AMP5. The case for recruitment for each new position requires the approval of the Executive Team.'[14]

23. The increase in workforce and in workforce pay means the gross payroll cost has risen by 25% in five years. Average cost per employee has risen by 11%.

24. Bristol Water told us that these figures which are drawn from the regulatory accounts include both capital and operating staff. It has provided an extract from its HR records to provide a better understanding and this is shown in Table 5.

Table 5: Bristol Water reported headcount excluding non-appointed activity

	March 2012	*March 2014*	*FTE variance (March 2012 to March 2014)*
Engineering	[✂]	[✂]	[✂]
Production	[✂]	[✂]	[✂]
Customer Services	[✂]	[✂]	[✂]
Legal services, HR and central admin	[✂]	[✂]	[✂]
Asset planning	[✂]	[✂]	[✂]
Business improvement	[✂]	[✂]	[✂]
Environment	[✂]	[✂]	[✂]
Network	[✂]	[✂]	[✂]
Procurement	[✂]	[✂]	[✂]
Finance	[✂]	[✂]	[✂]
Quality	[✂]	[✂]	[✂]
Regulatory affairs	[✂]	[✂]	[✂]
Directors	[✂]	[✂]	[✂]
Risk management	[✂]	[✂]	[✂]
Total	420.4	461.4	[✂]

Source: Bristol Water.

25. Table 5 illustrates that much of the growth is [✂], which would accord with a greater capex programme, but there has been an overall increase in activities that will be classed as opex.

26. From this information, it can be seen that staff numbers have risen by almost 10% in two years. Bristol Water has said that it is undertaking a business review programme that will entail a reduction in staff of 10%. [✂]. We have taken this into account in considering an efficient recurring opex within AMP6.

27. Bristol Water has also provided details of pay increases awarded by other companies across AMP5 as a comparison to those awarded by Bristol Water, to seek to demonstrate that its labour costs include efficient pay increases. It

[14] Bristol Water SoC, paragraph 184.

has not been possible to compare all companies fully, but from the data available it suggests that Bristol Water is not an outlier compared to the industry. We note that Bristol Water is higher than the Wessex Water average, but also that this may be as a result of timing.

Forecast operating cost trends in AMP6

28. Bristol Water has supplied a forecast of additional enhancement opex over AMP6. Bristol Water described the increase in 2019/20 (£0.5 million) as being due to new treatment at Cheddar WTW for the algae problem.[15]

29. There are special factors relating to the Bristol Water area that add to costs, such as the payments made to the Canal and River Trust for abstraction. These have been considered as part of our econometric analysis.

30. Bristol Water describes the forecast as 'a realistic, evidence based and challenging assessment of its requirements'.[16] The forecast does not directly associate any savings with the additional capital maintenance expenditure requested however, on the basis that these are implicitly captured in the overall efficiency assumption.

31. Bristol Water has included an opex efficiency challenge which it indicates will reduce AMP6 opex by a cumulative £8.5 million,[17] equivalent to £2.5 million lower opex in the final year.

32. This is based on Oxera work that is said to move Bristol Water towards upper quartile performance. Although this suggests a level of efficiency at 1.5% yearly (0.9% yearly net of RPE factors), this is based on total opex which includes a large element (around 20%) that is more difficult to reduce (rates of £4.7 million and payments to the Canal & River Trust of £3.5 million). If it is accepted that there should be no efficiency challenge on these costs, then the implied efficiency on other costs would be 1.125% yearly (net of RPEs), relative to RPI inflation.[18]

33. We have compared the business plan level of opex efficiency to other recent regulatory benchmarks and these are shown in Table 6. These reflect settlements of a productivity rate of 1% opex yearly, and in this context the Bristol Water business plan, which includes a total of 1.5% (1% for productivity and a further 0.5% relative efficiency to move Bristol Water

[15] Bristol Water SoC, paragraphs 906 & 907 and Table 55.
[16] Bristol Water SoC, paragraph 926.
[17] Bristol Water SoC, paragraph 908 and Table 56.
[18] That is 1.725% efficiency on 80% of opex and 0% on the remainder, offset by 0.6% RPE on the whole.

towards the upper quartile) might be considered reasonable. This compares to the 1.2% efficiency Bristol Water has assumed for the retail business.

Table 6: Recent opex productivity targets

Opex productivity	*% yearly*	*Date*
Ofgem – GB DNOs	0.8-1.1	November 2014
Ofgem – Transmission & Gas Distribution	1.0	November 2012
CC decision for Northern Ireland Electricity	1.0	March 2014
UR – Water and sewerage	0.9	December 2014
PPP Arbiter – underground infracos, opex	0.9	2010

Source: CMA analysis.

34. The additional items that Bristol Water has included in its business plan which we must consider are the base opex adjustments, the impact of new connections and the AMP6 enhancement adjustments to base opex. These are forecast by Bristol Water to be £1.1 million, £1.8 million and £1.5 million respectively.[19]

35. The base opex increase comprises those items shown in Table 7. Although relatively small, it might be expected that these would have been covered by the RPEs calculated by Oxera and factored into the offset to the overall efficiency challenge (0.6% yearly). Bristol Water told us that the carbon reduction commitment was an adjustment for the above-inflation element of the increase that is not reflected in the base year (2013/14) opex.[20]

Table 7: Bristol Water base additions to opex

£m

	2015-16	*2016-17*	*2017-18*	*2018-19*	*2019-20*	*AMP6*
Carbon reduction commitment	0.2	0.2	0.2	0.2	0.2	0.8
Leakstop SP replacement	0.1	0.1	0.1	0.1	0.1	0.3
Open Water programme	0.1	0.0	0.0	0.0	0.0	0.2
Base opex adjustments	0.3	0.2	0.2	0.2	0.2	1.3

Source: Bristol Water SoC, Table 53.

36. The additions for new connections (shown as supply/demand balance (SDB)) and PR14 enhancement scheme impacts are shown in Table 8.

Table 8: Bristol Water enhancement additions to opex

£m

	2015-16	*2016-17*	*2017-18*	*2018-19*	*2019-20*	*AMP6*
SDB expenditure	0.2	0.3	0.4	0.5	0.5	1.8
PR14 enhancement schemes	0.0	0.1	0.2	0.4	0.9	1.5
AMP6 enhancements	0.2	0.3	0.6	0.8	1.4	3.3

Source: Bristol Water SoC, Table 55.

[19] Bristol Water SoC, Tables 53 and 55.
[20] Bristol Water SoC, paragraph 900.

37. The enhancement costs shown in Table 8 are based on:

(a) the impact of new connections is based on assumed growth and the average cost per connected property in 2012/13; and

(b) the level of new opex relating to AMP6 enhancement schemes.

38. It is noted that the current work to refurbish the Bristol Water headquarters is designed to generate efficiency. We have seen no estimates of where these cost savings might be (Bristol Water has suggested that impacts of MNI spend are a part of the overall challenge). It is reasonable to assume that this, and the impact of other capital schemes (for example IT projects will reduce opex).

39. The remaining items are pensions and recharge for retail use of wholesale assets.

40. We note that Mott MacDonald was asked to provide assurance on the reforecasting of opex data. Mott MacDonald's review appears to have concentrated on changes from the opening position as identified by Bristol Water. Mott MacDonald drew attention to the significant enhancement cost forecast for 2014/15, but did not challenge the underlying scheme delivery this forecast was predicated on. We also note that in response to challenge from the LEF Mott MacDonald confirmed that: 'We did not review opex build-up in detail'. Several parties have looked at aspects of opex,[21] but it is not clear that any one party reviewed all the assumptions and linkages.

41. We have performed a number of sensitivities to our various assumptions and a summary of that work is shown in Table 9. These sensitivities have been based on:

(a) our various potential approaches to establishing an appropriate base starting point; and

(b) our view on potential disallowance of additions to the base.

[21] Bristol Water SoC, paragraphs 982-986.

Table 9: Sensitivity of total opex allowed to CMA judgements

			£m
Starting point	*Disallowance from base*	*Base additions*	*Opex total*
2013/14	Regulation £0.4m; capitalisation £0.2m; EA refund £0.1m	PR09 enhancement nil; PR14 enhancement £1m; base additions £0.5m	221
2013/14	Regulation £0.4m; capitalisation £0.2m; EA refund £0.1m	PR09 enhancement nil; PR14 enhancement £1.5m; base additions £1.5m	222
2014/15	Regulation £0.4m; capitalisation £0.2m; Restructure £2m; CMA determination £1.4m; EA refund add back £0.4m	PR09 enhancement nil; PR14 enhancement £1m; base additions £0.5m	220
3 year average (2010/11 - 2012/13)	CC10 £1.5m; EA costs £0.1m pa	PR09 enhancement nil; PR14 enhancement £1m; base additions £0.5m	210
3 year average (2010/11 - 2012/13)	CC10 £1.5m	PR09 enhancement £2.5m; PR14 enhancement £1m; base additions £0.5m	213
AMP5 average	CMA determination £1.4m; CC10 review £1.5m	PR09 enhancement nil; PR14 enhancement £1m; base additions £0.5m	215

Source: CMA analysis.
Note: We have followed the Bristol water approach on efficiency in these scenarios and have therefore not considered this as a sensitivity for provisional findings.

Infrastructure renewals expenditure

42. In this section we provide additional background on:

(a) CC10 and comparison to AMP5 and AMP6;

(b) Bristol Water and Ofwat's views on the appropriate business planning process for IRE; and

(c) additional analysis from our engineering consultants (Aqua).

CC10 and actual performance for AMP5

43. At the PR09 review, Bristol Water made the case that a higher level of mains replacement was required. The CC, having engaged Halcrow to review, made a sufficient allowance for additional mains replacement of 47.5km each year.[22]

44. Bristol Water replaced around 240km[23] in the first four years of AMP5 (ie all that was funded for five years). Provisionally, Bristol Water has reported a figure of 56.5km actual replacement in 2014/15. Bristol Water claimed during the CC determination process that this level of mains replacement might be

[22] CC10 Final determination, paragraph 3.34.
[23] This figure includes 31.9km of trunk mains renovation work. The overall length of mains replaced in AMP5 was 295.9km, of which 58.18km was trunk mains renovation.

insufficient to meet leakage targets.[24] However, leakage targets were exceeded, as shown in Table 10.

Table 10: Bristol Water leakage reduction compared to target (Ml/d)

		2008/09	*2009/10*	*2010/11*	*2011/12*	*2012/13*	*2013/14*
Target	*Ml/d*	54	54	52	51	50	49
Actual	*Ml/d*	54	53	50	43	42	44
Difference	*%*	1	2	3	16	16	10

Source: CMA analysis.

45. In practice, Bristol Water has spent more than allowed at PR09 for total capital maintenance[25] (£32 million, in 2012/13 prices).[26] However, the actual capital maintenance spend for 2009/10 (ie the last year of AMP4) was £93 million compared to an allowance of £103 million.[27]

Bristol Water forecasts and views

46. Bristol Water described two factors that it suggests will mean higher infrastructure costs than other companies:

(a) Bristol Water has a proportionately greater amount of upstream assets than most other companies and therefore would be expected to incur more maintenance costs in this area; and

(b) Bristol Water has the second oldest network in the industry. An older network has a higher rate of degradation and therefore needs more maintenance to maintain its performance.'[28]

47. The first factor is based on the proportion of upstream assets (raw water assets) that a company has as measured by MEAV.[29] Bristol Water provided a graph to illustrate the levels and this shows Yorkshire Water with around 24%, Bristol Water with around 25% and United Utilities with around 35%.[30]

48. Table 11 demonstrates where Bristol Water intends to spend the AMP6 IRE compared to previous periods. The figures show that the main differences to AMP4 levels are the mains replacement programme (£12 million increase) and raw water reservoirs (£6 million increase).

[24] CC10 Final determination, paragraph 3.35.
[25] IRE and MNI.
[26] Bristol Water SoC, table 24.
[27] Per Bristol Water June Return 2010 quoted in CC10 Final determination, page 26, footnote 87.
[28] Bristol Water SoC, paragraph 946.
[29] Modern Equivalent Asset values. ie. the cost to replace an asset to current modern equivalent standard.
[30] Bristol Water SoC, Figure 11.

Table 11: Bristol Water historic and forecast IRE

£m (2012/13 prices)

Asset type	*AMP4*	*AMP5*	*AMP6*
Aqueducts	6.2	12.1	5.5
Raw water reservoirs	4.6	10.3	10.6
Mains and communication pipes	35.1	91.2	47.6
Infrastructure other	14.9	14.7	12.7
Total	60.8	128.3	76.3
Less trunk main lining*		26.2	
Total excluding trunk main lining	60.8	102.1	76.3

Source: Bristol Water SoC, Table 59.
* During AMP5, Ofwat required Trunk Main Lining to be categorised as Capital Maintenance. Thus it is removed from the AMP5 total for comparison purpose.

Ofwat's view

49. Ofwat has not specifically commented about the level of IRE, but has responded to Bristol Water's assertion that older mains imply greater cost, noting that 'there is no meaningful relationship between mains condition (proxied by bursts per km) and mains age'.[31] This disagrees with the Bristol Water position, supported by graphical representation of the data, that:

> 'A key element of network degradation is mains that have never previously burst beginning to start bursting.'[32]

50. Ofwat has further clarified its position:

> 'We consider that risk to a company's service to its customers should drive asset replacement rather than age. Serviceability of assets is dependent on the role played by individual assets and their condition – the latter having multiple causes such as soil type, depth, pressure, the approach to network operation and effectiveness of maintenance, etc. An old asset can provide a good level of service to customers.'

51. Ofwat has also investigated Bristol Water's claim that the proportion of upstream assets is a factor that suggest higher costs. The Ofwat analysis found that there was:

> 'No substantial relationship between the extent of companies' upstream assets and the PR14 efficiency assessment – suggesting that upstream assets are not an important variable in

[31] Ofwat response, paragraph 147.
[32] Bristol Water SoC, paragraph 949.

explaining differences in costs between companies and are not an important factor to take into account in benchmarking costs.'[33]

CMA analysis of Bristol Water specific factors

52. We have initially considered the reasons that Bristol Water give to support a higher level of IRE than other water companies. Bristol Water has argued that older mains and more upstream assets give rise to higher costs.

53. In this section we include analysis provided by Aqua, which we used to inform our understanding of Bristol Water's proposals.

54. The proportion of upstream assets that Bristol Water has is higher than most other water companies, although significantly less than that of United Utilities and similar to Yorkshire Water.

55. On upstream assets, Bristol Water states that: 'As a result, we should be expected to incur proportionally more upstream asset maintenance costs than other companies.'[34] If this is a significant factor, it might also be the case that Yorkshire and United Utilities would have the same issue.

56. This argument follows if, as claimed by Bristol Water, the replacement value (MEAV) was an indicator of maintenance cost requirements. If, however, these upstream assets are high value but with very long lives compared to the remaining assets, then the expected level of intervention could be minimal. An alternative view could suggest that the higher level of upstream assets reduces the need for maintenance costs. For example, these assets (frequently storage reservoirs) tend to have a large MEAV, long lives and require less intervention as there are fewer working parts.

57. Bristol Water has agreed that these assets will typically have a low maintenance cost compared to their value but suggest that compared to the number of customers or length of mains it would lead to higher costs. This does not follow: for a company with relatively higher upstream assets, which typically have a low maintenance cost, the weighted average costs compared to customers or mains would be lower.

58. In its business plan, Bristol Water has planned to spend around £16 million (21% of IRE) on upstream assets. This also implies that there may be no clear link, or at least only a relatively small relationship, between the upstream MEAV and the level of maintenance.

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[33] Ofwat response, paragraph 151.
[34] Bristol Water SoC, paragraph 261.

59. The second factor relating to age of network is based on data provided to Ofwat in 2009. Ofwat has since provided an update of data to illustrate that the underlying data appears not to be robust.

60. We note that Bristol Water does have relatively older mains compared to other companies, although Ofwat has advised us that the reliability of this data is questionable.

61. We have asked Aqua Consulting to provide a view on whether this should be a major determinant of required spend and they have said that in their view age is not an important factor. This is consistent with Ofwat's view.

62. Thames Water and Southern Water are companies that also show as having old infrastructure (1st and 3rd overall). Table 12 shows that both companies have not replaced significantly high levels of mains but sit 16th and 3rd on the leakage performance (Table 13). Additionally, United Utilities appears to have the youngest assets but the highest levels of leakage.

63. While intuitively older assets might be expected to have greater intervention requirements, there are other factors that will impact burst rates (ground conditions, pressure, and quality of pipe manufacture). These may all impact on the need for interventions.

64. After adjusting for winter extremes, the actual rate of bursts for Bristol Water has fallen[35] from the levels seen in AMP3 to a more constant level. Bristol Water reports the serviceability of these assets as 'stable' for the AMP4 years[36] and has beaten the leakage target for the past four years. This does not appear to support the need for an unusually high level of IRE.

65. Ofwat, however, has assessed serviceability for 2012/13 as marginal and for 2013/14 and 2014/15 as deteriorating.[37] This assessment relates to breaches of the interruptions to supply exceeding 12 hours measure in 2011/12, 2013/14 and 2014/15 (with a close call in 2012/13). This might suggest additional investment is required.

66. A longer-term review of the level of mains relining and replacement, suggests that, despite the higher level of AMP5 investment, Bristol Water has still been investing less in its mains compared to other companies (see Table 12) over the last ten years, which shows Bristol Water ranks 15th out of 18 on investment in mains.

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[35] See Bristol Water Regulatory Performance Report 2014, page 7.
[36] Bristol Water SoC, paragraph 282 and Figure 14.
[37] Ofwat: Final Price control determination notice: company specific appendix – Bristol Water, page 103.

Table 12: Total % mains relined and replaced 2002/03 to 2013/14

		%	
Company	*Average % replaced or relined*	*Total*	*Rank*
Anglian Water	0.3	3.4	17
Dwr Cymru Cyfyngedig (Welsh)	1.4	16.6	2
Northumbrian Water Ltd	1.2	14.9	3
Severn Trent Water Ltd	0.7	7.9	14
South West Water Ltd	2.1	25.5	1
Southern Water Services Ltd	0.2	2.8	18
Thames Water Utilities Ltd	0.8	9.1	12
United Utilities Water Plc	1.2	13.8	6
Wessex Water Services Ltd	0.8	9.2	9
Yorkshire Water Services Ltd	1.2	14.7	4
Bristol Water plc	0.6	7.0	15
Affinity Water	0.9	10.5	7
Dee Valley Water Plc	0.8	9.1	11
Portsmouth Water Ltd	0.7	8.6	13
Sembcorp Bournemouth Water	0.3	3.5	16
South East Water Ltd	0.8	9.3	8
South Staffordshire Water Plc	0.8	9.2	10
Sutton & East Surrey Water Ltd	1.2	14.6	5

Source: CMA analysis.

67. In its WRMP, Bristol Water confirmed that leakage is below the defined economic level. It is also observed that Bristol Water has one of the lower rates of leakage as a proportion of distribution input.[38] This suggests that mains replacement expenditure is higher than economically necessary and may Bristol Water may be able to reduce from AMP5 levels. In its 2012 Annual Report Bristol Water suggests that it has gone further than economic with its leakage reduction programme, due to wider considerations relating to weather conditions:

> 'Bristol Water has always met or bettered its regulatory leakage targets. This year the company's leakage target was set at its lowest ever level, and with our strong commitment to lowering leakage still further and the benefit of a mild winter we recorded the lowest leakage level in the company's history - approximately 15% below our target level.
>
> Leakage targets are set at a level where the overall value of the water lost is balanced out by the costs of increased leakage control activity. Achieving the 15% reduction below our target level required a significant additional effort, and we chose to make it in order to reduce the risk of needing to impose water supply restrictions following a sustained period of dry weather over the past two years.'[39]

[38] From econometric analysis.
[39] Bristol Water Annual Report 2012, page 6.

68. Table 13 illustrates that Bristol Water is an above average performer (5th out of 18) in terms of water lost per distributed volume as at March 2013.

Table 13: Company reported leakage as at 2012/13

Company	*%*	*Rank*
Anglian Water	17.3	7
Dwr Cymru Cyfyngedig (Welsh)	22.4	15
Northumbrian Water Ltd	16.7	6
Severn Trent Water Ltd	25.3	17
South West Water Ltd	19.6	10
Southern Water Services Ltd	14.9	3
Thames Water Utilities Ltd	25	16
United Utilities Water Plc	26	18
Wessex Water Services Ltd	20.6	11
Yorkshire Water Services Ltd	22.1	14
Bristol Water plc	16.3	5
Affinity Water	18.9	9
Dee Valley Water Plc	13.6	1
Portsmouth Water Ltd	20.8	12
Sembcorp Bournemouth Water	14.8	2
South East Water Ltd	17.4	8
South Staffordshire Water Plc	21.8	13
Sutton & East Surrey Water Ltd	15	4

Source: CMA analysis.

69. Bristol Water has also said that, despite commenting that leakage targets are set at an economic level, its strategy is: 'By 2020, we aim to reduce leakage to 15% of water produced (compared to over 20% in 2009/10).'[40] Table 13 shows the substantial reductions made in AMP5 following the increased replacement activity.

70. Bristol Water has explained that this strategy is based on moving towards the long run economic level of leakage rather than the short term measure (which is reflected in Ofwat targets). This seems an appropriate strategy, but we have not been able to review the calculation of this figure.

71. In terms of unplanned interruptions, Bristol Water has improved performance and is on track to meet its 2020 target.

72. Ofwat has suggested that the cause of increase in supply interruptions >12 hours could be due to poor management of burst incidents, rather than lack of investment. We agree that this is a consideration.

73. Bristol Water has confirmed that its approach to targeting mains for replacement is based on burst history. Bristol Water suggest that:

> 'Bristol Water's situation is that it has a relatively old mains network in relatively good condition, partly because of the targeting approach we have developed for mains replacement since 2004. The older network leads to higher degradation, and

[40] Bristol Water Annual Report 2014, page 14 (Repeated in most Annual Reports.)

the relatively good performance constrains the effectiveness of the mains replacement approach. As a result, the level of activity required to maintain the network is relatively high.'

74. Aqua has reviewed the mains replacement programme and has identified from the evidence provided by Bristol Water that the assessment of how much mains should be replaced is derived through the WILCO model primarily based on age/burst relationship. Aqua understand that this is partly predicated on the principle that older mains will show the fastest degradation. The value derived by the WILCO model is then targeted using burst history. The actual targeting process via the company specific Distribution and Trunk Mains Rehabilitation Tools to prioritise the mains replacement programme and specify the trunk mains relining schemes seem robust.

75. Aqua has commented that there is not sufficient evidence that the distribution mains replacement programme proposed will deliver stable serviceability, the stated need to undertake smarter network management is not well defined, and there is cost uncertainty.

76. In summary, there are a number of factors that influence the appropriate level of IRE, and in particular where Bristol Water may sit relative to an implied level calculated through benchmarking. These are summarised below:

(a) Bristol Water mains are older than most other companies, although it is not clear how significant this factor may be.

(b) Bristol Water has replaced (or relined) less mains than most other companies over the last 12 years, based on allowances in previous determinations.

(c) Ofwat has assessed serviceability for 2012/13 as marginal and for 2013/14 and 2014/15 as deteriorating, due to increased long-term interruptions to service (>12 hours). Bristol Water has assessed serviceability as Stable, although, as discussed further in the serviceability paper, this is for the purpose of avoiding a penalty.

(d) Bristol Water is an above average performer on leakage levels and has achieved a significant reduction in leakage; and

(e) Total unplanned incidents are reducing in line with target, and bursts are reducing. Based on previous assessment, the Bristol Water target to reduce leakage to 15% of production by 2020 may involve investment beyond the economic level of leakage.

Maintenance non-infrastructure

77. In this section we provide additional background on:

    (a) CC10 and a comparison to AMP5 and AMP6;

    (b) Bristol Water and Ofwat's views on the appropriate business planning process for MNI; and

    (c) Additional analysis from our Aqua.

CC10 determination and actual performance for AMP5

78. In PR09, Bristol Water requested a much greater level of MNI than had been expended in AMP4 as shown in Table 14.

Table 14: Bristol Water increased capex request at PR09

Requested MNI capex at PR09 £m – 2012/13 prices	*AMP4*	*AMP5*	*Increase*
Pumping stations (eg additional maintenance on Axbridge, Blagdon and Victoria in AMP 5)	6.2	14.9	8.7
Increasing the meter replacement rate given the increasing number of metered customers	2.1	4.1	2.0
Management and general IT	10.1	16.5	6.4
Treatment works	14.3	15.6	1.3
Other non-infrastructure maintenance	16.6	16.6	0.0
Total	49.3	67.7	18.4

Source: CMA analysis.

79. There were some major MNI specific projects:

    (a) Refurbishment of Shipton Moyne treatment works.

    (b) Replacement of Victoria Pumping Station.

    (c) Refurbishment of Axbridge Pumping station.

    (d) Replacement of Blagdon Pumping Station.

    (e) Replacement of customer meters.

80. In PR09 Bristol Water requested additional funding, saying that: 'Additional maintenance investment is required for non-infrastructure assets to maintain their serviceability after a period of restricted investment that has left 20% of our pumping equipment over 40 years old. This will reduce power consumption, reducing our carbon footprint.'

81. Following the PR09 business plan submission Bristol Water identified additional work at Chew Stoke WTW, which was estimated at £2.8 million (2012/13 prices), which the CC allowed. There was also an additional

£3.7 million allowed for Purton Reservoir (although this was IRE). Table 14 shows the Bristol Water request uplifted to 2012/13 prices (excluding Chew Stoke and Purton).

82. Ofwat made small reductions to the overall MNI programme requested, and these were mostly reversed by the CC decision (eg Chew Stoke). In essence, Bristol Water received the funding requested.

83. One reduction to the MNI programme was in meter replacement. Bristol Water does not intend to deliver its targeted replacement of meters in the period. This was apparently a strategic decision.

84. Overall in AMP5 Bristol Water has now said that it expects to spend £12 million (2012/13 prices) more than allowed under the CC10 determination on MNI capex.[41]

Bristol Water forecasts and views

85. Bristol Water calculated that it has requested overall maintenance expenditure at 23% less than the AMP5 expenditure. This has been based on assessment of need and detailed analysis of asset deterioration and resulting refurbishment or replacement requirements.[42] Within this, however, MNI increases by 8%.

86. It has also used a variety of ways to consider the required expenditure including developing a maintenance model, econometric modelling and comparison to the rest of the industry. Bristol Water also highlight the implied MNI required by an approach that considers MEAV and average asset lives which they use to determine an implied spend per AMP.[43]

87. Bristol Water highlight the major elements of the required MNI as:

> 'Continuing to maintain our treatment works, pumping station and reservoir assets including work on treatment works structures, the reconstruction of our Bedminster reservoir and major Health & Safety initiatives.'

88. As Table 15 shows, the AMP5 period saw a large increase in the rate of MNI. The Bristol Water business plan continues that higher level of MNI, although there are changes in individual categories.

[41] Bristol Water SoC, paragraph 354.
[42] Bristol Water SoC, paragraph 1009.
[43] Bristol Water SoC, paragraph 1028 and Table 64.

Table 15: Bristol Water historic and forecast MNI

			£m (2012/13 prices)
Asset type	*AMP4*	*AMP5*	*AMP6*
Raw water reservoirs and sources	2.4	1.8	0.0
Treatment works – process	11.6	19.4	26.9
Treatment works – structures	0.8	1.2	7.2
Pumping stations	4.4	13.9	9.3
Reservoirs and towers	2.1	3.0	10.3
Meter replacements and leakage reduction	3.4	3.7	4.5
M&G buildings	0.3	10.3	2.5
M&G H&S	0.1	0.4	4.3
M&G information technology	7.1	13.8	9.6
M&G other	7.9	6.1	5.3
Total	40.0	73.6	79.9

Source: Bristol Water SoC, Table 60.

89. Bristol Water has also referred to two factors that will impact its level of MNI:[44]

(a) Water treatment complexity.

(b) Additional pumping requirements.

Ofwat's view

90. Ofwat has accepted that Bristol Water will have higher costs due to treatment complexity but these appear to be opex in nature (eg additional chemical dosing) rather than capex.

91. Ofwat commented on the special cost factors allowed:

> 'We made significant adjustments to Bristol Water's modelled allowances to take account of water treatment complexity, canal payment and traffic costs. These factors meant that Bristol Water's cost threshold increased by 14% from draft determination to final determination, the biggest percentage increase of any company.'[45]

92. In the Ofwat review of special factors, Ofwat said it failed the Bedminster project on the basis that the investment is not exceptional for the industry:

> 'While this may be lumpy expenditure for BRL, we have not seen sufficient evidence that it is genuinely exceptional for the industry.'[46]

[44] Bristol Water SoC, paragraph 965.
[45] Ofwat response, paragraph 164.
[46] Ofwat: Final Price control determination notice: company specific appendix – Bristol Water, page 74.

CMA analysis

93. There seems to be less of a case that MNI costs are generally higher due to Bristol Water's operational conditions, as maintenance projects are proposed on a case-by-case basis, and these may only be marginally impacted by operational factors specific to Bristol Water. However, given the material changes between categories of investment over time, there appears to be the potential for lumpy investment requirements to result in higher cost requirements in some price control periods than others.

94. For example, the proposed expenditure on treatment works represents three times that of AMP4, and 50% more than allowed in AMP5. Bristol Water has suggested that this relates to specific characteristics of the assets, which were constructed in the 1990s. It might be expected that this factor would impact all other water companies since this was a national programme.

95. Bristol Water has supplied little supporting evidence that this is a major factor and have stated that this comment 'was not intended as a complete explanation of the variance'. Bristol Water does identify around £3.5 million of potential assets, although this is only a small portion of the overall increase of around £13.5 million (and of which might be expected to be covered in the underlying request). We have seen little evidence to support this claim.

96. Bristol Water has also referred to a greater level of pumping required. In AMP5 the MNI for pumping stations rose to around £13.9 million from £4.4 million as three major stations were refurbished.[47] We note that Bristol Water does have a higher (15%) than average pumping head, but that there are other companies with a much greater difference (notably Sutton & East Surrey, at 45%).

97. Ofwat has drawn attention to the Mott MacDonald assurance for Bristol Water and in particular have pointed out some specific comments:[48]

> 'Further consideration of the detail raises a number of more significant concerns. The particular findings that caused us concern were:
>
> *(a)* **Maintenance** – 'the process has developed significantly since PR09 but future improvements should focus on modelling service rather than end of asset life and improving the forward look element of risk analysis of

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[47] Bristol Water SoC, paragraph 958.
[48] Ofwat response, paragraph 160.

named schemes, to extend beyond addressing current or near-term risks' (section 3.3.8 p18);

(b) **Asset level models** – 'Most models are driven by either asset failure, performance or predicted end of life assets not service. Investment is mainly not risk-driven as cost and service are not targeted which means that there is an inherent assumption that all assets are required and need to be maintained' (Appendix B p B94-B102);

(c) **Uncertainty** – 'it is being included in the asset models and named schemes and can influence the outcomes of the optimiser but at the time of the review little information was available on the robustness of the whole process.' (Appendix B, pB38); and

(d) **Cross asset optimiser** – 'The approach is reasonable but depends on the options presented to it. A significant proportion of the investment (£144 million or 41% in total, 21% is quality and growth) is not challenged by the optimiser, being passed through as 'must invest'. We reviewed a sample of five 'must invest' schemes and considered that more could have been left open to the optimiser.' (Overview of findings p17)'.

98. These comments from Mott MacDonald suggest an asset replacement strategy that could lead to earlier asset replacement than necessary and therefore a higher overall level of replacement.

99. Bristol Water has said that it does not consider that the points in paragraph 97 imply a conservative approach and responded to each in turn:

(a) comments on maintenance were related to how modelling can evolve and was not a criticism of the approach;

(b) comments on asset level models specifically related to use of asset level models which are not service driven;

(c) comments on uncertainty were indicative of the timing of the Mott MacDonald work; and

(d) comments on the cross asset optimiser should be taken in the context that subsequent to the assurance report the 'must invest' was reduced to 30%.

100. Mott MacDonald subsequently supplied a letter that clarified its earlier views and included the observation from the report conclusion that ‘assets are often not linked to service or it is too generic to make a difference and so investment is often driven by assets, not service’. Mott MacDonald concluded in its letter to Bristol Water that ‘For your approach to be best practice you would need to improve source data, more closely link individual asset failures to service and increase the number of options available to the optimiser.’

101. While Ofwat has accepted that Bristol Water will have higher costs due to treatment complexity, these appear to be opex in nature (eg additional chemical dosing) rather than capex. There will be an impact on MNI, since a certain level of additional treatment plant is in use, but it is not clear if this is significant.

Other enhancement expenditure schemes

1. This appendix includes our assessment of smaller enhancement schemes. The basis of our review of these schemes has primarily been an assessment of evidence presented by Bristol Water.

Raw water deterioration schemes

2. We reviewed relevant evidence on the three individual schemes that, with Cheddar WTW, comprised Bristol Water's approach to addressing raw water deterioration.

3. We considered that DWI undertakings and orders that imposed a legal duty to deliver the schemes demonstrated need. Where a letter to commend had been issued by DWI, we considered this with additional supporting evidence.

4. We placed weight on Mott MacDonald's review with respect to whether the schemes were the most appropriate, and Mott MacDonald and Chandler KBS' (CKBS) respective work on whether the cost of the schemes was appropriate.

5. We set out the key pieces of evidence for each project in turn.

Barrow WTW UV

6. This scheme relates to the installation at Barrow WTW of ultraviolet light treatment equipment to inactivate cryptosporidium, a parasite that causes cryptosporidiosis, a gastrointestinal illness, in humans.

7. The scheme is included in Bristol Water's SoC at £6.8 million.[1]

Need

8. The scheme is subject to a DWI instrument to address cryptosporidium.[2]

9. Mott MacDonald reported to Bristol Water that it recognised the need for the scheme, and commended Bristol Water for its thorough assessment of the options.

[1] Bristol Water SoC, Table 82.
[2] DWI Barrow TW Regulation 28 Notice 2014.

10. We found that need had been demonstrated through the DWI's requirement for Bristol Water to undertake the scheme.

Most suitable option

11. We understand that slow sand filters are generally effective at removing cryptosporidium oocysts as part of water treatment,[3] and that slow sand filters are installed at Barrow. We further understand that exposing treated water to ultraviolet light is a standard additional treatment process for inactivating cryptosporidium and provides a safeguard to circumstances where other treatment processes fail to remove oocysts.[4]

12. Bristol Water has installed UV equipment at five water treatment works in AMP5.

13. We found that the proposed option was appropriate and further noted installation is a requirement of the DWI.[5]

Cost estimation

14. The scheme was included in a review by Mott MacDonald of large capital schemes which concluded that the project costs appeared to be in the right order of magnitude. We noted Bristol Water's statement that it had received a tender for the Barrow scheme that would give rise to a total cost of £6.9 million (2015-16 prices; equivalent to £6.5 million 2012-13 prices), compared to the £6.8 million included in its submission.

Stowey WTW pH correction

15. The scheme relates to the installation of sodium hydroxide storage and dosing equipment to maintain the alkalinity of treated water at Stowey WTW.

16. It is included in Bristol Water's SoC at £0.8 million.[6] It is the subject of a 'commend for support' letter from DWI.

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[3] DWI, Cryptosporidiosis: A report on the surveillance and epidemiology of Cryptosporidium infection in England and Wales, paragraph 8.9; Cryptosporidium in Water Supplies, Third report of the Group of Experts (The Bouchier Report), paragraph 5.3.1.
[4] UKWIR, UV Inactivation of Cryptosporidium (08/DW/06/20); Foundation for Water Research, Cryptosporidium in water supplies, 2011, p10.
[5] DWI Barrow TW Regulation 28 Notice 2014.
[6] Bristol Water SoC, Table 82.

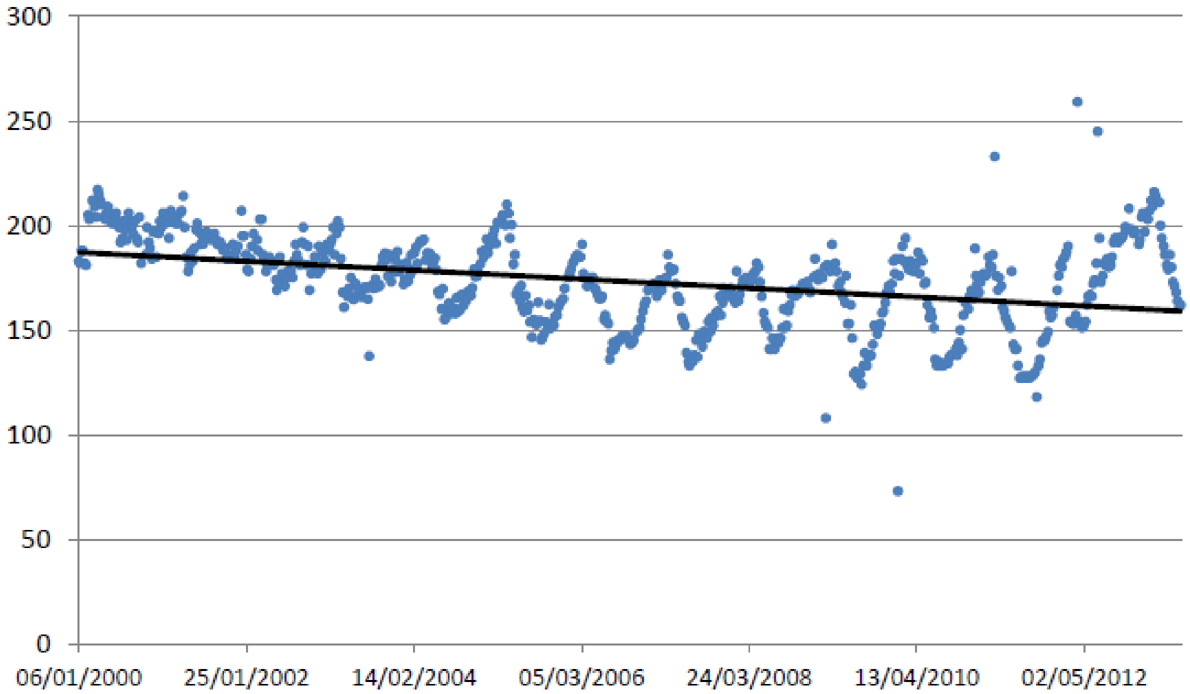
Need

17. Bristol Water stated that the final water quality leaving Stowey WTW demonstrates seasonal variation, including pH and alkalinity due to increased frequency and intensity of algal blooms in Chew Valley Lake as a result of raw water deterioration.

18. The scheme is subject of a 'commend for support' letter from DWI as it will improve the quality of the drinking water supplied to consumers at times when high levels of algae are present in the raw water. We noted that DWI stated that there was no clear link between the performance of the existing treatment processes and any non-compliance with the drinking water standards in the final water. We did not, however, discount the need for the scheme given Bristol Water's arguments on the possible impact of reduced alkalinity on corrosion of pipes.

19. Bristol Water presented evidence of a decrease in alkalinity (Figure 1). We noted the increase in 2012 but considered Bristol Water's argument that this was due to weather in 2012.

Figure 1 Alkalinity levels in Chew Valley Lake (mg/l as $CaCO_3$)



Source: Bristol Water's PR14 Business Plan – Wholesale Plan, Figure 74.

20. We considered that the evidence on alkalinity appeared to demonstrate the need for the equipment. We reviewed Bristol Water's argument on increased

levels of algae in the reservoir,[7] but did not consider whether algae was the specific cause of reduced alkalinity.[8]

Most suitable option

21. We noted that Bristol Water had introduced a catchment management plan to reduce the level of nutrients entering the raw water and affecting the level of algae, but that this wouldn't address algae levels in the short term.

22. We reviewed Bristol Water's assessment of possible options for this scheme and found that Bristol Water had presented a rational case for its chosen implementation of pH correction. We did not see evidence of Bristol Water's decision not to address the presence of algae (in response to specific blooms and in addition to its long-term catchment management).

23. We considered that the proposal was a relatively low cost capital project and would address the impact of algae in the short term, subject to the longer term catchment management plan.

Cost estimation

24. CKBS estimated that an appropriate benchmark for the project was £0.6 million against Bristol Water's initial estimate of £0.9 million (subsequently reduced post-efficiency to £0.8 million). Bristol Water stated that with an adjustment for risk, CKBS' benchmark would be £0.63 million.

25. Mott MacDonald reviewed the direct costs elements of the scheme (£0.4 million out of £0.8 million post-efficiency) and found they were in the right order of magnitude. We noted that Mott MacDonald found that benchmarked indirect costs were 79% of Bristol Water's across a number of projects. We adjusted the indirect cost element (£0.5 million of the original £0.9 million cost) by 21% (100 to 79%), which, when added to £0.4 million of direct costs, gave a figure of £0.8 million.

26. We found that the amount in included in Bristol Water's statement of case was broadly appropriate.

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[7] Bristol Water's PR14 Business Plan – Wholesale Plan, Figure 25.
[8] We noted Mott MacDonald's comments in 2013 that Bristol Water's analysis of apparent changing algal populations was not conclusive.

Metaldehyde catchment management

27. This scheme relates to a catchment management scheme for metaldehyde, a pesticide, and was included in the statement of case at £0.4 million.[9]

Need

28. This scheme is subject to a DWI undertaking requiring the existing catchment management scheme to be continued.[10]

29. Mott MacDonald reported that:

> 'The raw water supply to both the Purton and Littleton Treatment Works […] is known to contain metaldehyde, a molluscicide. Both of the treatment works are unable to remove metaldehyde to levels below the individual pesticide standard and there is a continual risk of drinking water failure with respect to individual pesticide or total pesticides at these works. There is no cost effective solution available for metaldehyde removal at these works […].'[11]

30. We found that the DWI undertaking demonstrated the legal requirement for Bristol Water to undertake the scheme.

Most suitable option

31. We found that DWI's undertaking prevented any significant optioneering.

Cost estimation

32. Mott MacDonald stated that:

> '[C]atchment management is the only viable option identified since treatment options are either not cost effective, or currently represent unproven technology requiring further development that cannot guarantee quality standards are met.'

33. On the issue of cost, Mott MacDonald responded to an LEF query that catchment management is likely to be the lowest totex solution until such time as an effective treatment process is available.

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[9] Bristol Water SoC, Table 82.
[10] There appear to be two versions of the undertaking dated 21 May and 29 May (DWI website).
[11] Mott MacDonald further stated that analytical records show that significant peaks in raw water metaldehyde content are not consistently reduced at either works to a level below the drinking water standard of 0.1 µg/l.

34. We have not reviewed evidence on the specific costing of the scheme given its relatively low size compared to other enhancement projects.

Growth Expenditure

Overview of the proposed enhancement

35. Bristol Water's proposed programme is to build four trunk mains and three reservoirs to accommodate population growth. It was included in Bristol Water's SoC at £12.5 million. The individual elements are set out in Table 1.

Table 1: Summary of BW Growth enhancement schemes

	£m
	Cost
Forum to Shepton Mallet Mains Reinforcement	1.4
Marksbury to Timsbury Mains Reinforcement	1.1
Paulton to Midsomer Norton Mains Reinforcement	0.5
Tetbury Main	0.3
Croscombe New Service Reservoir	2.1
Draycott New Service Reservoir	3.4
Windmill Hill New Service Reservoir	3.7
Total	12.5

Source: Bristol Water SoC, Table 82 (excludes growth element in Southern Resilience scheme).

36. Bristol Water told us that growth schemes could be categorised as one of the following:

(a) **Balancing supply and demand** – ensuring there is sufficient water to meet customer demand.

(b) **New development** – new mains to new properties.

(c) **Growth** – expenditure to reinforce the network in relation to overall growth.

37. Bristol Water told us that these growth schemes were in the final category.

Need

38. Ofwat, in its review of special cost factors, found that the company demonstrated that the projects planned to deal with growth were likely to be required.

39. We reviewed evidence on the need for the schemes based on Bristol Water's analysis of population projections. We noted Aqua's comments on the current level of capacity in service reservoirs across the network, but placed weight on Bristol Water's modelling of the localised effects of future growth, with

particular reference to 2020 and 2040 and the additional resilience that the schemes would provide to the respective local communities.

40. We considered that Bristol Water's evidence demonstrated evidence of need.

Most suitable option

41. We reviewed Mott MacDonald's conclusions on Bristol Water's growth schemes (set out in paragraph 50) and considered that this indicated that an appropriate consideration of options had been undertaken.

42. In its initial review of special cost factors Ofwat found that Bristol Water had set out the detailed 'optioneering' that had been carried out but it had not presented how these options fit with the overall least cost plan to maintain the supply/demand balance. Without visibility of these strategic options, Ofwat concluded that it was not possible to say if the detailed options selected were the most cost beneficial way of ensuring the supply demand balance was maintained.[12]

43. In its subsequent review of these growth schemes prior to final determination, Ofwat reviewed Bristol Water's evidence on its investment modelling (Wilco and Cross Asset Optimiser). Ofwat stated that Mott MacDonald's review showed Bristol Water's process was reasonable, using robust source data and specialist strategic network modelling to determine the potential effects on customers. Furthermore, Ofwat found that Mott MacDonald's assurance identified a strong 'line of sight' from the company's plans to accommodate population growth to outcomes for customers.[13]

44. We considered the above and found that the evidence that Bristol Water had presented demonstrated Bristol Water's optioneering was appropriate.

Cost estimation

45. Ofwat did not formally assess the robustness of the cost estimate but noted MM's review, which we discuss below.[14]

46. As part of its assurance programme Mott MacDonald sampled the Paulton to Midsomer Norton Mains project in September 2013. Mott Macdonald estimated its cost at some £0.36 million (49.0%) less than Bristol Water's pre-efficiency estimate of £0.74 million. As a result of the scale of this variance,

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[12] Ofwat, Bristol Water - Special Cost Claims, s5.
[13] PL14W011, Feeder template, Sheet DD06, cell G78.
[14] In Ofwat's view, Bristol Water had failed in its special cost claim to prove the need and cost benefit for the programme as an un-modelled cost because the total growth expenditure included in BW's business plan was below the bottom-up implicit allowance.

Bristol Water reviewed all of its growth mains laying projects, which was completed in September 2014.

47. Mott MacDonald also reviewed the Windmill Hill service reservoir in September 2014, and its benchmark was £0.11 million (2.6%) lower than Bristol Water's estimate of £4.2 million. Bristol Water's post-efficiency cost of £3.7 million is around 10% lower than Mott MacDonald.

48. The mains relining scheme (Paulton to Midsomer) reviewed by Mott MacDonald was also reviewed by CKBS as part of its benchmarking. CKBS estimated the cost at an almost identical level to Mott MacDonald (Mott MacDonald £0.377 million; CKBS £0.379 million). Bristol Water amended the costs in response to Mott MacDonald's review (to £0.528 million pre-efficiency, £0.462 million post-efficiency)) to which Mott MacDonald (referring to pre-efficiency costs) concluded:

> 'Mott MacDonald consider the direct costs are reasonable and offer a high level of confidence. In addition the recent cost reduction with regards to the in-directs also offer more confidence.'

49. Mott MacDonald concluded on a review of five growth schemes (including both Paulton to Midsomer and the Glastonbury Street scheme) that:

> 'We found that overall your costs were about 18% lower than the competitor average although corporate overhead costs had not been included. We considered the direct costs were robust and aligned well with your previous out-turn costs. We made suggestions to better align the estimating techniques of different suppliers.'

50. Mott MacDonald further concluded that:

> 'We reviewed your approach to modelling growth and the cost assumptions you have made. Your process was reasonable, using a robust source data and specialist strategic network modelling to determine the potential effects on customers. There is a strong 'line of sight' from your plans to accommodate population growth to outcomes for customers.'

51. Mott MacDonald identified in its initial review that there were some inconsistencies in the approach to costing of different growth schemes by the two firms (Atkins and Black & Veatch) that were responsible for the design of one or other, and that only Black & Veatch's estimates were sufficiently detailed to allow its projects to be benchmarked. Similarly, Mott MacDonald

found that in a review of the opex costs for large capital schemes, the reports provided for review did not provide detailed calculations to support each cost area.

52. We found that the scheme costs included in Bristol Water's SoC appear to be appropriate, but note that Bristol Water's initial cost estimation appeared to be significantly above an industry benchmark.[15]

National Environment Programme

Overview of the proposed enhancement

53. Water companies are required by Defra to include schemes in Business Plans to address adverse environmental impacts. The schemes required are compiled as the NEP by the EA every five years.

54. AMP6 is the first time that Bristol Water has been subject to a requirement under the NEP.[16] Broadly, the schemes that Bristol Water is required to complete are:

(a) catchment management;

(b) baseline surveys;

(c) invasive species investigations; and

(d) eel protection.

55. The schemes are included in Bristol Water's SoC at £11 million. The individual schemes that Bristol Water intend to pursue to comply with the NEP are set out in Table 2.

Table 2: Sustainable environmental impact schemes

Scheme	*Performance commitment*	*Regulatory requirement*	*Expenditure*
Catchment management	Raw water quality of sources	NEP	4.0
Baseline surveys	Raw water quality of sources	NEP	0.9
Invasive species investigations	Biodiversity index	NEP	0.1
Eel protection	Biodiversity index	EA exemption notice	6.0
		Total	11.0

Source: Bristol Water SoC, Table 85.

[15] In this regard, we also noted that the Glastonbury and Street scheme, which was not included in Bristol Water's SoC was subject to CKBS benchmarking which found a benchmark to be 29% lower than Bristol Water's estimated costs.
[16] Such obligations arise from UK and European legislation including the Water Framework Directive (WFD), The Countryside and Rights of Way Act 2000, The Environmental Permitting Regulations 2010 and the Eels (England and Wales) Regulation (2009) (Eels Regulation). Bristol Water SoC, s2.4.3.2.

Need

56. Bristol Water state that the requirements under the NEP are mandatory, and failure to comply is subject to financial penalties and/or enforcement orders, and the validity of Bristol Water's permits to abstract water are linked to compliance with the NEP.

57. Ofwat made no comments on the need of the projects.

58. We noted Mott MacDonald's comment that that it was unclear whether eels were present in the canal and whether they were being affected by the current abstraction, and hence whether changes at Purton would have any beneficial effect. Bristol Water told us that eel protection works were required in watercourses that historically would be expected to have an eel population.

59. We found that Bristol Water had provided evidence that there is a statutory obligation to achieve the requisite standards that these schemes seek to deliver.

Most suitable option

60. Ofwat made no comments on the suitability of the projects.

61. We reviewed Bristol Water's evidence and focused on catchment management (£4 million) and eel protection (£6 million), which comprise 91% of the NEP schemes by expenditure.

Cost estimation

62. The project passed Ofwat's robustness of estimate assessment gateway during the risk-based review.

63. We reviewed Mott MacDonald's assurance work and noted that Mott MacDonald considered that because of the uncertainty of the effectiveness of the approach adopted by Bristol Water in protecting eels in the Sharpness that its cost may be understated.

64. Ofwat did not raise specific concerns with the cost estimation of this project.

65. We did not find evidence to indicate that Bristol Water's cost estimation was inappropriate.

Asset reliability – discoloured water contacts

Overview of the proposed enhancement

66. This scheme seeks to reduce negative contacts (complaints) relating to discoloured water by relining 30.5km of iron pipes to prevent leaching. Bristol Water included a cost estimate of £10.2 million for this scheme in Bristol Water's SoC.

67. Bristol Water included a performance target to reduce negative water quality contacts by 14% in its business plan. In its stage 2 acceptability research, customers ranked reducing the number of complaints about discoloured water as ninth in importance for investment.

Need

68. No disagreement around need appears to exist.

69. We reviewed Bristol Water's submitted evidence on its targeted reduction in discoloured water contacts and relevant customer preference and found that it demonstrated need, and noted the amendment to the scheme to reflect customer priorities.

Most suitable option

70. Bristol Water stated that discoloured water was one of the most volatile elements of its commitment to reduce 'negative water contacts'. Bristol Water undertook an investigation as to the cause of discolouration found that 'leaching' from iron trunk mains was the cause. Bristol Water initially identified 143km of mains as being potential contributors to the discolouration experienced by customers. Following further investigation and cost benefit studies, Bristol Water found that relining some 30.5km (set out in Table 3), together with some operational activities would provide a reduction of discoloured water contacts, which would be supported by its customers.[17]

[17] Bristol Water SoC. Bristol Water originally identified 143km of cost beneficial trunk mains relining work. As part of customer engagement it asked customers to consider a plan involving 47km of relining with an improvement of 19% in the number of negative water quality contacts (ie a reduction from 2,572 down to 2,081). Customers however did not consider this to be a key area for investment, and Bristol Water reduced the level of improvement to 14% (ie a reduction from 2,572 down to 2,221).

Table 3: Summary of proposed relining

Scheme	*km* *Length*
12inch Fishponds Rd to Durdham Down	9.1
12inch/16inch Summerlands Rd, Weston	3.8
18inch Chelvey to Portishead	8.4
27inch Portway	3.7
8inch WWM2252 to Durdham Down	1.0
Henleaze Rd- Durdham Down	4.5
Total	30.5

Source: Bristol Water.

71. We found that given the nature of customer complaints on discoloured water and Bristol Water's approach to investigating the cause of discolouration, the proposed project appears appropriate. The length of mains subject to relining has been adjusted to reflect relative customer priorities.

Cost estimation

72. The relining costs were reviewed by Mott MacDonald as part of its review of capital costs of large schemes. Mott MacDonald raised a number of concerns with its trunk mains schemes, which Bristol Water responded to. It was not clear from our review of the Mott MacDonald document what the final outcome of some of the cost challenges was. However, we noted that the claimed cost of the scheme had reduced significantly by £2 million from the Ofwat draft determination.[18]

73. Relining schemes were included by Aqua in its review of mains replacements schemes. It found that Bristol Water had included a significant level of risk and contingency in its cost estimates that it did not expect, given the nature of the scheme. Aqua considered that £9.54 million would be an appropriate level of expenditure on the scheme.

[18] In the draft determination, Bristol Water had sought £12.3 million.

Reconciliation of Bristol Water performance

1. The following appendix provides additional details and calculations made when considering the reconciliation of Bristol Water's performance.

2. This should be read in conjunction with the representations and reasoning made in the provisional findings document.

3. The rest of this appendix follows the structure:

   (a) Ofwat assessment of Bristol Water's serviceability;

   (b) Summary of Bristol Water major DG3 UI>12 events;

   (c) DG3 UI>12 Comparison between 2010 workshop exercise and Bristol Water's current situation;

   (d) Ofwat statements around updated guidance on assessing serviceability;

   (e) COPI figures;

   (f) Views on accuracy of COPI series; and

   (g) Party views on CIS indexation methods.

Ofwat assessment of Bristol Water's serviceability

4. Table 1 below shows the serviceability indicators, and Ofwat's assessment of Bristol Water's performance in 2010-15.

Table 1: Table of serviceability measure and Ofwat assessment

	Description of metric	*Ofwat assessment of Bristol Water*
Infrastructure metrics	Total bursts (#)	Stable
	DG3 interruptions >12hr (# properties)	Deteriorating
	Iron non-compliance (% mean zonal compliance)	Stable
	DG2 low pressure (# properties)	Stable
	Customer contacts - discolouration (#/1000 properties)	Stable
	Distribution index TIM (% mean zonal compliance)	Stable
Non-infrastructure metrics	Water treatment works coliforms non-compliance (%)	Stable
	Service reservoir coliforms non-compliance (%)	Stable
	Turbidity performance at treatment works (#)	Stable
	Enforcement orders from DWI (# incidents)	Stable
	Unplanned maintenance (#)	Stable

Source: Bristol Water SoC, Tables 120 and 121; Bristol Water company-specific appendix, Tables AA3.8 and AA3.10.

5. Serviceability was primarily based around whether performance in this set of indicators oscillated around the reference level and within the control limits that were specified at FD09 (or subsequently amended in 2012). Where

performance did this, it was considered to be stable. Where it did not, performance was assessed as not being stable (either marginal or deteriorating).

6. Ofwat states that it then considered out a case-by-case review of any evidence companies provide to explain the impact of exceptional events that were outside the control of the company on performance. This could include commissioning external assurance on its judgements on company claims around exceptional events.

7. Bristol Water was assessed as being ‘deteriorating’ in a single metric (and hence ‘deteriorating’ on its infrastructure serviceability), and as such had a shortfall applied of £4.1 million to its RCV. This metric is referred to as DG3 UI>12, and represents the number of properties which experienced an unplanned interruption for more than 12 hours.

Summary of Bristol Water major DG3 UI>12 events

8. There were a number of specific larger events which contributed to Bristol Water exceeding its DG3 UI>12 allowances over the past ten years.

9. Based on Bristol Water’s interpretation of Ofwat’s guidance, successive increases in 2014 and 2015 above the control limit alone would result in a ‘marginal’ assessment[1] and hence a shortfall being applied. Therefore, consideration of the events in these two years is key.

10. A summary of the events which resulted in Bristol Water exceeding its control limits for DG3 UI>12 in these two years is included in Table 2 below. This included CH2M’s assessment of degree of management control.

[1] Bristol Water SoC, paragraphs 1811-1812, 1831.

Table 2: Summary of major events impacting DG3 UI>12 (>100 properties), 2014 and 2015

Event name	*Year*	*# of Properties*	*Time*	*Details of activity*	*Ofwat's view*	*Bristol Water's view*	*CH2M assessment of management control*		
							Fully within control	*Partially within control*	*Outside control*
Luckington Bridge	2014	801	17 hrs	During a planned shutdown of a mains pipe, crew accidently left a valve partially closed	• Not outside management control, as due to one of the company's valves being partially closed	• Was planned works that ran into difficulties therefore does not represent an infrastructure investment issue • Due to human error (of a contractor) despite planning, preparation, and risk assessments • CH2M determined event was entirely unpredictable	10 hrs	7 hrs	-
Wedmore Vale	2015	450	15 hrs 4 mins	A burst pipe which required a deep excavation in unstable ground, close to a park gate as well as gas and electricity mains, and requiring additional shoring (after the trench collapsed). Complications with re-zoning prevented its use.	• Not outside management control, as delays were due to staff not having appropriate training or competence for installation of shoring	• Complex repair, including proximity to gas and electrics • Delays from need for bigger shoring to complete the repair • H&S concerns identified during event requiring deep excavation training were exceptional • CH2M concluded that elements beyond/partially within control extended the interruption beyond 12 hours	-	12 hrs 3 mins	3 hrs
Burnham-on-Sea	2015	12,270	14 hrs 15 mins	Large burst at extremity of area-time for crew to reach, which required a particularly large and deep excavation.	• The material of the main (asbestos cement) is known to fail at a much higher frequency, yet no mention of a separate risk assessment • Particularly lacking given the large number of properties the mains served • No contingency plans in place	• Complex repair • Service reservoir ran dry and needed refilling • Both the material used and the mains in question, were not considered higher risk than others due to historic burst rate comparisons • An alternative pipe was in process of being replaced due to high burst rates, which overran due to complexity of the repair • CH2M concluded that significant elements of the event which were only partially in management's control extended the interruption beyond 12 hours	-	14 hrs 15 mins	-

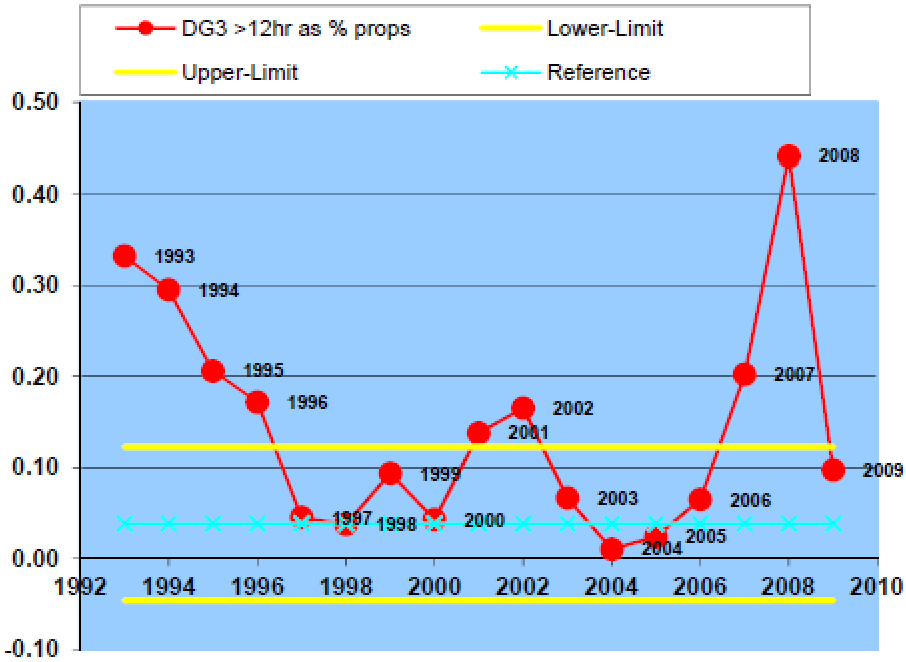
Event name	Year	# of Properties	Time	Details of activity	Ofwat's view	Bristol Water's view	*CH2M assessment of management control* Fully within control	Partially within control	Outside control
Fisher Road/ Kingswood	2015	28,391	43 hrs	Large burst main. Crew were denied access for 21 hours by Fire Service due to potentially ruptured gas main. 8 hours of repair. Wessex Water also onsite in case of failure in nearby sewage network which could contaminate water. 11 hours delay due to gas provider monitoring an adjacent mains. Re-zone was considered (to protect 9,000 houses) but rejected due to high risk of discolouration.	• Wider network was less resilient at time of outage due to planned outages of numerous principal trunk mains • Management had made the choice to manage their network and associated risks this way	• 21 hour delay as Fire Service prevented access • Led to service reservoir and parts of the network running dry which needed to be refilled and flushed • Only a single additional main was out of service, and had it been operating, 8k households would still have been affected • CH2M concluded that elements beyond/partially within control extended the interruption beyond 12 hours	3 hrs	8 hrs	32 hrs

Source: Bristol Water SoC, paragraphs 1866-1876; Bristol Water reply paragraphs 510-519; Ofwat response paragraphs 508-510.
Note: CH2M assessment taken from SOC334, in answer to: 'Identify how much, if any, of the duration of the interruption was caused by aspects outside management control'.

Comparison between 2010 workshop exercise and Bristol Water's current situation

11. In its SoC, Bristol Water presented charts on bursts (as it was considered to be the headline indicator) and DG3 UI>12. Regarding DG3 UI>12, Bristol Water highlighted the relevant example chart in the workshop:

Figure 1: Ofwat Serviceability 2010 Workshop Exercise 2, Question 1: DG3 Interruptions >12 Hours



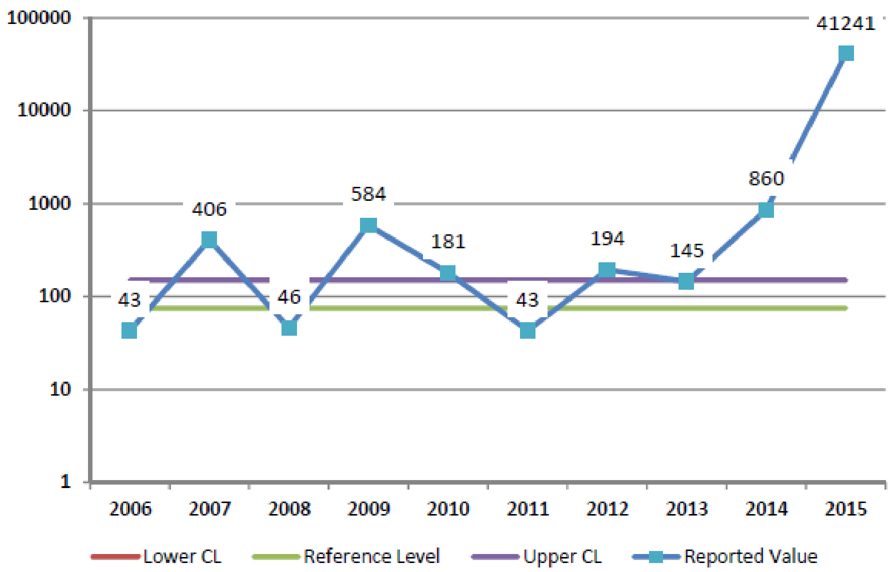
Source: Bristol Water SoC, Figure 87.

12. It compared this with its own performance in DG3 UI>12, as is shown in Figure 2 below, commenting that they appear analogous.[2]

Figure 1: Bristol Water Serviceability DG3 UI>12 performance

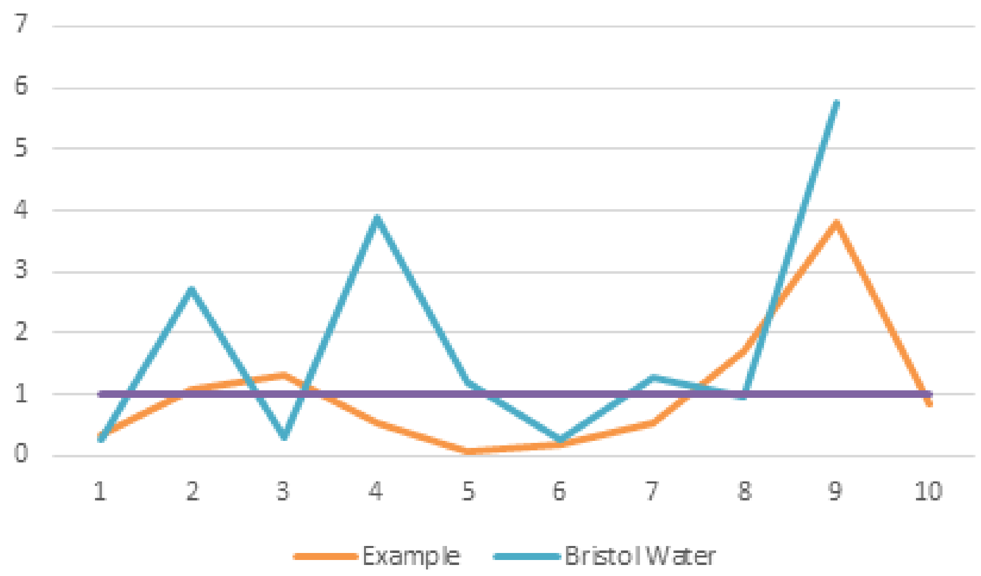
[2] Bristol Water SoC, paragraph 1823.

Source: Bristol Water SoC, Figure 89.



13. We note that the relative scales of these charts (including the use of a logarithmic scale in Figure 1) are potentially misleading, and converting figures to a percentage of the control limit (such that any figures >1 represent exceeding the limit) and putting on the same axis may provide a better comparator. This is provided both with and without Bristol Water's performance in the final year due to issues with scale (see Figure 3).

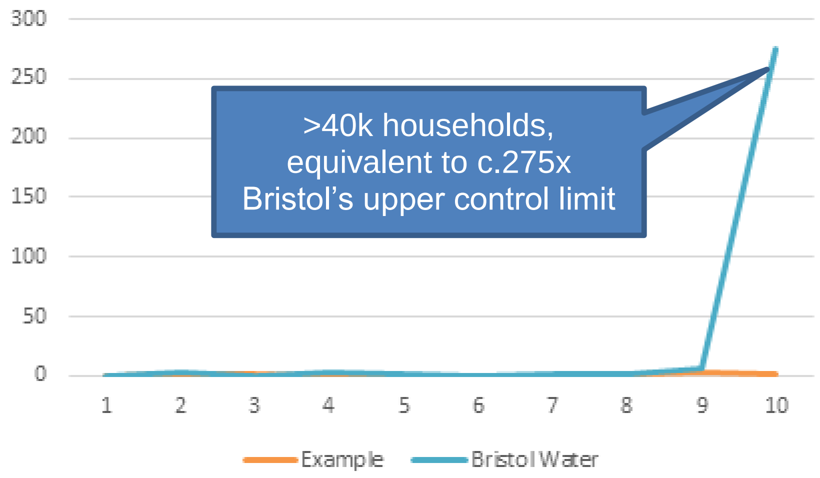
Figure 3: Example vs Bristol Water scaled to control limit, last 10 years data, excluding final year for Bristol Water



Source: CMA analysis, Bristol Water SoC Figure 89.

14. Figure 4 shows that the scale of the performance breach by Bristol Water was substantially in excess of scales in the workshop example, which also reduced to being below the upper control limit prior to the end of the period:

Figure 4: Example vs Bristol Water scaled to control limit, last 10 years data, including final year for Bristol Water



Source: CMA analysis, Bristol Water SoC Figure 89.

15. Bristol Water also provided the following table from the workshop exercises in support of its overall assessment.

Table 3: Ofwat Serviceability 2010 Workshop Exercise 2, Question 1

Sub Service	*Indicator*	*Notes*
Bursts	Stable	Headline indicator
DG3	Marginal	
Fe	Stable	
DG2	Stable	
Discoloured	Stable	
TIM	Stable	
Assessment	Stable	

Source: Bristol Water SoC, Table 122.

Ofwat statements around updated guidance on assessing serviceability

16. Ofwat states that Bristol Water referred to RD15/06 which was published in 2006, but that this was superseded by final determinations at PR09, where Ofwat set out its methodology both in the confidential supplementary reports that were sent to companies alongside the 2009 final determination, and the public letter PR09/38.[3]

[3] Ofwat response, paragraph 103.

17. Ofwat states that its expectation, as set out in its FD09 supplementary report, was for each company to monitor its performance against the indicators and to manage and maintain assets such that all indicator values remain well within the control limits and that they exhibit a stable or improving trend year on year. In particular, it highlighted text stating:[4]

> ‘Should you fail to demonstrate a stable or improving trend in **any indicator** in 2014 our starting point will be a shortfall in output’ (emphasis added by Ofwat subsequently).[5]

18. Ofwat also referenced a statement from its technical summary document from PR09 (PR09/38) on individual indicators:

> ‘We expect the companies to monitor **each indicator** and to manage and maintain assets so that **all indicator values** remain well within the control limits’ (emphasis added by Ofwat subsequently).[6]

19. Nor does Bristol Water mention the timeline published in PR09/38 in which Ofwat said on short-falling consequences:

> ‘Stable serviceability required for **all indicators** from 2012, if less than stable company should assume it is at risk of shortfall. Shortfall will be applied at the next periodic review if marginal or deteriorating in 2014"’(emphasis added by Ofwat subsequently).[7]

COPI figures[8]

20. The figures quoted by BIS/ONS for COPI are as follows (note the series use different base years).

Table 4: Construction output price indices

	2007-08	*2008-09*	*2009-10*
CC10 1995 COPI	162.5	159.0	149.6
Finalised 1995 COPI	162.5	159.0	149.3
2005 COPI	111.3	114.0	110.5

Source: Ofwat, Bristol Water, ONS.

[4] Ofwat response, paragraph 488.
[5] Ofwat response, paragraph 104.
[6] Ofwat response, paragraph 489.
[7] Ofwat response, paragraphs 104 and 490.
[8] Annual figures based on mean averages of quarterly data (where 2007-08 = 2007Q2 to 2008Q1 inclusive). ‘COPI’ refers to the ‘All new construction output price index’, which reflects the output price for all tracked types of new construction projects in the period.

21. Indexing these to 100 in 2007/08 (set as the base year) results in the following indices.

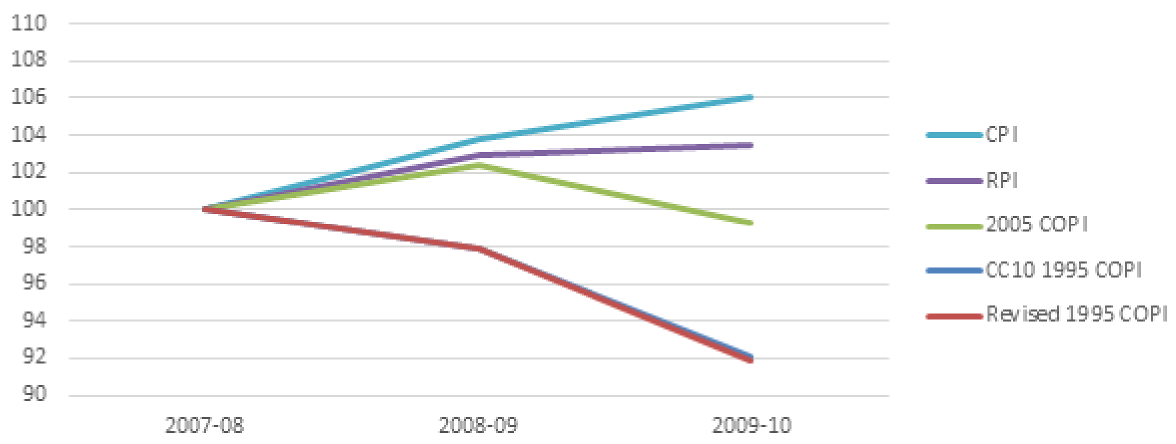
Table 5: Construction output price indices, indexed to 100 in 2007-08

	2007-08	*2008-09*	*2009-10*
CC10 1995 COPI	100.0	97.8	92.1
Finalised 1995 COPI	100.0	97.8	91.8
2005 COPI	100.0	102.4	99.3

Source: Ofwat, Bristol Water, ONS.

22. These indexed figures, along with RPI and CPI, can be displayed graphically as shown below:

Figure 5: COPI series, RPI and CPI over time period in question



Source: Ofwat, Bristol Water, ONS.

Views on accuracy of COPI series

23. We considered how well the series reflected underlying cost inflation rates, and in particular the expected accuracy of each series in doing so.

24. In principle, series are revised in order to more accurately reflect the underlying conditions they are trying to reflect. This would imply that, in theory, the updated 2005 series should more accurately reflect underlying inflation.

25. However, we note that there are significant ongoing concerns around the accuracy of the 2005 COPI series, and COPI in general. COPI was revised twice in 2010,[9] and is currently suspended from being issued due to concerns regarding its methodology.[10]

26. This would imply that any improvements in accuracy from changing series are likely to be small, if they exist at all.

27. We also put weight on guidance issued by BIS at the time of the first revision which stated that for existing arrangements, the original series should be used up to 2Q 2010.

> 'in any existing arrangement for the OPIs (2010) for New Construction […], where the old superseded 1995=100 series [1995 COPI] […] are being used, and subject to the wording of any contract, they should continue to be used up until 2Q2010'.[11]

28. If followed in this case, the BIS guidance would imply that it is not appropriate to change methodology to use the 2005 COPI series based on arguments around increased accuracy.

Party views on CIS indexation methods

29. The actual capex for the period is compared with the allowed amount to determine the value to add to the RCV.

30. Both of these values need to be converted to 2007/08 prices (the base year used for PR09), for which Ofwat used the following approach:

    (a) Adjust actual capex using outturn RPI.

    (b) Adjust allowed capex to outturn prices using COPI, then deflate using RPI.

31. For the second of these steps, Ofwat now states that it was inconsistent in its use of RPI. It used **outturn RPI** for this calculation, but **forecast RPI** for its

[9] Annual construction statistics. See figures in Table 4.9 that show different values for COPI. Also referenced in subsequent guidance such as COPI notes and definitions (methodology and revision policy), page 2 which refers to an 'old 2010 series'.
[10] Suspended by BIS in December 2014, with subsequent transfer of responsibility to ONS on 1 April 2015; Suspension of construction OPIs, BIS; Update on Construction Output Statistics, ONS, 8 May 2015.
[11] COPI notes and definitions (methodology and revision policy), page 2, bullet 2.

financing cost adjustments.[12] It therefore proposes using **forecast RPI** in this calculation as well.[13]

32. Bristol Water also highlighted that the FD09 methodology which used **outturn RPI** but **forecast COPI** resulted in companies bearing RPI risk (which the regulatory regime is designed to avoid). It elaborated around the risks the company bears through different methods, as shown in Table 6 below.

Table 6: Possible methods and implied impact on Bristol Water

	RPI used	*COPI used*	*Impact on Bristol Water*
Method 1 (Final Determination)	Outturn	Forecast	N/A
Method 2 (Current proposition)	Forecast	Forecast	–£9.3m
Method 3 (Bristol Water possible alternative)	Outturn	Outturn	+1.1m

Source: Bristol Water.

33. On 26 March 2015, Ofwat published a consultation on its proposed approach (Method 2) which applies to all the licensees.

34. Bristol Water said that either method 2 or method 3 should be used depending on Ofwat's intentions at the time around whether companies were expected to bear RPE (real price effects) risk.[14]

35. Bristol Water stated that it has had insufficient time to review the PR09 methodology to determine which approach was intended, but highlighted that PR04 and earlier specifically protected the companies from RPE risks whilst PR14 specifically did not (ie companies bear the risk).

[12] The discount factor (for which RPI is a component) used to account for timing differences used to reconcile between the final determination and actual performance; PWC PR14 Reconciliation Rulebook March.
[13] Ofwat response, paragraph 515.
[14] Real price effects is the difference between RPI and COPI and represents the differential inflation of capital costs.

Outcome Delivery Incentives

1. The following appendix provides additional details and calculations made when considering Bristol Water's Outcome Delivery Incentives (ODIs).

2. This should be read in conjunction with the representations and reasoning made in the provisional findings document.

3. The rest of this appendix follows the structure:

   (a) Bristol Water vs Ofwat target levels for three metrics in contention.

   (b) Theoretical basis for ODIs.

   (c) Use of rewards in ODIs.

   (d) Unplanned customer minutes lost calculations.

   (e) Mean zonal compliance (MZC) industry performance data.

   (f) Bristol Water's views on reducing taste complaints.

   (g) Bristol Water Negative Water Quality Contacts.

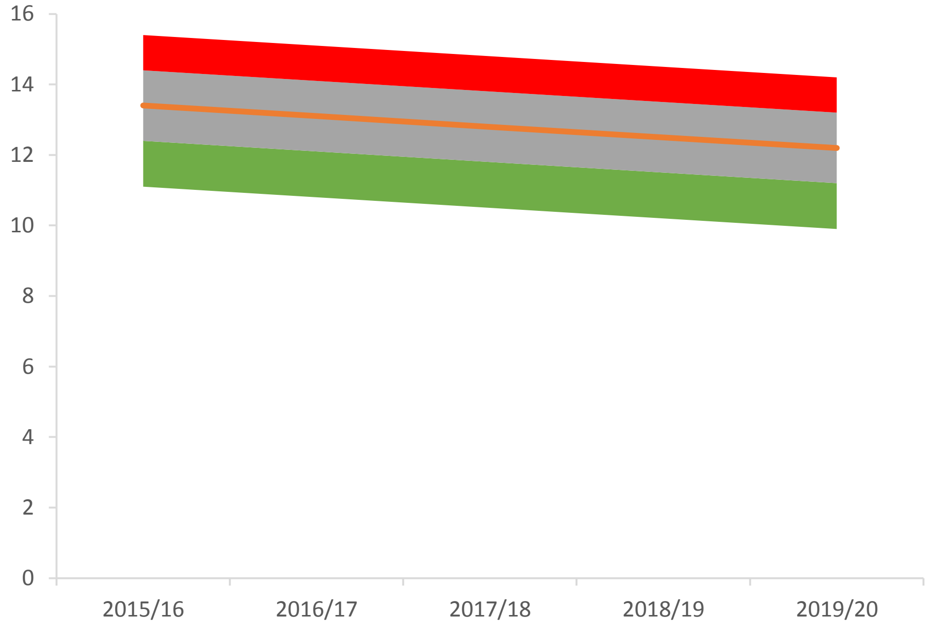
   (h) Bristol Water cross-industry service performance data provided to customers during research phase.

Bristol Water vs Ofwat target levels for three metrics in contention

Unplanned customer minutes lost

4. Figure 1 and the supporting table show Bristol Water's ODI figures for unplanned customer minutes lost:

Figure 1: Unplanned customer minutes lost ODIs – Bristol Water



Source: Bristol Water.

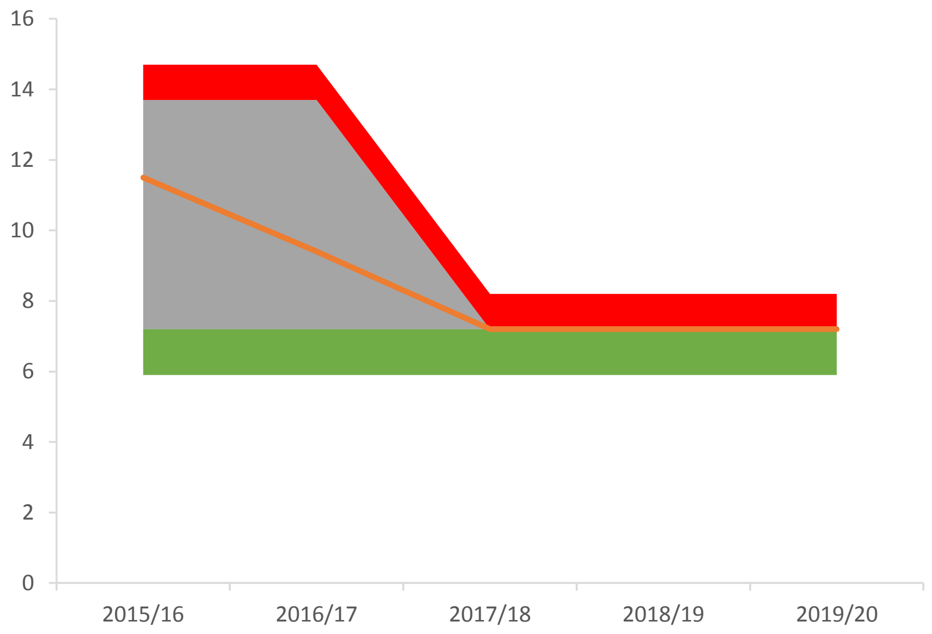
Table 1: Unplanned customer minutes lost ODIs – Bristol Water

	Current	*2015/16*	*2016/17*	*2017/18*	*2018/19*	*2019/20*
Reward Cap		11.1	10.8	10.5	10.2	9.9
Reward Deadband		12.4	12.1	11.8	11.5	11.2
Target	13.7	13.4	13.1	12.8	12.5	12.2
Penalty Deadband		14.4	14.1	13.8	13.5	13.2
Penalty Collar		15.4	15.1	14.8	14.5	14.2

Source: Bristol Water.

5. Figure 2 and the supporting table show the results of Ofwat's intervention on the ODI for unplanned customer minutes lost:

Figure 2: Unplanned customer minutes lost ODIs – Ofwat



Source: Ofwat.

Table 2: Unplanned customer minutes lost ODIs – Ofwat

	Current	*2015/16*	*2016/17*	*2017/18*	*2018/19*	*2019/20*
Reward Cap		5.9	5.9	5.9	5.9	5.9
Reward Deadband		7.2	7.2	7.2	7.2	7.2
Target	13.7	11.5	9.4	7.2	7.2	7.2
Penalty Deadband		13.7	13.7	7.2	7.2	7.2
Penalty Collar		14.7	14.7	8.2	8.2	8.2

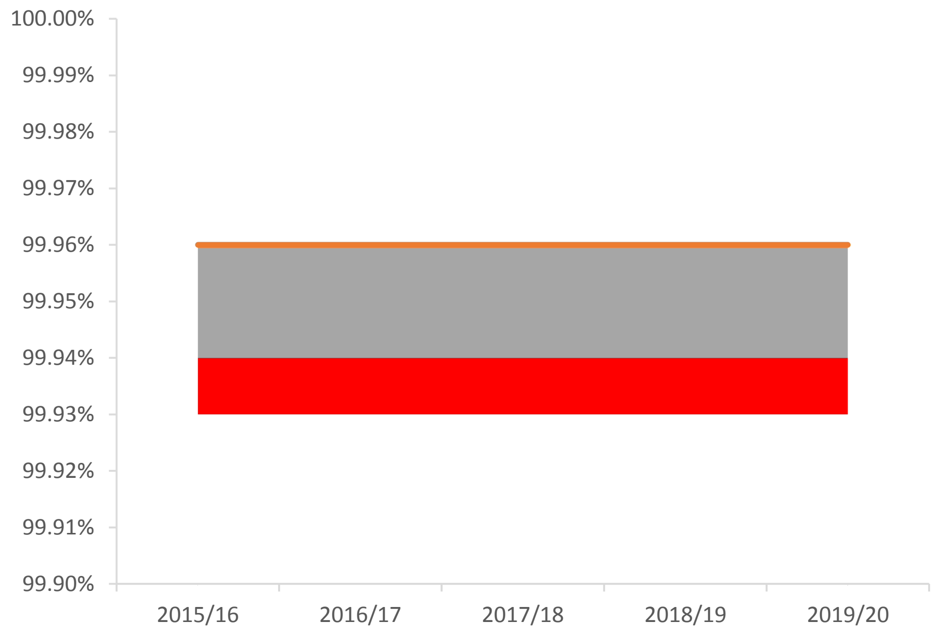
Source: Ofwat.

Mean zonal compliance

6. Mean zonal compliance (MZC) has a financial incentive (penalty only) with the standard level being uncontentious and only the penalty deadband and collar being contested.

7. Figure 3 and the supporting table show Bristol Water's ODI figures for MZC (note that the scale on this chart is broken to allow the data to be seen):

Figure 3: Mean zonal compliance ODIs – Bristol Water



Source: Bristol Water.

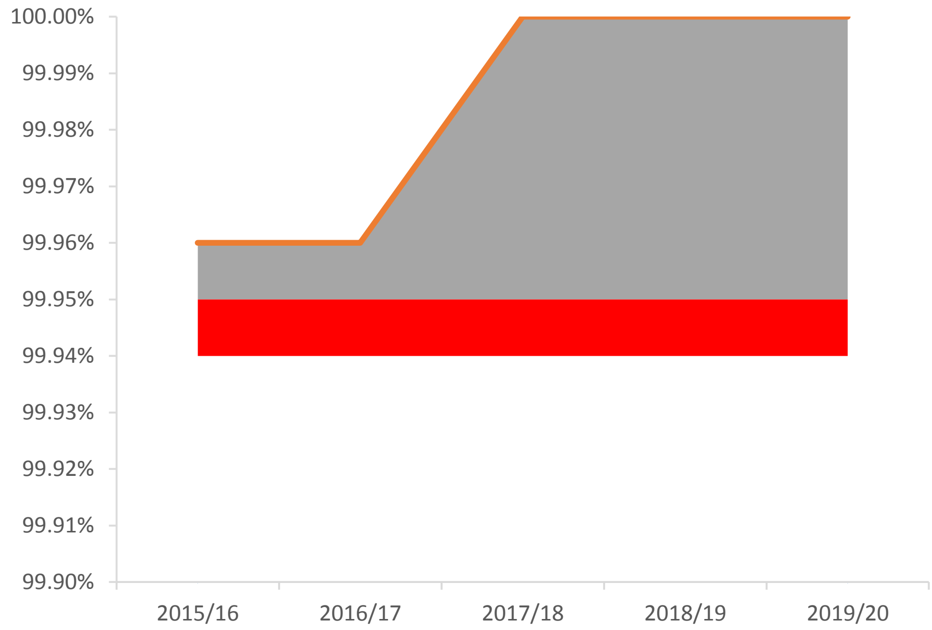
Table 3: Mean zonal compliance ODIs – Bristol Water

						%
	Current	*2015/16*	*2016/17*	*2017/18*	*2018/19*	*2019/20*
Standard	99.96	99.96	99.96	99.96	99.96	99.96
Penalty Deadband		99.94	99.94	99.94	99.94	99.94
Penalty Collar		99.93	99.93	99.93	99.93	99.93

Source: Bristol Water.

8. Figure 4 and the supporting table show the results of Ofwat's intervention on the MZC ODI (the axis remains broken at the same point as the Bristol Water chart for comparison purposes):

Figure 4: Mean zonal compliance ODIs – Ofwat



Source: Ofwat.

Table 4: Mean zonal compliance ODIs – Ofwat

%

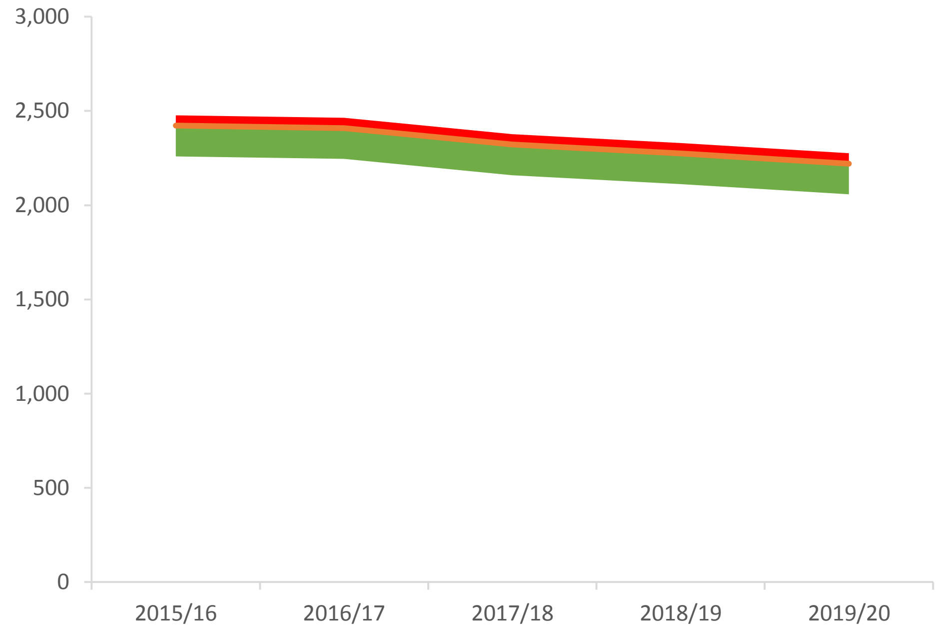
	Current	*2015/16*	*2016/17*	*2017/18*	*2018/19*	*2019/20*
Standard	99.96	99.96	99.96	100.00	100.00	100.00
Penalty Deadband		99.95	99.95	99.95	99.95	99.95
Penalty Collar		99.94	99.94	99.94	99.94	99.94

Source: Ofwat.

Negative water contacts

9. Figure 5 and the supporting table show Bristol Water’s ODI figures for negative water quality contacts:

Figure 5: Negative water quality contacts ODIs – Bristol Water



Source: Bristol Water.

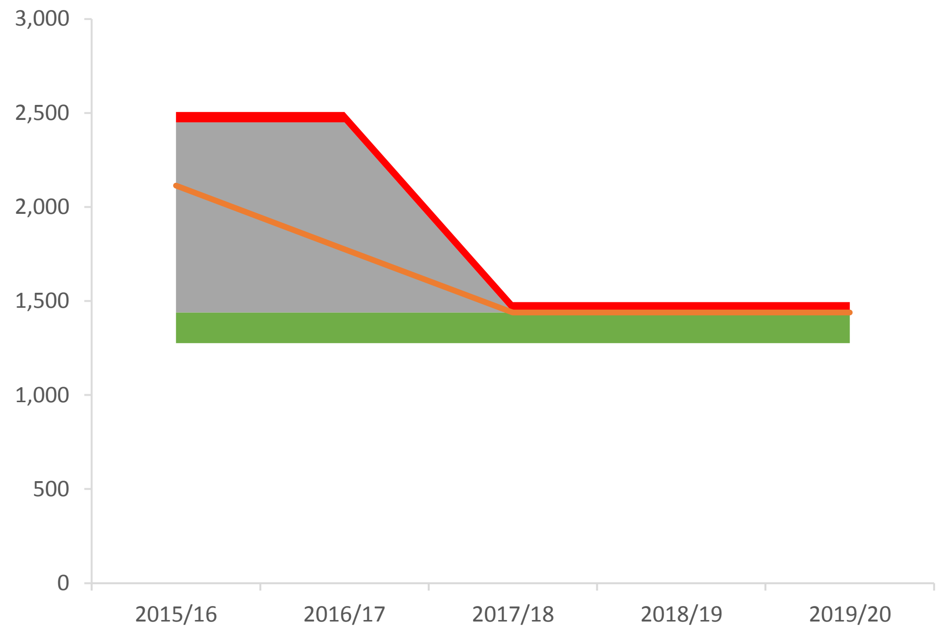
Table 5: Negative water quality contacts ODIs – Bristol Water

	Current	*2015/16*	*2016/17*	*2017/18*	*2018/19*	*2019/20*
Reward Cap		2,259	2,246	2,159	2,112	2,058
Reward Deadband		2,422	2,409	2,322	2,275	2,221
Target	2,450	2,422	2,409	2,322	2,275	2,221
Penalty Deadband		2,422	2,409	2,322	2,275	2,221
Penalty Collar		2,477	2,464	2,377	2,330	2,276

Source: Bristol Water.

10. Figure 6 and the supporting table show the results of Ofwat's intervention on the ODI for negative water quality contacts:

Figure 6: Negative water quality contacts ODIs – Ofwat



Source: Ofwat.

Table 6: Negative water quality contacts ODIs – Ofwat

	Current	*2015/16*	*2016/17*	*2017/18*	*2018/19*	*2019/20*
Reward Cap		1,276	1,276	1,276	1,276	1,276
Reward Deadband		1,439	1,439	1,439	1,439	1,439
Target	2,450	2,113	1,776	1,439	1,439	1,439
Penalty Deadband		2,450	2,450	1,439	1,439	1,439
Penalty Collar		2,505	2,505	1,494	1,494	1,494

Source: Ofwat.

Theoretical basis for setting performance commitment targets

11. The development of a reasonable target which companies should be targeting includes three components:

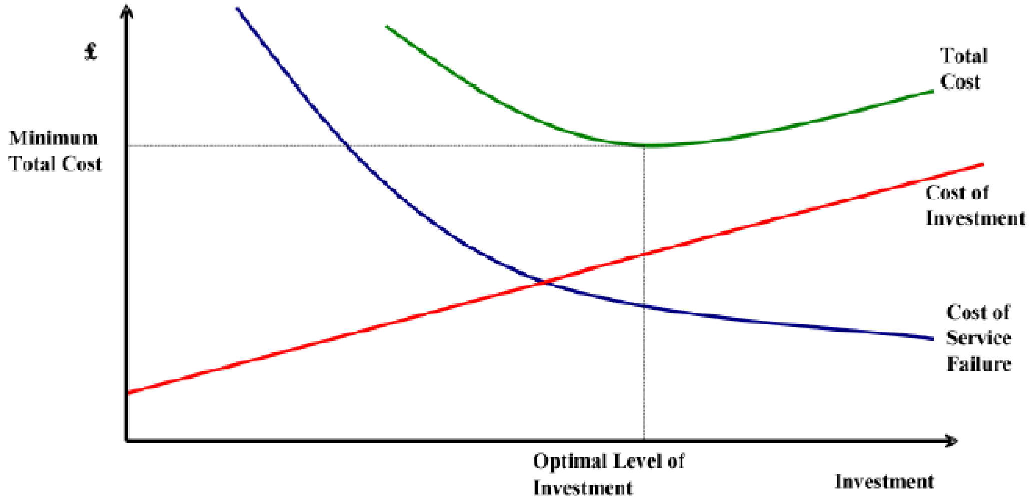
(a) the investment cost required to improve the metric to a particular level;

(b) the cost when a problem occurs; and

(c) the impact this has on consumers.

12. Bristol Water provided the following figure to help illustrate this concept (it has chosen to combine the second and third components that we discussed, and referred to this as the 'cost of service failure'):

Figure 7: Level of investment and cost



Source: Bristol Water.

13. For example, if considering leakage, the three components could be considered as:

    (a) the cost of replacing pipes to reduce leakage;

    (b) the ongoing cost of water lost to leakage; and

    (c) customers' views on the wastefulness of lost water.

14. It is therefore possible to use the economic level as an initial target (which includes the optimum balance of investment cost and required cost to fix), and then adjust this based on customer willingness to pay (an estimation of the impact on consumers).

Use of rewards in ODIs

15. Ofwat's approach encouraged companies to propose ODIs that included financial rewards for out-performance, in addition to penalties for poor performance.

16. Both CCWater[1] and the LEF suggested that it is not appropriate to fund financial rewards for out-performance through higher customer bills. Bristol Water's customers also rejected the concept of rewards being funded through an increase in bills.[2]

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[1] Summary of hearing with CCWater, paragraph 17.
[2] Summary of hearing with CCWater, paragraph 17.

17. Bristol Water agreed with this penalty-only approach. As a result, Bristol Water's initial business plan (in December 2013) had excluded financial rewards from its ODIs.[3] Bristol revised this following more specific guidance from Ofwat strongly recommending the inclusion of rewards.[4]

18. It is clear that there are pros and cons to the use of rewards. For example, we recognise that the Gray review highlighted the potential for introducing more financial rewards as well as penalties into Ofwat's overall price review framework. However, in our view, some aspects of performance are more likely to be suitable for penalties and rewards than others and the setting of risks and rewards should also take account of customer views.[5] Whilst this is an area not at the heart of the appeal, both the LEF and CCWater criticised Ofwat's approach of recommending financial rewards.

19. We considered whether some of the outcome delivery incentives would be better specified as penalty-only schemes rather than schemes that also provide financial rewards.

ODIs with financial rewards

20. Bristol Water has six ODIs which incorporate a financial reward for outperformance. These are:[6,7]

    (a) unplanned customer minutes lost;

    (b) negative water quality contacts;

    (c) Service Incentive Mechanism (SIM);[8]

    (d) leakage;

    (e) meter penetration; and

    (f) population in centres >25,000 at risk from asset failure.[9]

21. This appears to be close to average for the water companies (mean of 7.2, median and mode of 6), although this does not consider the size of any

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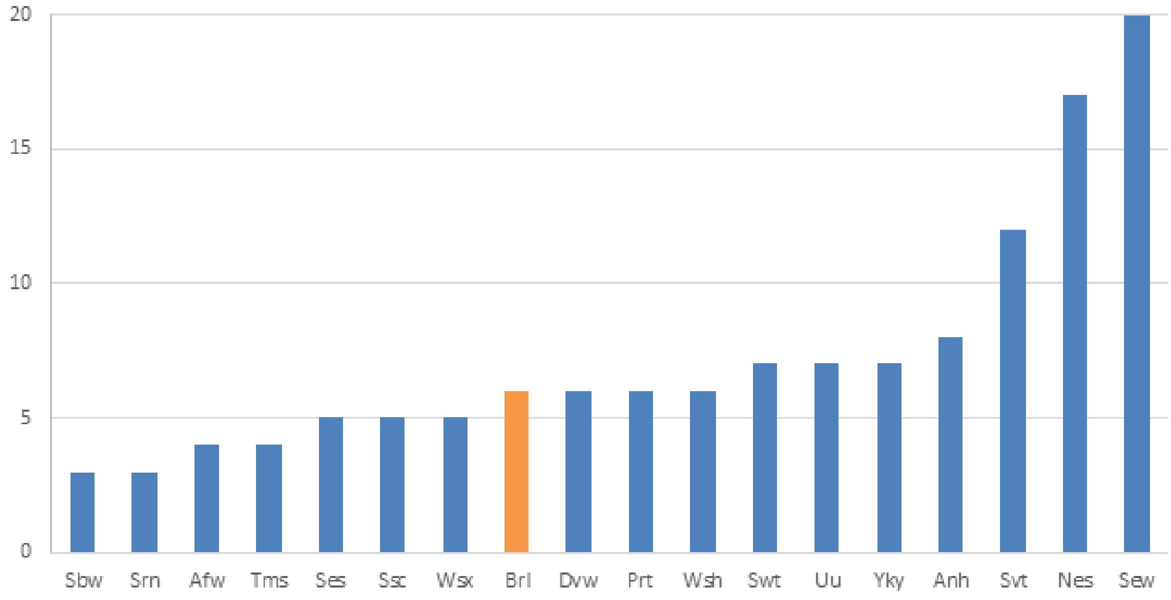
[3] Bristol Water SoC, paragraph 1898.
[4] Bristol Water SoC, paragraph 1904.
[5] We note that the Gray review stated that 'Incentives [should aim to provide] the right balance between rewards and penalties in the context of the challenges facing the companies, with increased emphasis on incentives for behavioural change'; Defra (2011) Review of Ofwat and consumer representation in the water sector, p30.
[6] Bristol Water company-specific appendix, pp123–171.
[7] MZC did not have a reward.
[8] An Ofwat metric which measures customer service levels based on a mix of data sources.
[9] Defined as populations in centres of greater than 25,000 who are at risk of failure of the single supply source serving them.

associated rewards, only the number of them included. The numbers for each company can be seen in Figure 8 below:

Figure 8: Number of wholesale water and retail ODIs with financial rewards, by company



Source: Company-specific appendices.

22. In particular, all 18 water companies have included a financial reward for two particular metrics:

(a) SIM; and

(b) leakage.

23. Bristol Water can receive a maximum of £12.3 million in rewards from its ODIs, which is less than the maximum potential penalties in the same ODIs of £18.8 million.[10]

CMA observations

24. Ofwat stated that it was concerned that removing rewards for ODIs would introduce asymmetric risk on the company, and would theoretically result in a higher cost of capital. However, Ofwat separately highlighted that there have been many changes to the PR14 framework and Ofwat did not seek to establish a direct link between assessment of each company's business risks and the cost of capital allowance. It is also likely that the scale of this effect would be small in the context of the overall cost of capital.

[10] Bristol Water SoC, Table 124.

25. If an increase in risk did represent a material concern, there are other ways to address the issue than through the introduction of rewards. For example, it may be appropriate to address this by a small adjustment to the weight given to a more conservative cost of capital estimate.

26. The impact on the cost of capital did not appear to represent a material concern for the original company business plans which included penalty-only incentives. We note that the maximum penalties are relatively high, at around 2% RoRE (approximately 0.75% on the cost of capital). However, this level requires the companies to breach the penalty collar on every incentive. Given that the incentives relate to very different areas of network performance, this seems to be an unlikely result, so the expected impact is likely to be much lower.

27. The £12.3 million reward could represent an increase in bills of around £5 over the period.[11] However, to be rewarded in this way, Bristol Water would need to:

(a) reduce its time of all interruptions to about 35% of its current level;

(b) halve its negative water quality contacts;

(c) achieve leakage levels beyond 2019/20 targets in the first year (and every subsequent one);

(d) advance expected levels of meter penetration by a year; and

(e) deliver the Southern Resilience Scheme two years early, and ensure all major population centres have backup water supplies by 2017/18.

28. Since the original calculations on the ODIs are based on customer willingness to pay (which the LEF supported), the benefits to customers from such improvements are necessarily worth this bill increase.

29. There are also possible alternatives to the outright removal of financial rewards which could have been considered. For instance, it may be possible to disallow a net total reward, but to allow potential rewards to be used to offset penalties incurred in other ODIs. This would allow the company to benefit from over-performance (if it incurs penalties elsewhere), whilst ensuring customers do not pay more (which is aligned with their views).

[11] Estimated based on 12.3/5 = £2.5 million pa. Based on 493,000 properties, this would imply an increase of £4.99 per household per year.

(f) It may be necessary to nuance such an approach to include/exclude particular ODIs (eg SIM rewards may be excluded, and penalties associated with capital project 'clawback' mechanisms such as Bristol Water's Southern Resilience Scheme may also be excluded).

Unplanned customer minutes lost calculations

30. Throughout this appendix, we refer to Bristol Water's choice of 'unplanned interruptions of all durations' as the **Bristol Metric**, and 'all interruptions >3 hours' as the **Ofwat KPI**.

31. Ofwat and Bristol Water have suggested four methodologies for estimating the upper quartile (UQ) performance level for unplanned customer minutes lost.

32. Ofwat calculated an implied upper quartile performance level based on Bristol Water's 2013-14 **Ofwat KPI** performance vs upper quartile **Ofwat KPI** performance. It then applied this to current **Bristol Metric** performance levels to derive an implied upper quartile figure.

33. We note that the actual methodology Ofwat stated it used was to use the ratio of performance in the **Bristol Metric** to the **Ofwat KPI** and then apply to the upper quartile performance level, but this has the equivalent effect to the above.[12]

34. In response to a comment from Bristol Water, Ofwat noted that if it had used a longer time period (2010/11 to 2013/14), then this has the effect of reducing the implied target even more to 6.1 minutes/property/year.[13]

35. These calculations can be seen in Table 7 below:

Table 7: Ofwat calculation of implied upper quartile level

	1 Year	*3 Year*
Ofwat KPI performance (BW actual)	23.5	22.7
Bristol Metric performance (BW actual)	14.0	11.7
Ratio	**0.60**	**0.51**
UQ Ofwat KPI (horizontal comparison)	12	12
Implied UQ Bristol Metric	**7.16**	**6.14**

Source: Ofwat response, Table A4.2.

36. Bristol Water suggested an alternative calculation based on a two-step process (on its own data) as follows:[14]

[12] Ofwat response to Bristol Water SoC, paragraph 448.
[13] Ofwat response to Bristol Water SoC, paragraph 451 and Table A4.2.
[14] Bristol Water SoC, paragraphs 1996–1999.

(a) **12** (UQ all > 3 hours) **x 62%** (10 year average share of unplanned) = **7.44** (UQ unplanned > 3 hours).

(b) **7.44** (UQ unplanned > 3 hours) **/ 55%** (10 year average share of unplanned which > 3 hours) = **13.5** (UQ all unplanned).

37. Therefore, Bristol Water concluded that it was already upper quartile performance.

38. Bristol Water said that this long time period (ten years) is appropriate to use because more recent years included major mains rehabilitation programmes which resulted in an increase in the level of planned interruptions, and hence is not representative of the expected future levels.[15]

39. Ofwat stated that the ten-year average Bristol Water relies on is inappropriate given how performance changes over time. If it used the last three years instead (as the other calculations are based on), then this results in an estimate of 6.15 minutes/property/year, which is lower than Ofwat's target.[16]

40. All these calculations are summarised Figure 9 below:

Figure 9: Summary of calculations used to estimate unplanned customer minutes lost upper quartile target

Ofwat Method

1 year data		*3 year data*
23.5 mins	*BW performance for Ofwat KPI*	22.7 mins
÷		÷
14.0 mins	*BW performance at own metric*	11.7 mins
0.60	*Ratio of BW performance*	0.51
x		x
12 mins	*UQ Ofwat KPI*	12 mins
7.16		6.14

Bristol Water Method

Ofwat 3 year data		*BW 10 year data*
12 mins	*UQ total, >3 hours (Ofwat KPI)*	12 mins
x		x
37%	*BW % unplanned vs planned, (for >3 hours events)*	62%
4.44	*UQ unplanned, >3 hours*	7.44
÷		÷
72%	*% unplanned events which are > 3 hours*	55%
6.2	*UQ unplanned, all*	**13.5**

Source: Bristol Water SoC, Table 132; Ofwat response, paragraph 453, Table A4.2.

[15] Bristol Water reply, paragraph 557.
[16] Based on a calculation of 12 x 0.37 / 0.72 (UQ Ofwat KPI x % of interruptions over 3 hours that are planned / % of unplanned interruptions that are over 3 hours); Ofwat response, paragraphs 452 & 453.

MZC industry performance data

41. The DWI provided Ofwat with 2014 MZC data under the new lead standard, as shown in Table 8 below:

42. Companies are ranked based on current views of performance in 2014.

Table 1: MZC performance by company, including 2014 data for performance under new lead standard

	2012	*2013*	*2014*	*%* *2013/14 Delta*
Sembcorp Bournem.	>99.99	99.96	>99.99	0.03
Sutton and E. Surrey	100.00	99.96	99.98	0.02
South Staffordshire	99.91	99.95	99.98	0.03
Affinity Water	99.95	99.99	99.97	–0.02
Wessex Water	99.99	99.97	99.97	0.00
Portsmouth Water	99.96	99.97	99.97	0.00
Southern Water	99.93	99.94	99.97	0.03
Thames Water	99.97	99.99	99.96	–0.03
South West Water	99.97	99.98	99.96	–0.02
South East Water	99.96	99.97	99.96	–0.01
Yorkshire Water	99.93	99.98	99.95	–0.03
United Utilities	99.95	99.97	99.95	–0.02
Anglian Water	99.96	99.96	99.95	–0.01
Northumbrian Water	99.92	99.93	99.95	0.01*
Severn Trent Water	99.96	99.97	99.94	–0.03
Dŵr Cymru	99.96	99.97	99.94	–0.03
Bristol Water	**99.99**	**99.97**	**99.92**	**–0.05**
Dee Valley Water	99.93	99.93	99.88	–0.05
Upper Quartile	**99.97**	**99.97**	**99.97**	
Mean	**99.957**	**99.965**	**99.955**	

Source: DWI 2014 water company statistics.
*Only +0.01 due to rounding of the 2013 and 2014 figures calculated from weighting the sub-regions of Northumbrian Water and Essex and Suffolk Water

Share of lead communication pipes versus 2014 MZC

43. Bristol Water highlighted that it had the fourth highest proportion of lead communication pipes in 2008, and it stated that it was unlikely this relative position had changed since then.

44. Table 9: below compares the proportion of lead communication pipes with 2014 MZC performance.

Table 9: Comparison of water company share of lead communication pipes and 2014 MZC performance

		%
	2014 MZC performance	*Share of communication pipes made of lead (2008)*
Sembcorp Bournem.	>99.99	0
Sutton and E. Surrey	99.98	56
South Staffordshire	99.98	68
Affinity Water	99.97	29
Wessex Water	99.97	10
Portsmouth Water	99.97	51
Southern Water	99.97	19
Thames Water	99.96	57
South West Water	99.96	31
South East Water	99.96	10
Yorkshire Water	99.95	33
United Utilities	99.95	36
Anglian Water	99.95	20
Northumbrian Water	99.95	35
Severn Trent Water	99.94	22
Dŵr Cymru	99.94	35
Bristol Water	**99.92**	**51**
Dee Valley Water	99.88	42

Source: Bristol Water and DWI 2014 water company statistics.

45. This would indicate that the other four companies with a high share of lead communications pipes[17] are able to achieve higher levels of mean zonal compliance than Bristol Water did in 2014. All of these companies would be above the deadband set by Ofwat for Bristol Water in FD14 (99.95%).

46. We also consider that Bristol Water received £0.165 million in PR09 to replace lead communication pipe which we would expect to reduce its proportion (and absolute length) of lead communication pipes.

Bristol Water's views on reducing taste complaints

47. Bristol Water provided the following evidence to support its views that reducing taste contacts is beyond customer willingness to pay due to high implementation costs. These are quoted directly from Bristol Water's submission in Figure 10.

[17] Sutton and East Surrey, South Staffordshire, Portsmouth Water, and Thames Water all have equal to or higher shares of lead communications pipes than Bristol Water.

Figure 10: Bristol Water submission on taste complaints

The majority of taste and odour complaints are chlorine or chlorine-related contacts. Customers tend to complain more about changes in the level of chlorine as opposed to the actual level. Due to variations in the supply arrangements customers see variations in the chlorine residual and as a result we get increased numbers of calls.

We consider that we have a relatively open and flexible supply system, more so than many other companies in our experience. This even extends to our raw water supply arrangements where we can move our raw surface waters around to most of the WTWs. Although this significantly increases our resilience it also has the unfortunate impact that a raw water source change slightly changes the characteristics of the water leaving the treatment works. This can then prompt customer contacts due to the change.

Complaints about the taste or odour of water can be driven by the geographic differences between companies, such as the topography, geology and nature of sources used, as well as the different treatment process used by companies. Water picks up minerals from rocks as it flows across and through the ground. For example, a hard water from the predominantly limestone catchment areas of our reservoirs will have a very different taste from soft water from a granite catchment.

Changing our free chlorine policy to chloramination would very significantly reduce chlorine complaints but due to our 'open' supply system with Purton water finding its way to virtually all parts of our system we would need to use chloramination at virtually all of our sites. This is a not a policy change we wish to adopt for the following reasons:

A. Additional costs due to further equipment need and increased ongoing costs due to need to dose ammonium.

B. Greatly increased risk of ammonium and nitrite failures in the network with consequential deleterious impact on our MZC.

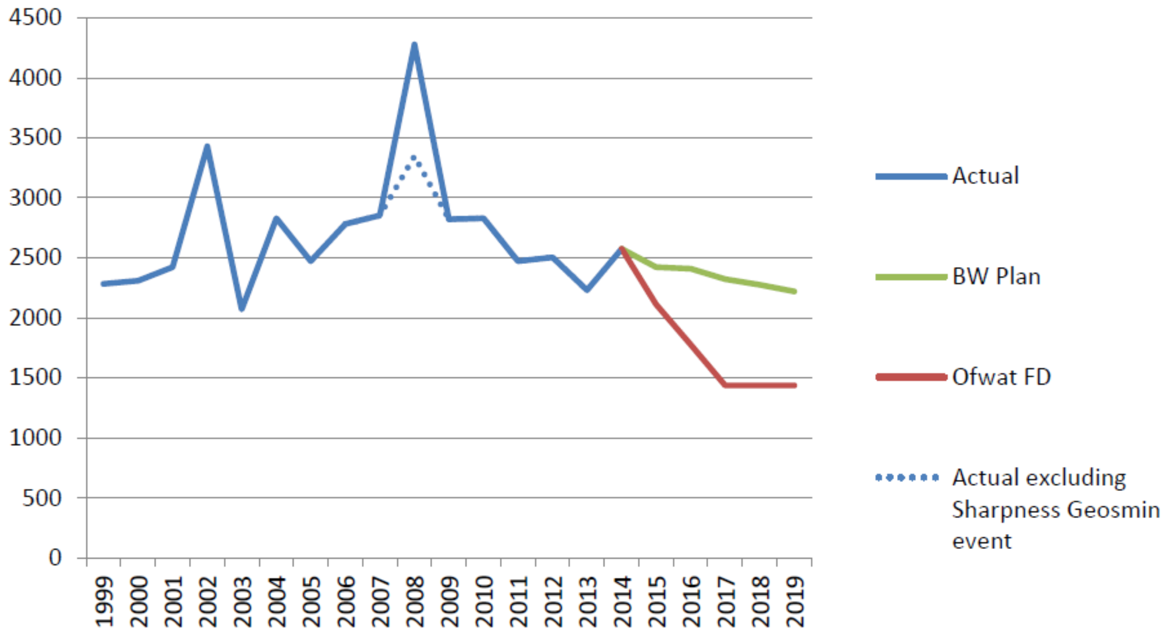
C. Reduced bacteriological quality in the network (combined chlorine residual is not as effective as free chlorine residual) again with possible impact on our MZC.

Source: Bristol Water.

Bristol Water Negative Water Quality Contacts

48. Bristol Water provided the following figure to show how its negative water quality contacts had evolved over time, along with its targets (both its own and Ofwat's intervention):

Figure 11: Bristol Water negative water quality contacts performance time series



Source: Bristol Water.

49. For more recent years, Bristol Water provided a breakdown of these contacts, by type (ie reason the contact was made):

Table 10: Bristol Water negative water quality contacts, by type

		2009	*2010*	*2011*	*2012*	*2013*	*Average*
Appearance	Discoloured Water – brown/orange	1,300	1,301	1,289	1,141	995	1,205
	Discoloured Water – blue/green	8	16	1	9	3	7
	Particles	79	65	56	62	48	62
	White – air	599	715	380	413	448	511
	White – Chalk	0	0	0	0	0	0
	Animalcules	7	10	2	3	5	5
	General conditions	81	87	84	74	89	83
Taste/Odour	Chlorine	300	281	351	314	431	335
	Earthy/musty	124	51	55	85	71	77
	Petrol/Diesel	11	9	2	19	14	11
	Other taste or odour	314	294	253	384	127	274
Appearance Total		2,074	2,194	1,812	1,702	1,588	1,874
Taste/Odour Total		749	635	661	802	643	698
DWI Taste/odour/appearance		**2,823**	**2,829**	**2,473**	**2,504**	**2,231**	**2,572**

Source: Bristol Water SoC, Table 136.

Bristol Water cross-industry service performance data provided to customers during research phase

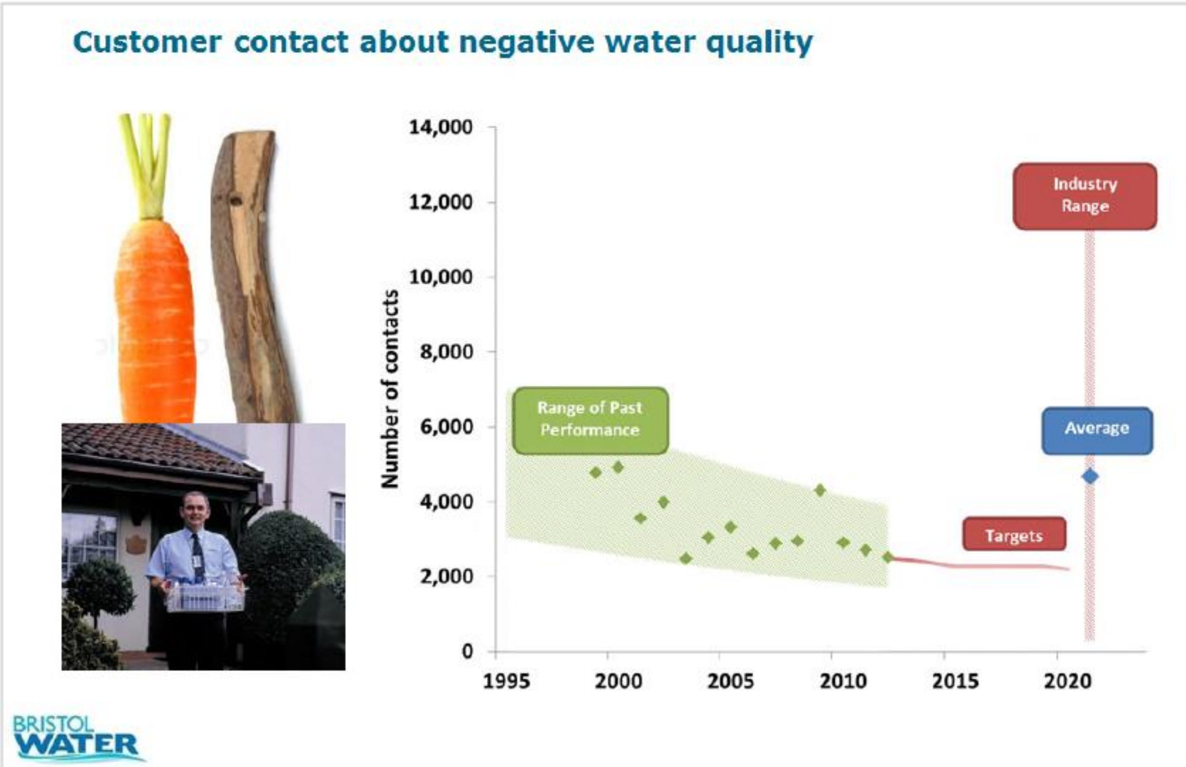
50. Bristol Water provided the following relevant material to its customers when it was conducting its ODI research:

Figure 12: ODIs information provided to customers

Measure		Current Bristol Water Performance	Industry Position	Industry Average
	*Interruptions to supply*	21 minutes per property per year	10th out of 21	20 minutes per property per year
	*Complaints about discoloured water*	1,577 per year	13th out of 21	2,201 per year
	*Leakage*	18% (43.1Ml/d)	10th out of 21	20%
	*Carbon Dioxide emissions (from electricity used to pump water)*	435 Kg/Ml *(N.B. Hilly terrain)*	18th out of 21	346 Kg/Ml

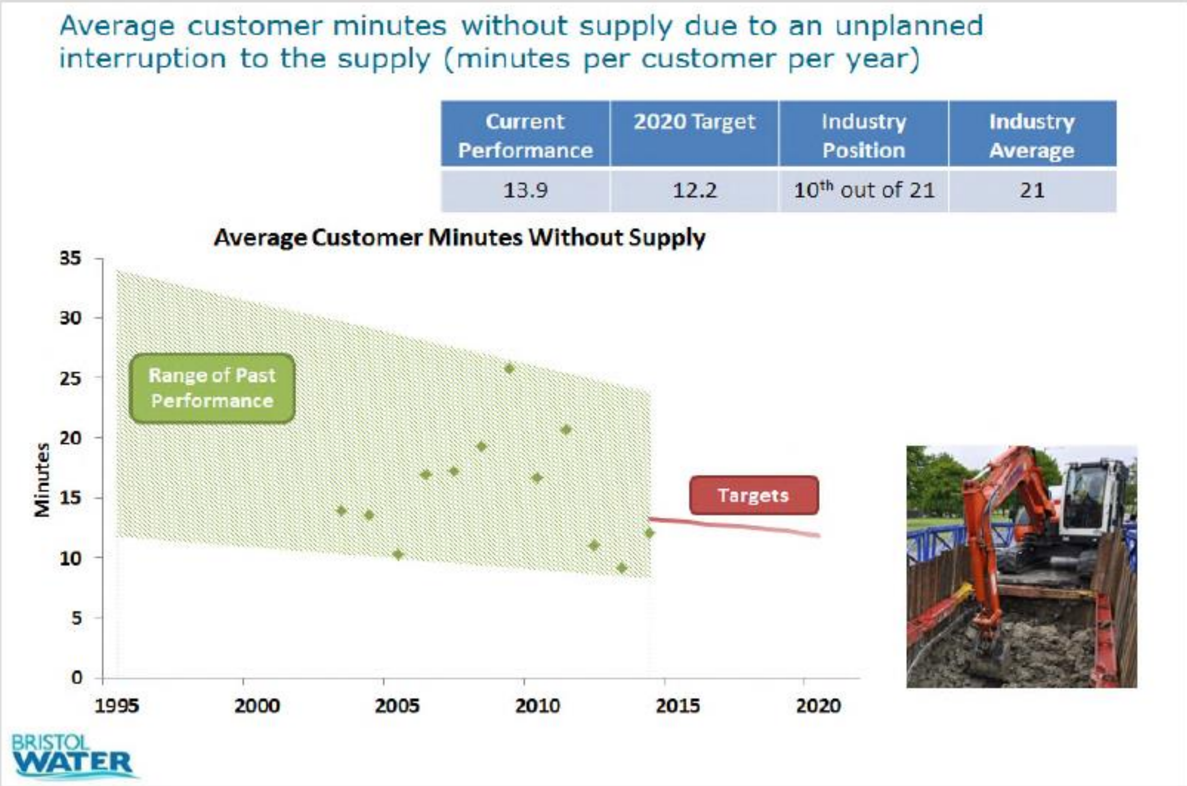
Source: Bristol Water response, Figure 12.

Figure 13: Negative water quality contacts information provided to customers



Source: Bristol Water response, Figure 13.

Figure 14: Interruptions to supply information provided to customers



Source: Bristol Water response, Figure 16.

Cost of capital

1. The following appendix provides additional details and calculations made when estimating a reasonable level for Bristol Water's cost of capital.

2. This should be read in conjunction with the representations and reasoning made in our provisional findings document.

3. The rest of this appendix follows the structure:

   (a) Bristol Water actual debt costs and adjustments.

   (b) Ofwat's customer benefits test.

   (c) Market-based asset beta analysis.

   (d) Bristol Water beta uplift.

   (e) Risk-free rate (RFR) market data analysis.

Bristol Water actual debt costs and adjustments

4. Based on the evidence Bristol Water presented in its SoC, its statutory accounts, and supporting KPMG documents, we have built a more granular table of Bristol Water embedded debt and its associated characteristics. The basic figures (before any adjustments) are presented in Table 1 below.

5. The table includes a reconciliation back to the figures presented in Bristol Water's SoC. In presenting this, we note that the nominal (and corresponding real) rate on debt classified as 'variable' appears slightly higher than that stated by Bristol Water (1.34% vs 1.22%). This is likely due to Bristol Water having access to more up-to-date data on these types of debt; however, the effects on the overall cost of embedded debt are very small.

Table 1: Bristol Water embedded debt cash costs

	Bristol Water Class	*Issuance*	*Maturity*	*Value at December 2014 (£m)*	*% Nominal cash interest rate*	*% Real cash interest rate (Bristol Water assumptions)**	*% Real cash interest rate (CMA assumptions)†*
Artesian bond index-linked	IL	2003-05	2032	125.7	3.64	3.64	3.64
Bond index-linked	IL	2011	2041	44.8	2.70	2.70	2.70
Artesian bond fixed rate	Fixed	2003-04	2033	57.5	6.01	3.55	3.32
Bank loan fixed rate	Fixed	2008	2017	10.0	5.73	3.27	3.05
Preference shares	Fixed	1992	N/A	12.5	8.75	6.29	5.99
Debentures	Fixed	Various	Various	1.6	4.00	1.54	1.36
Bank loan fixed rate (FFL)	FFL	2014	2019	50.0	2.40	-0.06	–0.19
Bank debt floating rate	Variable	2008	2017	10.0	0.70	-0.40	–0.45
Finance leases fixed rate	Variable	Various	Various	2.6	3.80	2.70	2.61
	IL total	N/A	N/A	170.5	3.39	3.39	3.39
	Fixed total	N/A	N/A	81.6	6.36	3.90	3.66
	FFL total	N/A	N/A	50	2.40	-0.06	–0.19
	Variable total	N/A	N/A	12.6	1.34	0.24	0.18
	Total blended	**N/A**	**N/A**	**314.7**	**3.92**	**2.85**	**2.76**

*Assumes RPI of 2.46%, Libor is -1.1% compared to this, and applies a straight subtraction of inflation when converting from nominal to real.
†Assumes RPI of 2.60%, Libor is -1.16% compared to this, and applies the Fisher formula for converting from nominal to real.
Note: IL refers to index-linked debt, and FFL refers to the Funding For Lending bank debt.
Source: Bristol Water SoC Table 114; KPMG assessment of embedded debt; Bristol Water 2014 annual accounts, pp85–97; CMA analysis.

6. We next considered a number of adjustments to these figures to determine the appropriate allowable embedded debt costs. Below, we specifically discuss the following in more detail:

(a) inflation estimates, and calculations;

(b) differentials between coupon and yield;

(c) preference shares;

(d) non-operational financing (eg financing of shareholder distributions); and

(e) scale of cash holding and issuance costs.

Inflation

7. We estimate the WACC in real terms. In doing so, it is sometimes necessary to derive real rates from nominal prices, for example yields on government and corporate debt. Since we are forecasting the WACC for the period 2015 to 2020, we use an estimate of inflation over this period to derive the corresponding real return.

8. Bristol Water calculated the rate of inflation by using the difference between nominal and index-linked government bonds, based on five-year bonds, as this is the length of the price control period. Over the first two weeks of January 2015, Bristol Water states that this was 2.46%.[1]

9. Ofwat's RPI assumption of 2.80% is based on a number of factors, including historical implications of ten-year government bonds, OBR forecasts, and yield differences between ten-year nominal and index-linked government bonds (accounting for inflation risk).[2]

10. As the difference between Ofwat and Bristol Water's estimates in the preceding two paragraphs shows, the time period being considered influences the estimates of RPI inflation. Using a five-year period reflects the time period of the price control which would appear a sensible starting point. However, any fixed-rate debt issued during this time period would have an implicit RPI estimate priced in by the market. Since most debt issued is longer-term, this would result in an RPI assumption based on a longer time period.

11. We would consider the Bank of England's implied inflation spot curve to reflect the latest views of the market, and so provides strong evidence for

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[1] Bristol Water SoC, paragraph 1722.
[2] December 2014, Final price control determination – risk and reward, p36.

expected inflation levels. The average (arithmetic mean) forward-looking five-year daily rate from 31 December 2014 to 29 May 2015 was 2.47%, whilst the equivalent ten-year rate was 2.74%.[3]

12. In NIE (2014), the CC/CMA also emphasised that the OBR's economic and fiscal outlook on inflation represented a coherent and independent forecast.[4] The OBR forecasts are updated in March and December of each year. The OBR's latest estimate for RPI during the five-year period is 2.48%.[5]

13. We therefore considered that an estimate for RPI inflation of 2.6% appears appropriate for converting between nominal and real returns where required. Table 1 above shows the estimated real level of Bristol Water's debt calculated using both 2.46% RPI (Bristol Water's suggested estimate) and 2.60% (CMA proposed estimate).

14. LIBOR estimates from five-year swap rates indicate a level of 1.44%.[6] This is 1.16% below our RPI estimate which is similar to Bristol Water's view (of 1.1% below RPI) in its SoC.[7]

15. When using these inflation rates to convert nominal figures to real ones, we have applied the Fisher formula (real = (nominal + 1) / (inflation + 1) – 1). This differs from Bristol Water's approach, where it simply subtracted the inflation figure, and hence results in slightly different estimates for real yields.

Differentials between coupon and yield

16. When the Artesian bonds were being issued, interest rates dropped subsequent to the coupon level being set. Rather than adjusting the coupon to reflect this, the bonds were instead sold at a premium of between 0% and 14% (depending on exact timing of each tranche).

17. This results in a coupon rate which does not accurately reflect the true costs associated with issuing the bond. We have therefore adjusted for this by calculating the yield at issuance for these bonds.

18. Table 2 shows the yield at issuance for each tranche of debt and our estimate of the weighted average yields at issuance of the Artesian bonds; for index-

[3] Bank of England UK implied inflation (GLC) spot curve. We note that the five-year averages have fluctuated from 2.15% to 2.74% over this period, with a range of 2.33 to 2.60% within one standard deviation of the mean. The ten-year average fluctuated from 2.43% to 3.01%, with a range of 2.61 to 2.87% within one standard deviation of the mean.
[4] NIE, paragraph 11.33.
[5] Economic and fiscal outlook charts and tables – March 2015, OBR Chart 3.21.
[6] Mean average of daily swap rate from Bloomberg (BPSW5) on 1 January 2015 to 15 June 2015.
[7] Bristol Water SoC, Table 114.

linked Artesian bonds this is 3.13% (rather than the coupon of 3.64%) and for fixed rate Artesian bonds, it is 5.94% (rather than 6.01%).

Table 2: Yield at issuance calculations on Bristol Water's Artesian bonds

	Term at issuance	*Coupon*	*Par value (£m)*	*Price (index to 100)*	*Yield at issuance*
1st tranche fixed rate	30.4	6.01%	30.0	100	6.03%
1st tranche index-linked	29.4	3.64%	15.0	102	3.54%
2nd tranche fixed rate	29.7	6.01%	27.5	102	5.85%
2nd tranche index-linked	28.7	3.64%	26.0	105	3.33%
3rd tranche index-linked	27.4	3.64%	50.1	114	2.90%
Index linked total		3.64%		109	3.13%
Fixed total		6.01%		101	5.94%

Source: Bristol Water; CMA analysis.

Preference shares

19. Bristol Water holds £12.5 million worth of preference shares which were issued in 1992.

20. We believe that although preference shares display some debt-like characteristics, their predominant features and risk profile (eg being subordinate to bonds) is more aligned with equity. Therefore it is appropriate to exclude these from consideration of actual debt costs for Bristol Water.

21. This is consistent with the treatment of preference shares in CC10 in which they were excluded from consideration of the cost of embedded debt,[8] as well as when considering financeability.[9]

22. We also note that when stating headline net debt figures in its 2014 annual report, Bristol Water excluded preference shares from these calculations.[10]

Non-operational financing

23. Bristol Water stated that it previously made a £68.5 million loan to its holding company.[11] In its assessment of embedded debt, KPMG highlighted that the source of this was £57.5 million of fixed rate Artesian loans which had been combined with £11 million of other funds.

24. As these funds were not used for financing its ongoing operations, it may be considered appropriate to remove them from Bristol Water's cost of debt.

[8] CC10 Appendix N, Table 1 on pN56.
[9] CC10 Appendix O, footnote 11 on pO5.
[10] Bristol Water 2014 annual accounts, p31.
[11] Bristol Water reply, Appendix 1, Table 3.

25. However, Bristol Water's current gearing level is not substantially above the notional level which Ofwat has set. We also note Bristol Water's points that prior to the introduction of Artesian debt, WoCs found it hard to secure long term debt.

26. This would imply that Bristol Water's level of debt is appropriate, much of which was taken out as a 'catch-up' through the Artesian issuances, and to exclude this may be penalising Bristol Water for reasonable behaviour.

27. We have therefore considered a range of actual embedded debt costs to include two options:

(a) Do not exclude any debt which was used to finance intercompany loans;

(b) Exclude about £23 million of the fixed rate Artesian loans (total of £57.5 million) assumed to fund intercompany loans. This has the effect of degearing Bristol Water to the 62.5% notional level set by Ofwat.[12]

28. Ofwat highlighted that the regulatory accounts implied that index-linked Artesian debt was used to finance the parent company loans rather than the fixed rate issuances. Although this would expose the regulated entity to a greater risk of interest movements since the loan was not made on a 'back-to-back' basis,[13] it would not have a major impact on the assessment of embedded cost in this review. That is because the estimated real costs of the Fixed Artesian and Index-linked Artesian debt is small (as can be seen in Table 3 below).

Scale of cash holding and issuance costs

29. Companies incur additional costs from issuing debt beyond the base coupon/interest payments.

30. The largest of these are associated with issuing the debt in the first place (eg fees of the investments banks which organise the issuance), and the ongoing costs from not breaching any covenants of the debt (eg holding cash or retaining sufficient undrawn lending facilities).

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[12] 68% gearing currently on an RCV of £411 million implies a reduction to 62.5% gearing: 5.5% x 411 = about £23 million; Bristol Water's 2014 annual accounts, p1. This excludes the latest FFL bank loan.
[13] Artesian fixed rate loan interest payable of 6.01%, whilst the parent company loans have an average of 5.888%. Using index-linked debt would result in the possibility of larger differences; Ofwat response, paragraph 311.

31. CC10[14] and Ofwat in PR14[15] both allowed an addition of 10 basis points (0.1%) for the issuance costs associated with debt. We consider this to remain appropriate now.

32. Regarding cash holding costs, CC10 estimated that the implied cost associated with these was 0.2%.[16] In PR14, Ofwat acknowledged that these costs could exist, but believes that an efficient treasury function can mitigate these, particularly at a time of low interest rates (and Ofwat did not include the lower cost short term floating debt in its cost estimations).[17,18]

33. We believe that it is more appropriate to include these costs at this point, and consider the impact of short term debt in the round. As part of this 'in the round' assessment, we note that Bristol Water's unused credit facilities (of £70 million) which Capstone recently referenced are likely to be at a lower rate than CC10 estimated.

34. Therefore, an estimated cost of 0.1 to 0.2% for cash holding costs would appear appropriate.

Impact of changes on Bristol Water's actual embedded debt costs

35. Having made the adjustments listed above, we have recalculated Bristol Water's embedded debt costs as shown in Table 3 below:

Table 3: Updated Bristol Water actual embedded debt costs

	Bristol Water Class	*Issuance*	*Maturity*	*Value (£m)*	*Nominal cash interest rate (%)*	*Real cash interest rate (including adjustments) (%)*
Artesian bond index-linked	IL	2003-05	2032	125.7	3.13	3.13
Bond index-linked	IL	2011	2041	44.8	2.70	2.70
Artesian bond fixed rate	Fixed	2003-04	2033	34.8–57.5	5.94	3.26
Bank loan fixed rate	Fixed	2008	2017	10.0	5.73	3.05
Preference shares	Fixed	1992	N/A	N/A	N/A	N/A
Debentures	Fixed	Various	Various	1.6	4.00	1.36
Bank loan fixed rate (FFL)	FFL	2014	2019	50.0	2.40	–0.19
Bank debt floating rate	Variable	2008	2017	10.0	0.70	–0.45
Finance leases fixed rate	Variable	Various	Various	2.6	3.80	2.61
	IL total	N/A	N/A	170.5	3.02	3.02
	Fixed total	N/A	N/A	46.1–69.1	5.83–5.87	3.15–3.18
	FFL total	N/A	N/A	50	2.40	–0.19
	Variable total	N/A	N/A	12.6	1.34	0.18
	Total blended	**N/A**	**N/A**	**279.5–302.2**	**3.30–3.50**	**2.34–2.41**

Source: Bristol Water SoC Table 114; KPMG assessment of embedded debt, Bristol Water 2014 annual accounts, pp85–97; CMA analysis.

[14] CC10, appendix N, paragraph 48.
[15] Ofwat FD14 Final price control: policy chapter A7 – risk and reward, p42, Table A7.10.
[16] CC10, appendix N, paragraph 48 and footnote 20.
[17] PwC company specific uplift analysis, p22.
[18] Jan 2014, Setting price controls for 2015-20 – risk and reward guidance, p21, footnote 23.

36. Including a 0.1% issuance cost, and a 0.1% to 0.2% cost for cash holding would imply an actual embedded debt cost of 2.5% to 2.7%. We would therefore consider 2.5% to 2.7% a reasonable range estimate for Bristol Water's embedded debt cost.

Ofwat's customer benefits test

37. For PR14, having determined that smaller companies have a higher cost of debt than larger companies, Ofwat introduced a new customer benefits test before allowing the company in question to recover these higher costs from customers. This has the effect of disallowing the acknowledged higher financing costs of some small companies.

38. Specifically, Ofwat considered if no uplift in WACC was awarded, how this would impact:[19]

(a) the likelihood of a merger occurring;

(b) whether mergers which removed a comparator would result in weaker efficiency challenges;

(c) whether mergers which removed a comparator would result in weaker service level challenges; and

(d) implied reduction in financing costs from not requiring an SCP.

39. Based on this, Ofwat allowed two companies (Portsmouth Water and Sembcorp Bournemouth) a 15 basis point increase in WACC (equivalent to a 25bp increase in the cost of debt), but did not allow this for any other company, including Bristol Water.[20]

40. The most substantive quantitative factor was an estimate of the implied costs associated with losing a specific company as a wholesale benchmark. This was based on the likelihood of the company being in the top efficiency quartile (and hence included in the efficiency benchmarks) and the associated impact of removing them. On top of this, the implications of the loss of comparators for SIM (quantitatively assessed) and ODI (qualitatively assessed) were also included.[21]

41. Ofwat's approach could result in some companies, in particular very small companies, being in a position where their actual cost of efficient finance, is

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[19] December 2014, Final price control determination – risk and reward, p49.
[20] December 2014, Final price control determination – risk and reward, p49.
[21] December 2014, Final determination annex 3 – benefits assessment of an uplift on the cost of capital, pp22–47.

higher than Ofwat's assumption. If the notional company is based on a total industry average, the resulting cost of debt could be perceived as too low for these very small companies, which appears as being potentially inconsistent with its financing duty.

42. We have reproduced below the result from Ofwat's customer benefits test, resulting in four of the six companies in question being disallowed an SCP:

Table 4: Ofwat final customer benefits test for company-specific uplift

Impact (£m, 20-yr NPV)

		BRL	*DVW*	*PRT*	*SBW*	*SES*	*SSC*
Wholesale costs benchmark		–19 to –10	–11 to –6	7 to 15	4 to 8	–7 to –4	–4 to –2
SIM		1 to 3	–2 to –1	–0 to –0	2 to 4	1 to 1	2 to 4
ODIs	WQC	×	×	✓	✓	✓	×
	MZC	✓	×	×	✓	✓	×
	WSI	×	✓	✓	✓	×	×
Comparator benefits		–18 to –7	–13 to –7	7 to 15	6 to 12	–6 to –3	0 to 0
Increased financing cost		–13	–2	–4	-4	–6	–9
Net benefits		–29 to –21	–16 to –9	4 to 11	2 to 8	–12 to –9	–9 to –9

Source: December 2014, Final determination annex 3 – benefits assessment of an uplift on the cost of capital, Table A7A.19 (p49).
Notes: WQC stands for negative water quality contacts, MZC stands for mean zonal compliance, and SWI stands for water supply interruptions. Figures may not add due to rounding. The six companies in order are Bristol Water; Dee Valley Water, Portsmouth Water, Sembcorp Bournemouth Water, Sutton & East Surrey Water and South Staffordshire Water.

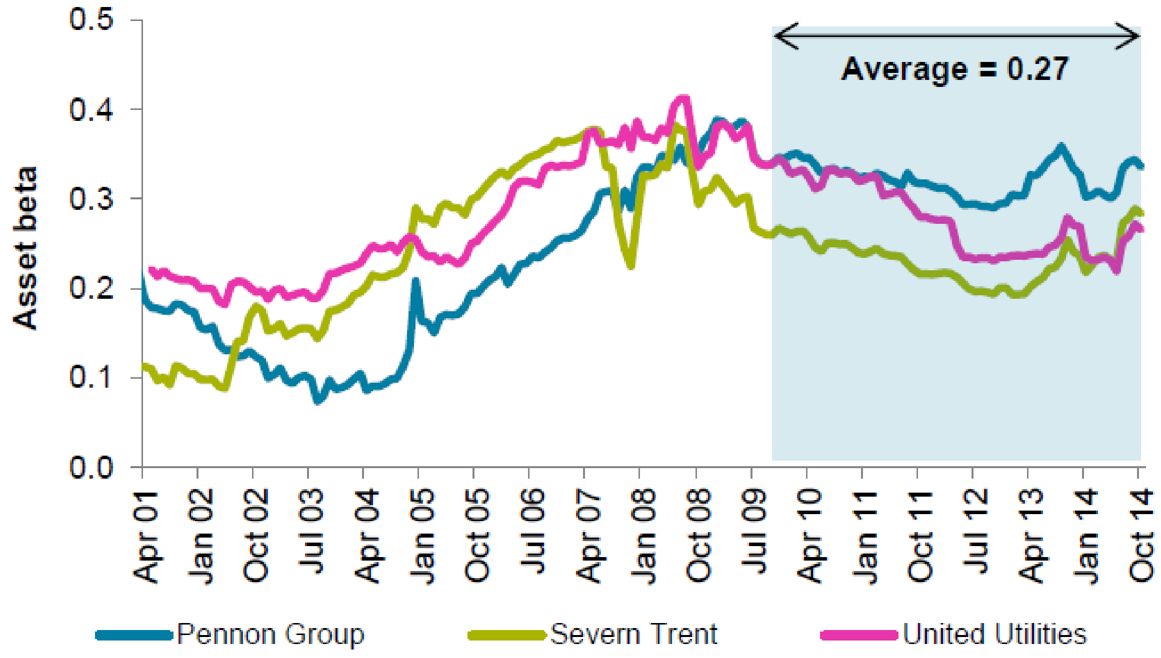
Market-based asset beta analysis

43. Bristol Water's beta is not observable, and therefore the starting point for estimation is usually the quoted water companies. This then has the potential to be adjusted to reflect any differences in systematic risk between Bristol Water and these comparators. Both Ofwat and Bristol Water agree that FD14 fairly estimated the beta of the comparators.[22]

44. Ofwat noted that the recent evidence is consistent with a range of 0.2 to 0.3. It also compared to other regulated industry betas, which indicated a range of 0.27 to 0.46.[23] On this basis, it concluded that the top end of this range (0.3) represented a reasonable asset beta.

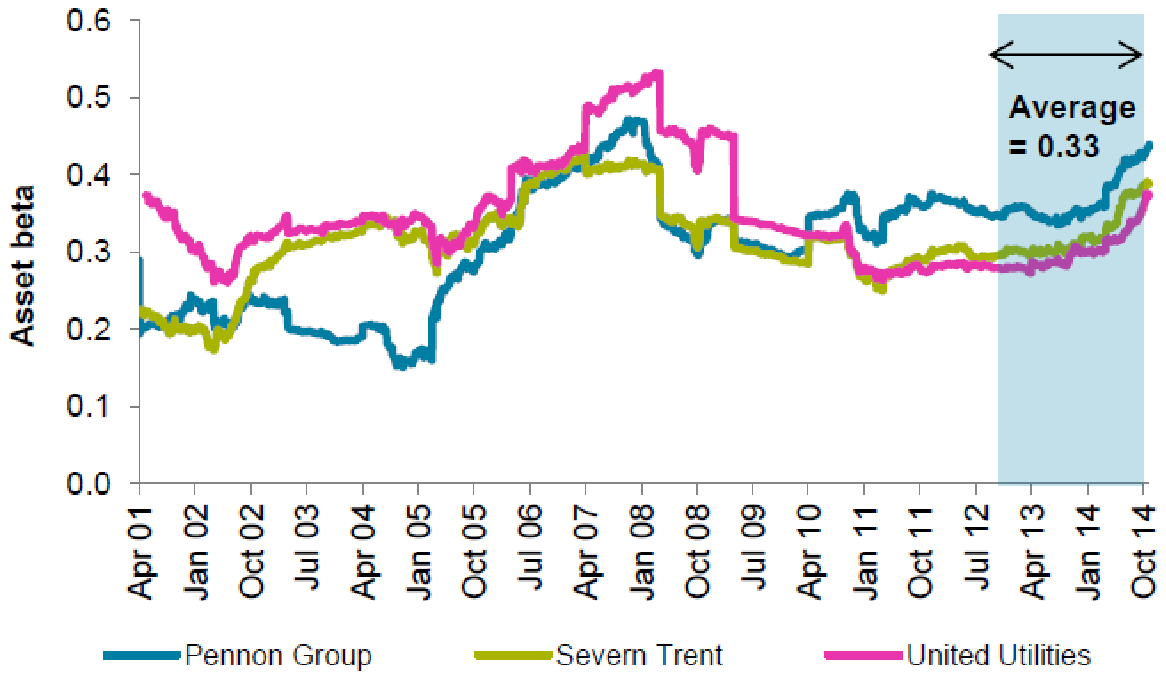
[22] We have not included Dee Valley in the analysis of water companies' beta as due to its small size and associated illiquidity, we are concerned with the level of potential error in estimating its asset beta.
[23] January 2014, Ofwat risk and reward guidance notice, pp17–18.

Figure 1: Ofwat beta estimates using monthly sampling over five years



Source: Ofwat risk and reward final determination notice (December 2014), Figure A7.2.

Figure 2: Ofwat beta estimates using daily sampling over two years



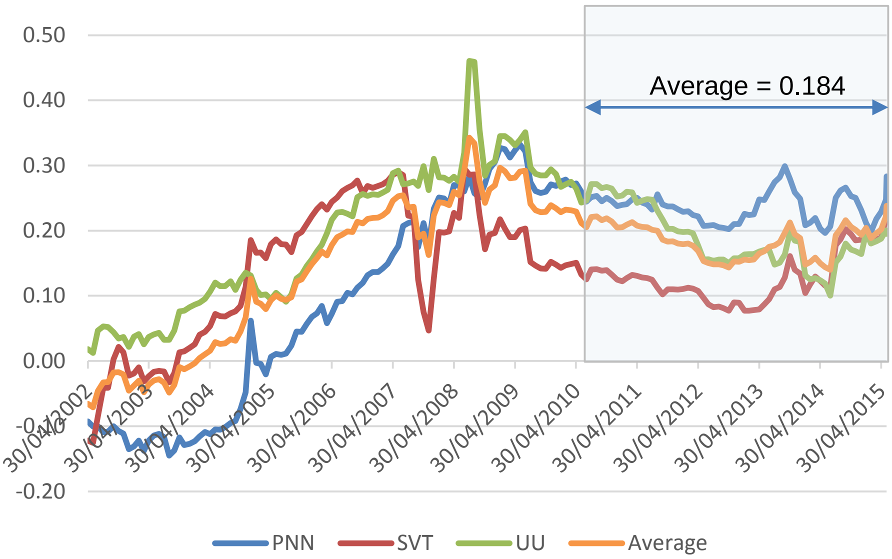
Source: Ofwat risk and reward final determination notice (December 2014), Figure A7.3.

45. Ofwat's choice of asset beta is still low relative to regulatory precedent. For example, Ofgem recently chose an asset beta of 0.38 within the RIIO-ED1 conclusions. The reason for this was in part due to persistent caution about the use of market data which indicate very low equity risk. The CC's asset

beta for NIE was based on an initial range of 0.31 to 0.40, which was a narrowed to a range of 0.35 to 0.40 due to consideration of differences between NIE's characteristics and circumstances to those of the market comparators used.[24]

46. We have used the latest data to calculate the mean average beta values for the three public comparators (Pennon Group, Severn Trent, and United Utilities), using a range of sampling frequencies and periods, which can be seen in Figure 3, Figure 4 and Table 5 below. In doing so, we have not applied a Blume adjustment[25] (unlike Ofwat) since, as in CC10, we do not consider that the evidence suggests that water companies' betas converge to one (nor would one necessarily expect this for regulated companies).

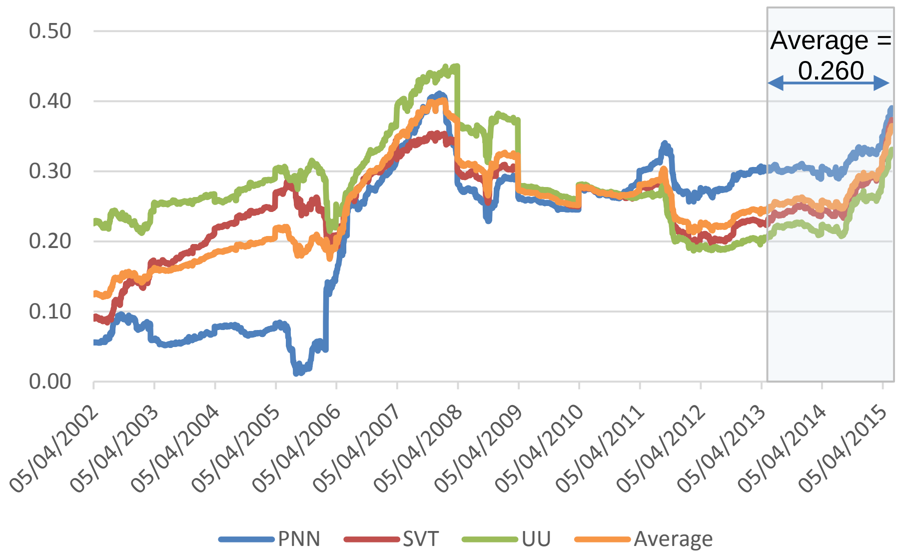
Figure 3: CMA beta estimates using monthly sampling over five years



Source: CMA analysis, Bloomberg.

[24] NIE 2014, paragraph 13.183.
[25] A Blume adjustment is an attempt to adjust for forecast future betas based on historic observations. Blume observed that over time, betas tended to converge towards '1'. Therefore he made the empirical estimate of weighting up future betas based on the following equation: $\beta_{future} = 0.6667 \times \beta_{past} + 0.3333$.

Figure 4: CMA beta estimates using daily sampling over two years



Source: CMA analysis, Bloomberg.

Table 5: Mean average beta of public WaSCs, to 1 June 2015

	Single day (01/06/2015)	*Last year*	*Last 2 years*	*Last 5 years*
2-year daily	0.365	0.277	0.260	0.268
2-year weekly	0.438	0.389	0.343	0.283
5-year weekly	0.287	0.268	0.273	0.307
5-year monthly	0.238	0.205	0.188	0.184

Source: CMA analysis, Bloomberg.

47. The different frequency/sampling for large public water companies' betas gives a wide range of beta estimates of around 0.184 to 0.438. We noted that half the observations are within a narrow range of 0.26 to 0.31, which has formed the basis for our estimated range for the asset beta.[26]

48. We note that despite not applying a Blume adjustment (which would increase beta estimates), we have provisionally found that the asset beta range is similar to Ofwat. This is because:

(a) Ofwat's choice of sampling frequencies and periods as shown in its charts above appear to have resulted in particularly low beta estimates (equivalent to 0.18 to 0.26 using our analysis).

(b) Asset betas appear to have increased somewhat since Ofwat's final determination.

[26] We also conducted this analysis based on an unweighted portfolio of the three public comparators and the results are very similar, with the same tightened range (0.26-0.31) of the middle observations.

(c) Ofwat included the CC10 range (0.21 to 0.31) in its considerations.

Bristol Water beta uplift

49. The case for an uplift for Bristol Water was made by the CC in 2010. The CC observed that:

(a) size alone did not support the need for an uplift. Whilst there is theoretical evidence that small companies require a higher return on capital (such as the Fama-French model), there is insufficient evidence to show that small water companies have higher systematic risk;

(b) by contrast, operational gearing is relevant to the level of beta (at least in principle), and the evidence was that the smaller water companies, including Bristol Water, tended to have higher operational gearing; and

(c) one measure for this, the proportion of operating cash flow to revenue, would support an uplift of 18% in the asset beta.

Illiquidity

50. CC10 highlighted that treating Bristol Water as a stand-alone company means it would be appropriate to take into account the relative cost of investing in small companies. It considered that there may be higher costs associated with investing in unquoted smaller companies than in larger ones, but that these were likely to be relatively small.[27]

51. We believe that circumstances are unlikely to have changed, and no evidence has been presented which indicates that they have. In the context of the likely impact being small, we provisionally found the approach of considering any illiquidity uplift in the round with other potential uplifts to be appropriate (as in CC10).[28]

Levels of operational gearing

52. We have analysed a number of projected figures for operational gearing metrics based on Ofwat's final determination for AMP6. The results of these can be seen below:[29]

[27] CC10 Appendix N, paragraphs 125 & 126.
[28] CC10 stated that the uplift calculated on operational gearing was likely to overestimate the relevant effect, and it considered that the overestimate of this aspect should offset the CC's decision not to allow explicitly for the transaction costs involved in buying and selling smaller companies. CC10, Appendix N, paragraph 137.
[29] Figures are taken from Ofwat's published company-specific appendices for each company.

Table 6: Operational gearing comparisons for Bristol Water and comparators (AMP6)

	Bristol Water	*Comparators*	*WoCs*	*WaSCs*
Totex to average RCV	100%	62%	94%	63%
Revenue to average RCV	103%	79%	108%	78%
Wholesale totex to wholesale average RCV	100%	71%	94%	71%
Wholesale revenue to wholesale average RCV	103%	88%	108%	86%
Operating cashflow as % of revenue	45%	51%	38%	51%

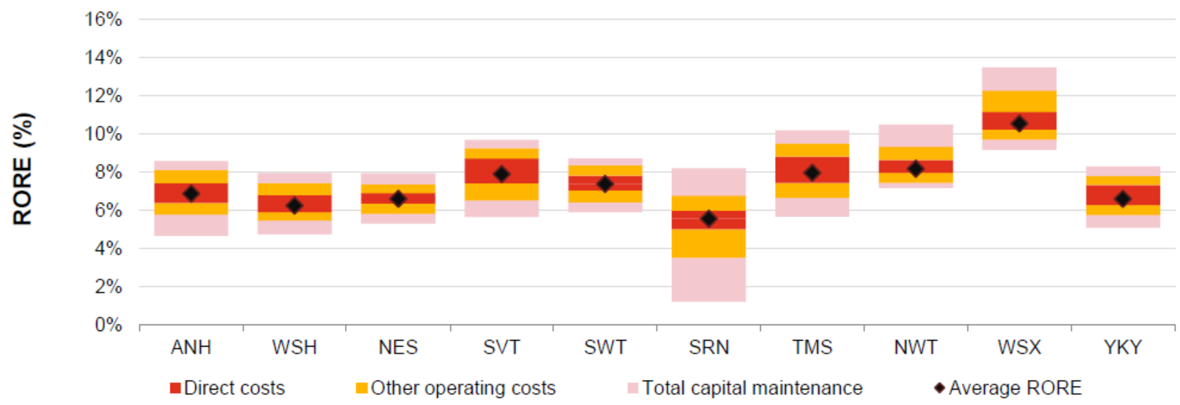
Source: Ofwat Final Determination, company-specific appendices, Tables A2.9/2.10/2.11, A3.9/3.10, A5.1/5.2/6.2/7.3.
Notes: Totex and Revenue (top two rows of table) figures used in these ratios include both wholesale water and wastewater figures, but excludes any retail controls. Operating cashflow (bottom row of table) represents the proportion of wholesale and wastewater revenue (excluding adjustments) which is made up of return on capital and RCV run-off.

53. All of these comparisons show that Bristol Water has higher operational gearing than the public comparators used in estimating beta.

Impact on beta

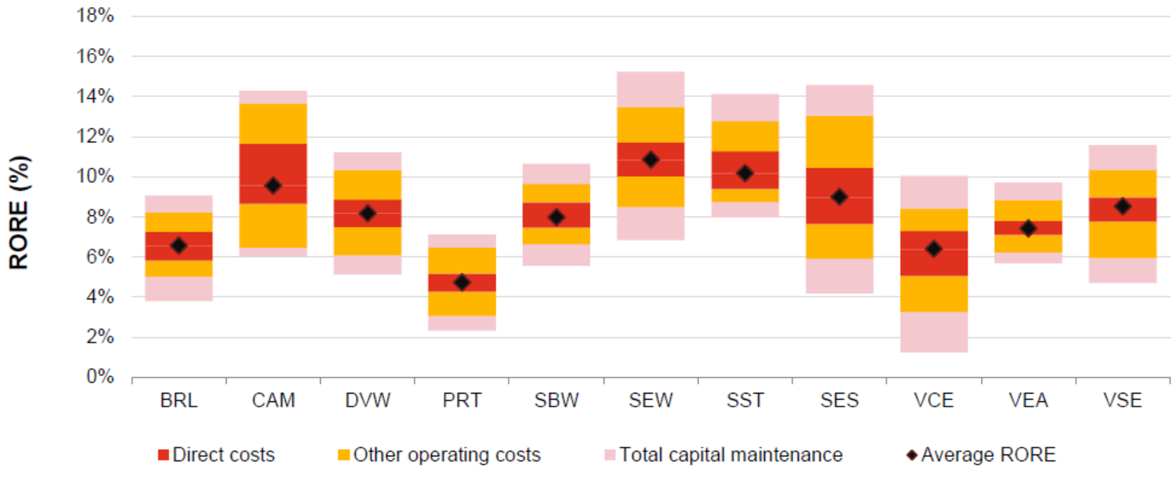
54. Figure 5 and Figure 6 below show PwC's analysis of the historic returns made on regulated equity for WaSCs and WoCs respectively for 2001/02 to 2012/13:

Figure 5: WaSC historic RoRE



Source: PwC company specific adjustments to the WACC, Figure 9.

Figure 6: WoC historic RoRE



Source: PwC company specific adjustments to the WACC, Figure 10.

55. This analysis seems to prima facie support the case made by Bristol Water and the approach assumed within CC10, which is that, on balance, the risks faced by WoCs tend to be higher than WaSCs.

56. The analysis cannot be extrapolated directly to a single value for the differential within the asset beta. In practice, the asset beta will be influenced by a range of factors, of which operational gearing is only one. However, it does represent a reasonable starting point for considering the potential scale for an uplift, if we consider one is required.

57. Based on the evidence available at the time, CC10 concluded that, on balance, there was sufficient evidence to allow an uplift to Bristol Water's beta. However this decision was taken in the context of a determination where the CC's estimated cost of capital was already significantly below that calculated by either Ofwat or Bristol Water.[30]

58. The case against an uplift is made by PwC in its report for Ofwat.[31] PwC has argued that there is no case for an uplift, in part because the circumstances have changed since CC10. Additionally:

(a) PwC presented a further comparison of return on regulated equity (RORE) based on estimates from forward-looking business plans. This analysis indicated that the pattern observed above was unlikely to

[30] CC10 stated that the CC considered that the arguments for a higher cost of equity due to small size in itself were weak. However, the CC saw merit in the argument that WoCs, including Bristol Water, had higher systematic risk than the WaSCs and therefore increased Bristol Water's asset beta by 18%. The CC noted that this was likely to overestimate the relevant effect, and it considered that the overestimate of this aspect should offset it not allowing explicitly for the transaction costs involved in buying and selling smaller companies. CC10 Annex N, paragraphs 129 & 137.

[31] PwC company specific adjustments to the WACC, August 2014.

continue into the future. However, our review suggests that PwC's conclusion is speculative, because it appears that the forward-looking estimates have been heavily influenced by specific guidance from Ofwat regarding target values, and as such provide limited evidence in this respect.[32]

(b) Dee Valley's asset beta is not demonstrably higher than that of the public WaSCs.

(c) Theoretical arguments that higher operational gearing does not lead to a higher asset beta.

59. We noted Ofwat's points regarding the use of PwC's historic RoRE analysis as presented, including concerns around whether it is fit for the purpose of considering systematic risk as it was not originally designed for this. We recognised the associated limitations, and provisionally considered it insufficient for calculating an uplift figure from directly; however, we considered that it is still a valid piece of evidence supporting an asset beta uplift for Bristol Water and noted that PwC used it as such previously.[33]

60. Regarding Dee Valley's beta, due to intrinsic difficulties of estimating a beta for an illiquid share, we were concerned with how much weight could be placed on this evidence. Also, as a single comparator, questions would remain about how well it would represent the wider group of WoCs and Bristol Water specifically.

61. PwC also stated that in theory the higher risk for the WoCs could actually reduce the beta, as the risks which are greater for WoCs appear to be negatively correlated to the overall economy. However, as noted by Bristol Water, if this was a major contributor to systematic risk, it would appear to suggest a relationship which could result in water companies having a negative beta. We noted that the quoted WaSCs all have observable positive betas. Therefore the evidence from actual market behaviour was not consistent with this theoretical argument.

62. Ofwat also highlighted that some of the changes to the regulatory framework in PR14 could reduce the risks, such as the move to a consistent incentive framework across all totex.

63. On balance, we did not consider that Ofwat or PwC had made a compelling case that no uplift existed. However, we did provisionally accept that there

[32] *"We expect a RoRE variance from base returns of +/- 3.5% to +/-4.5% or given an allowed cost of equity of 5.7%, a RoRE range between 2% to 10%."* Ofwat Risk and Reward Guidance, January 2014, p49.
[33] PwC company specific adjustments to the WACC, August 2014, pp32–33.

may be a case for some downward trend in the size of any uplift. More generally, the uncertainty about the level of any uplift remains.

64. Based on the evidence we have seen, we provisionally considered it appropriate (according to our financing duty) and conservative to retain the CC10 methodology of using operational gearing to calculate a reasonable uplift for Bristol Water which could be applied to the asset beta. This is based on the ratio of operating cash flow (consisting of return on capital, and depreciation) to revenue.[34]

65. As can be seen in Table 6 above, Bristol Water's operating cashflow is 45% of revenue, whilst the public comparators have a 51% ratio. This would imply that an uplift of around 13% [(51 / 45) – 1] may be appropriate.[35] This is similar to the figure used in CC10 (18%), and continues to reflect an 'in the round' judgement for higher systematic risk faced by Bristol Water than the comparators used to estimate beta.

Risk-free rate market data analysis

66. As highlighted in both CC10[36] and Northern Ireland Electricity (2014),[37] since 2000 the CC/CMA has taken the view that long-dated index-linked gilt yields are in principle the most suitable basis for estimating the RFR applicable to the cost of equity.

67. However, the CC/CMA has also previously discussed factors which could distort the yields of long versus shorter term gilts:

(a) Longer-dated index-linked gilt yields have been affected by factors such as pension fund asset allocations, central bank policies, and demographics (eg retiring baby boomers). However, we believe that these effects are increasingly well understood by the market, resulting in these factors increasingly being accurately represented in the yields.

(b) Shorter-dated index-linked gilts were affected by action by the authorities to address the credit crunch and recession which again could influence yield rates, although again this effect should diminish in time.

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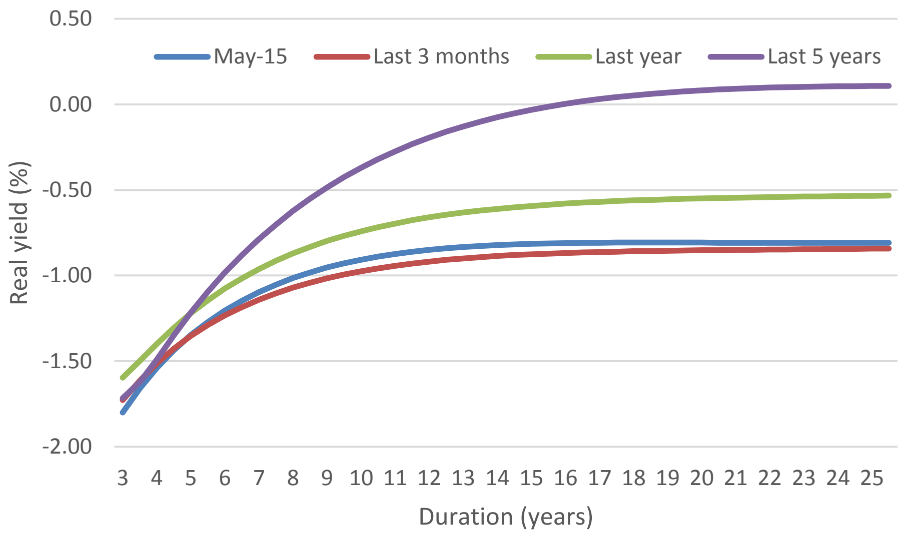
[34] Due to the introduction of 'RCV run-off' to replace depreciation, we would consider adjusting this if RCV run-off rates were no longer a fair reflection of underlying rates.
[35] These figures are based on Ofwat's Final Determination for the full next period. Bristol Water's estimates may change somewhat in the process of this redetermination, however, the operational gearing is likely to remain higher than the comparators.
[36] CC10, Appendix N, paragraphs 63–73.
[37] NIE (2014), paragraphs 13.117–13.129.

68. We therefore provisionally found that it is appropriate to consider both longer-term and shorter-dated index-linked gilt yields when considering the RFR.

69. Although it is possible to consider other measures to estimate a risk fee rate, we continue provisionally to regard index-linked gilt yields as in principle the most suitable source for estimating the RFR, since index-linked gilts have negligible default and inflation risk. Index-linked gilt yields (up to a 25-year duration) are shown in Figure 7 below:

Figure 7: Index-linked gilt rates



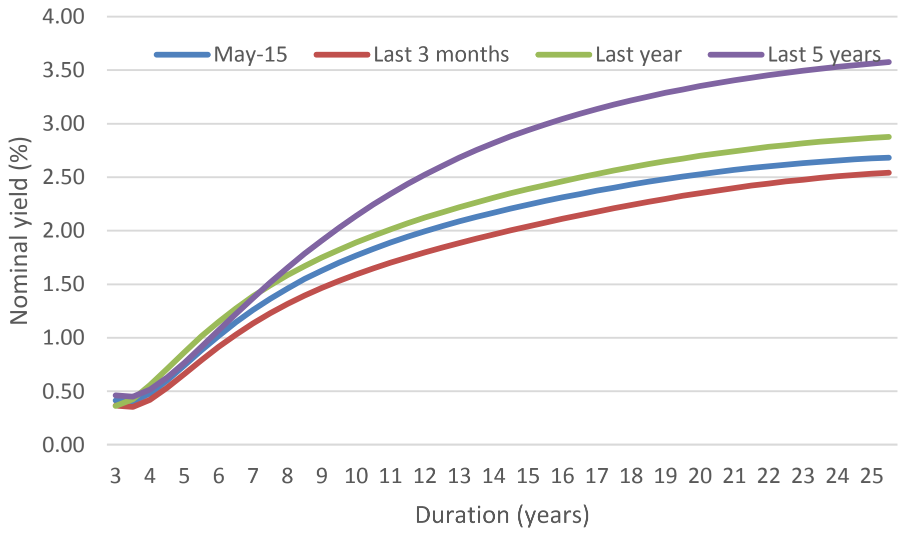
Source: Bank of England

70. As noted by the CC in NIE (2014),[38] long-dated index-linked yields have remained below 1 per cent for at least the last five years. The prolonged period of low yields may suggest that long-run rather than temporary factors are at work. Shorter term yields have consistently been below –1%.

71. Nominal gilts also have negligible default risk, but are subject to inflation risk. Nominal gilt yields can be used to estimate a real RFR if assumptions are made about expected inflation and any inflation risk premium. Nominal gilt rates can be seen below in Figure 8:

[38] NIE (2014), paragraph 13.127.

Figure 8: Nominal gilt rates



Source: Bank of England.

72. Adjusting nominal gilt yields for an RPI estimate of about 2.5 to 3.5% over this period[39] would indicate real yields of just over 0% for the periods in question.

[39] Depending on time period used, about 2.5% for past year, 3.5% for five-year data; ONS data selector.

Water company credit ratios (Ofwat calculations)

1. Table 1 and Table 2 below show Ofwat's calculations of the water companies' credit ratios, and their industry ranking respectively (note, for gearing a lower value is considered better).

Table 1: Ofwat calculations of water company credit ratio values

					%
	ACICR	*ICR*	*FFO/debt*	*RCF/debt*	*Gearing*
AFW	2.17	3.56	12.08	9.51	63.49
SBW	1.90	3.32	11.08	8.45	61.32
NES	1.84	3.54	11.48	8.84	62.01
WSX	1.78	3.30	10.44	7.84	63.93
SEW	1.76	3.03	9.20	6.61	62.94
BRL	1.69	3.63	12.07	9.41	64.89
UU	1.65	3.28	10.25	7.53	59.83
YKY	1.65	3.03	9.20	6.59	60.49
WSH	1.59	2.54	6.97	4.41	62.52
SVT	1.55	3.12	9.60	6.97	63.09
SWT	1.53	3.08	9.74	7.11	62.04
DVW	1.52	3.33	10.87	8.43	67.59
SSC	1.51	3.70	12.31	9.68	67.21
ANH	1.46	2.88	8.57	5.98	62.62
SRN	1.46	3.44	11.08	8.42	62.02
TMS	1.40	2.84	8.43	5.92	64.5
PRT	1.33	2.68	8.04	5.45	62.23
SES	1.19	3.46	11.23	8.62	65.51

Source: Ofwat, Final price control determination notice: policy chapter A8 – financeability and affordability, Table A8.9.

Table 2: Ofwat calculations of water company credit ratio rankings

	ACICR	*ICR*	*FFO/debt*	*RCF/debt*	*Gearing*
AFW	1	3	2	2	12
SBW	2	8	7	6	3
NES	3	4	4	4	4
WSX	4	9	9	9	13
SEW	5	14	14	13	10
BRL	6	2	3	3	15
UU	7	10	10	10	1
YKY	8	13	13	14	2
WSH	9	18	18	18	8
SVT	10	11	12	12	11
SWT	11	12	11	11	6
DVW	12	7	8	7	18
SSC	13	1	1	1	17
ANH	14	15	15	15	9
SRN	15	6	6	8	5
TMS	16	16	16	16	14
PRT	17	17	17	17	7
SES	18	5	5	5	16

Source: Ofwat, Final price control determination notice: policy chapter A8 – financeability and affordability, Table A8.9.

Glossary

ACTS	Average cost to serve. The average cost per customer for the household retail activities. The ACTS was used as part of the calculation of **Ofwat**'s household retail price controls.
Adjustment factor	See **K factor**.
AFW	A term occasionally used by **Ofwat** to refer to Affinity Water.
AIC	Average incremental cost. AIC is based upon the financial net present value of a scheme. **AISC** also includes environmental and social costs of the project.
AISC	Average incremental social cost. See **AIC**.
AMP	Asset Management Plan: a plan submitted by a **water company** to **Ofwat** for a five-year period.
AMP period	A five-year period in relation to which an **AMP** is submitted by **water companies** to **Ofwat**. Also known as a price control period. AMP2—the AMP period April 1995 – March 2000 (the PR94 price control period); AMP3—the AMP period April 2000 – March 2005 (the PR99 price control period); AMP4—the AMP period April 2005 – March 2010 (the PR04 price control period); AMP5—the AMP period April 2010 – March 2015 (the **PR09** price control period); AMP6—the AMP period April 2015 – March 2020 (the **PR14** price control period); and AMP7—the AMP period April 2020 – March 2025 (the **PR19** price control period).
ANH	A term occasionally used by **Ofwat** to refer to Anglian Water.
AOD	Above Ordnance Datum. AOD is the elevation of a location relative to the Ordnance Survey's measure of mean sea level measured at Newlyn, Cornwall.
Appointment	The instrument by which the Secretary of State or **Ofwat** (with a general authorization given by the Secretary of State) appoints a body under the **WIA 91** to be the **water**

	undertaker for the area described in that instrument. The word '**Licence**' is used interchangeably with 'Appointment'.
Aqua	Aqua Consultants. Engineering consultants used by the **CMA**.
Basic cost threshold	For its **PR14** cost assessment, Ofwat produced a basic cost threshold for each water company. This represented an estimate of the company's efficient total expenditure requirements for the period 1 April 2015 to 31 March 2020 (in 2012/13 prices and before RPI indexation) that was based on the output of Ofwat's benchmarking modelling and analysis. The basic cost threshold did not include allowances for **policy items** or adjustments for **special cost factors**.
BCT	See **Basic Cost Threshold**
Benchmarking analysis	Comparisons and comparative analysis across companies (or other entities) on aspects of their performance (eg costs or quality of service) so as to assess the relative performance of different companies and/or to estimate what a good or efficient level of performance would be. **Econometric analysis** is one possible method to use for benchmarking analysis.
Botex	Base totex. **Opex** + capital maintenance expenditure (capital expenditure required to maintain existing assets) but excluding **capex** attributed to enhancement projects.
Business Plan	**Ofwat** requires each appointed **water company** to submit a business plan at each **price review**.
Bristol Water	Bristol Water plc.
Bristol Water reply	**Bristol Water**'s reply to **Ofwat's response**, submitted to the **CMA** on 13 April 2015.
Bristol Water SoC	**Bristol Water**'s statement of case, submitted to the **CMA** on 11 March 2015.
BRL	A term occasionally used by **Ofwat** to refer to Bristol Water.

Capex	Capital expenditure. Expenditure and costs for new, replacement or refurbished capital assets, such as construction and buying machinery.
Capex bias	The tendency for companies to prefer **capex** solutions to **opex** solutions.
Capital maintenance	**Appointed water companies'** planned activity to replace and renovate water and sewerage assets to provide continuing services to consumers.
CC	Competition Commission. (As from April 2014, the functions of the CC have been taken over by the **CMA**.)
CC10	Bristol Water plc price determination (2010). On 8 February 2010, **Ofwat** referred an appeal from **Bristol Water** to the **CC** following the company's decision to reject the regulator's **FD** on price limits for the period 2010–2015, broadly on the grounds that they were too low.
CCG	Customer Challenge Group.
CCWater	The Consumer Council for Water. A statutory consumer body representing water and sewerage consumers in England and Wales.
CEPA	Cambridge Economic Policy Associates. Consultants used by **Ofwat**.
CH2M	An engineering company.
Cheddar 2	A proposed second reservoir at Cheddar, Somerset.
Cheddar WTW	Cheddar water treatment works.
CIS	Capital Expenditure Incentive Scheme. A system of incentives used at **PR09** that explicitly recognises that **appointed water companies** have access to better information about their future **capex** needs than **Ofwat** does. It was used with the aim of providing incentives to encourage regulated water companies to produce realistic and credible capex forecasts before price limits were set. After price limits have been set each company retained incentives to outperform **Ofwat**'s determinations, with the

	reward being higher for those companies that have made more challenging expenditure assumptions.
CMA	Competition and Markets Authority.
Cobb-Douglas	A specific type of model or equation that was used by **Ofwat** in the **econometric models** used its **benchmarking analysis** for **PR14**.
COPI	Construction output price index. The index measures the change in the costs of construction over time.
Cost of capital	The cost of financing a company. See **WACC**.
Cost sharing incentive	**For PR14**, **Ofwat** developed and applied a system of incentives in relation to companies' **totex**. The cost sharing incentive (scheme) meant that there was sharing, between a company and consumers, of the financial risk that the company's outturn expenditure is higher or lower than the wholesale expenditure allowance which was used to set its wholesale revenue control. The cost sharing incentive applied equally to **capex** and **opex**.
Cost sharing incentive rate	Under **Ofwat**'s **cost sharing incentive** for **PR14**, the cost sharing incentive rate is the proportion of any over- or under-spend against the wholesale expenditure allowance that is retained by the company and not subsequently passed through to consumers. A higher rates means that companies face a greater financial exposure to variations in their outturn expenditure and also to the cost assessment used to set the wholesale price control.
Draft Determination	Produced by **Ofwat** during each periodic review, serving as the basis for consultation on the price controls for each company for the relevant price review period. The **PR14** Draft Determinations were published on 30 April 2014 for the enhanced companies, 30 May 2014 for the early Draft Determination companies and 29 August 2014 for all other companies.
Deep dive	A deep dive is an **Ofwat** term for a focused review of a specific element of a **business plan**.

Determination	In the context of the **Periodic Review**, the setting by **Ofwat** or the **CMA** of the price control conditions under Condition B of the **Licence** of a **water undertaker**.
DI	Distribution input. The average amount of potable water (ie suitable for drinking) entering the distribution system to be supplied to customers in a water company's area of supply.
Dinobryon	Dinobryon is a unicellular flagellate algae (that is, one with a flagella or whip-like structure, or organelle, extending from the cell).
DVW	A term occasionally used by **Ofwat** to refer to Dee Valley Water.
DWI	Drinking Water Inspectorate.
EA	Environment Agency.
Econometric(s)	Econometrics is concerned with the analysis of economic data using, for example, statistical methods.
Econometric model	A model or equation used for econometric analysis.
Enhanced company	A company selected for enhanced status, due to the high quality of its **business plan**. The benefits of being awarded enhanced status include a higher **totex** allowance and an increased cost of capital, acceptance of the **business plan** 'in the round' and an earlier publication date for the **draft determination**. Also known as a fast-tracked company.
Enhancement	Enhancement is a level of service delivered better than previously defined. Examples of enhancements include: fewer supply interruptions for customers; fewer disruptions for the public in general; and less pollution.
Enhancement expenditure	Expenditure needed to deliver or achieve **enhancements**.
ERP	Equity risk premium. The return that an equity provides over the **risk free rate** which reflects the relative risk of holding equity.
FD	Final determination: produced by **Ofwat** at the end of each **periodic review**, setting out the **K factor**s for each **water company**. To indicate which one is being referred to, a

year indication is added, for example the most recent final determination for the period 1 April 2010 to 31 March 2015 is referred to as ‘FD14’. The **PR14** FDs were published on 12 December 2014.

FFO Funds from operations. An accounting measure of operating cashflow. It is used by Ofwat in credit ratio analysis when expressed as a proportion of a company’s net debt.

GLS Generalised Least Squares. GLS is a technique for estimating the unknown parameters in a linear regression model. It is applied, for example, when some of the assumptions of the classical regression model break down – such as when the variance of the disturbances is assumed to be non-constant across observations (heteroscedasticity) or when there may be correlation between the disturbances (autocorrelation).

GMEAV Gross Modern Equivalent Asset Value.

Halcrow Halcrow Management Sciences Limited, the consultant engineers engaged by the **CC** to advise it about **Bristol Water**’s **capex** proposals for the **CC10** determination.

IDoK Interim Determination of K: a new determination of the **K factor** by **Ofwat** between **periodic price review**s in response to changes in circumstance as set out in Condition B of the **Licence**.

Implicit allowance The amount of any **special cost factor** claim that Ofwat considered to be included in the **basic cost threshold**.

Instrument of Appointment See **Licence**.

IRE Infrastructure renewals expenditure. Infrastructure is mainly below-ground or 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 the appointed water companies manage, operate and maintain them.

K or K factor The wholesale price control for **Bristol Water** operates as a restriction on a measure of its revenue from wholesale activities. The restriction specifies that the wholesale revenue restriction changes from one year to the next by a percentage given by the formula **RPI** + **K**. The factor **K** can be positive or negative and is determined by **Ofwat** (or the **CMA**) at a price control review every five years. **RPI** is expressed as the percentage increase in the retail price index in the year to the November before the charging year.

KPI	Key Performance Indicator.
Leakage	Water lost between the treatment works and supply to customers' premises.
LEF	Local Engagement Forum. The LEF is **Bristol Water**'s **CCG**.
Licence	An instrument appointing a **water undertaker** (or water and sewerage undertaker) under Part II of the **WIA 91**. See **Appointment**. The word 'Licence' is used interchangeably with the word '**Appointment**'.
Logging up	A process by which **Ofwat** takes into account at the next **periodic price review** any variations in costs which have not been taken into account in the current periodic review or in an **interim determination of K**.
M&G	Management and General.
MAR	Market asset ratio.
MEAV	Modern Equivalent Asset Valuation.
Menu scheme	The menu scheme was part of **Ofwat**'s price control framework for PR14. It is a complex regulatory incentive scheme, the main purpose of which was to give extra incentives for companies to submit accurate expenditure forecasts and provide further flexibility to companies in terms of the level of the **cost sharing rate** that each company faces. The menu scheme was a development of the CIS that **Ofwat** introduced at **PR09** which was, in turn, based on the information quality incentive (IQI) that Ofgem has used as part of its regulation of electricity distribution companies and gas distribution companies in Great Britain.

mg/l Milligrams per litre.

Ml Megalitre (1 million litres, 1,000 cubic metres or 220,000 gallons).

Ml/d Megalitres per day.

MNI Non-infrastructure maintenance. Non-infrastructure is mainly above-ground assets, such as water and sewage treatment works, pumping stations, company laboratories, depots and workshops.

MZC Mean Zonal Compliance.

NEP National Environment Programme.

NES A term occasionally used by **Ofwat** to refer to Northumbrian Water.

NIE Northern Ireland Electricity price determination. On 30 April 2013, the Northern Ireland Authority for Utility Regulation referred a price control determination for Northern Ireland Electricity Ltd to the **CC** following the company's decision to reject the Utility Regulator's price control determination for the period January 2013 to September 2017.

Notified item An item identified by **Ofwat** in an **FD** which, if its cost changed, could be used by **water companies** as a reason for a request for an **IDoK**. A 'one way' notified item allows the **water company** to request that **Ofwat** make an allowance before the next **periodic price review** if certain conditions are met. A 'two way' notified item also allows **Ofwat** to intervene to reduce an allowance.

ODI Outcome Delivery Incentive. These were introduced during **PR14** as part of **Ofwat**'s outcomes based approach to focus companies on delivering a result or action that customers and society value.

Ofwat The Water Services Regulation Authority. The economic regulator of water and sewerage companies in England and Wales.

Ofwat response **Ofwat**'s response to **Bristol Water**'s **SoC**, submitted to the **CMA** on 25 March 2015.

Ofwat submission	**Ofwat**'s initial submission, submitted to the **CMA** on 4 March 2015.
OLS	Ordinary Least Squares. Statistical method used in **regression analysis** that finds the relationship of best fit between a dependent variable and one or more explanatory variables by minimizing the sum of squared differences between that relationship and each combination of the dependent and explanatory variables.
Opex	Operating expenditure. Expenditure that is not treated as **capex**.
Oxera	Consultants used by **Bristol Water**.
PAYG rate	Pay-as-you-go rate. The proportion of 2015-20 **totex** that is recovered during the 2015-20 price control period. The remainder is added to the **RCV** and recovered in future periods. This rate is set by the company as part of its **business plan**.
Periodic review	See **price review**. The term 'periodic review' is used interchangeably with the term '**price review**'.
Policy items	Policy items are areas of a water company's costs that Ofwat excluded from its cost benchmarking analysis and its basic cost threshold. The policy items for **Bristol Water** included business rates and **Ofwat's** allowance for pension deficit repair contributions.
Policy additions	Allowances in the cost assessment for **policy items**
PR09	**Ofwat** 2009 **price review**.
PR14	**Ofwat** 2014 **price review**.
PR19	**Ofwat** 2019 **price review**.
Price control	A form of economic regulation that acts to constrain the prices or tariffs that a regulated company may charge (the price control may also regulate other aspects of the company's activities, such as service quality and performance). The price control may take the form of a

restriction on the company's revenues, rather than limiting specific tariffs directly.

Price control review The process undertaken every five years by **Ofwat** to determine water company **price controls** for the next five years. PR94 covered the period from 1995 until 2000; PR99 covered the period from 2000 until 2005; PR04 covered the period from 2005 until 2010; **PR09** covered the period from 1 April 2010 until 31 March 2015; **PR14** covers the period from 1 April 2015 to 31 March 2020; and **PR19** will cover the period from 1 April 2020 to 31 March 2025.

PRT A term occasionally used by **Ofwat** to refer to Portsmouth Water.

RCV Regulatory Capital Value. The capital base used in setting **price controls**. The value of the regulated business which earns a return on investment. It represents the initial market value (200-day average), including debt, plus subsequent net new **capex** as assumed at the time of initial price setting. It includes new obligations imposed since 1989. The capital value is calculated using **Ofwat**'s methodology. Also known as 'regulatory asset base' (RAB) and 'regulatory asset value' (RAV).

RCV run-off rate The proportion of the regulatory capital value that is recovered in period, equivalent to depreciation. This rate is set by the company as part of its **business plan**.

RFR Risk-free rate.

RoRE Return on Regulated Equity. A concept introduced in **PR14** as a key metric of returns to shareholders. Calculated as:

- Return due to shareholders/equity component of **RCV** assumed in notional capital structure.
- Return due to shareholders calculated as EBIT − tax − (cost of debt x average net debt).

RPE Real price effects. RPEs reflect the extent to which the input prices (including wages) that a company faces may grow faster, or slower, than the **RPI** which is used for the wholesale price control indexation.

RPI	Retail price index: a general purpose domestic measure of inflation in the UK.
SBW	A term occasionally used by **Ofwat** to refer to SembCorp Bournemouth Water.
Scheme	Schemes can be an individual capital project or a group of discrete or interconnected projects with the same strategic purpose.
SCP	Small company premium.
Serviceability	**Ofwat** makes an assessment of the capability of a system of assets to deliver an expected level of service to consumers and to the environment. This is done to ensure companies are not underinvesting in their assets, and is completed by considering the trend in performance of a number of different indicators such as bursts and long duration interruptions to supply.
SES	A term occasionally used by **Ofwat** to refer to Sutton & East Surrey Water.
SEW	A term occasionally used by **Ofwat** to refer to South East Water.
SFA	Stochastic Frontier Analysis, which is a type of **econometric** technique for **benchmarking analysis**.
SIM	Service Incentive Mechanism. An **Ofwat** metric which measures customer service levels based on a mix of data sources.
Special cost factor	The purpose of special cost factors is to take account of specific characteristics or circumstances of a company (in this case **Bristol Water**) that affect its costs and which may not be adequately captured by **benchmarking analysis**. **Ofwat** and Ofwat considered potential adjustments for special cost factors as part of its cost assessment for **Bristol Water**. We use the term special cost factor to refer to all types of adjustment considered by **Ofwat**, including what Ofwat referred to as modelling adjustments and cost exclusions.

SRN	A term occasionally used by **Ofwat** to refer to Southern Water.
SSC	A term occasionally used by **Ofwat** to refer to South Staffordshire Water.
SVT	A term occasionally used by **Ofwat** to refer to Severn Trent Water.
SWT	A term occasionally used by **Ofwat** to refer to South West Water.
TMS	A term occasionally used by **Ofwat** to refer to Thames Water.
Totex	Total expenditure. **Capex** + **opex**.
Translog	A specific type of model or equation that was used by **Ofwat** in the **econometric models** used its **benchmarking analysis** for **PR14**.
UU	A term occasionally used by **Ofwat** to refer to United Utilities.
UV	Ultra violet. Ultra violet light can be used in the treatment of water by inactivating microorganisms such as bacteria and protozoa.
WACC	Weighted average cost of capital. For an **appointed water company**, the average cost of its debt and the cost of its equity capital, weighted according to the balance of debt and equity which finances the company's assets. It is expressed as a percentage of the value of a company's capital.
WAFU	Water available for use. A concept used in the planning of water resources.
WaSC	An appointed water and sewerage company. WaSCs provide water and sewerage services.
Water company	See **water undertaker**. The term 'water company' is used interchangeably with the term '**water undertaker**'.
Water undertaker	A water company appointed under the Water Act 1989 or **WIA 91** to provide water services in a specified part of

England and/or Wales. '**Water company**' is used interchangeably with water undertaker.

WIA 91 Water Industry Act 1991 (as amended).

WoC An appointed water-only company. WoCs provide water but not sewerage services.

WRMP Water Resource Management Plan.

WSH A term occasionally used by **Ofwat** to refer to Dŵr Cymru.

WSX A term occasionally used by **Ofwat** to refer to Wessex Water.

WTW Water treatment works. A treatment plant which processes raw water.

YKY A term occasionally used by **Ofwat** to refer to Yorkshire Water.