Totex cost assessment at PR19

Draft for discussion

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This paper has been written by Anglian Water as a contribution to Water 2020, Ofwat's programme for determining the form of the 2019 review of water price controls.

This paper was drafted in advance of the publication by the Competition and Markets Authority of the Bristol Water price determination Provisional Findings and does not take account of those Findings.

1. Summary

- This paper is Anglian Water's initial contribution to the debate as to how Ofwat should address wholesale cost assessment for PR19. We have taken an objective, evidence-based approach to our analysis and hope that this will be a useful contribution to the developing debate.
- Operationally, Anglian Water has enthusiastically embraced the totex approach to cost definition. We see the removal of separate assessments for opex and capex (with the differing incentives associated with each cost category) as beneficial. Our critique and proposals set out here are based on the assumption that this approach should and will be maintained at PR19.
- After reviewing carefully the effectiveness and efficiency of the PR14 totex modeling approach for water and wastewater, we have developed an approach which builds on its successful aspects.
- This paper does not purport to cover all aspects of the PR19 methodology. It focuses solely on the wholesale cost assessment element.
- The key features of the Anglian Water proposed approach which builds on aspects of the PR14 approach are as follows:
    - Confine the econometric modeling of cost assessment to cover botex (base totex: opex + maintenance capex)
    - Enhancement costs should be assessed by a mixture of unit cost models and in-depth programme assessments[1] of the larger capital enhancement programmes. These costs must include enhancement opex as well as capex
    - Enhancement opex should be included in the modeling process.
    - The cost assessment of smaller capital enhancement programmes should be handled by an unmodeled uplift, modulated by Ofwat's quality assessment of the in-depth programme assessments
    - Ofwat should work with the industry to ensure the highest quality of input data for the cost assessment process.
- The basis for our proposals is that while botex is predictable across the industry, enhancement capex is both lumpy and subject to strategic prioritisation by individual Boards in consultation with their customers. Even where similar trends impinge on all companies, enhancement capex may differ widely – for example the different profile of expenditure on sludge treatment by WaSCs over recent AMPs.
- In conclusion, Anglian Water does not consider that accepting the principle of totex cost *recovery* implies an acceptance of an integrated totex cost *assessment*. The experience of PR14 and the approaches taken by Ofgem, Ofcom and the ORR all suggest that cost assessment should not rely on a single technique, even if cost recovery remains on a totex basis.

[1] Deep dives, in PR14 parlance

2. Introduction

2.1. Purpose

The purpose of this paper is to set out how the efficient level of wholesale totex should be assessed and evaluated for each WaSC /WoC at PR19.

With the exception of the CMA redetermination of Bristol's price controls, which will include a detailed review of the way in which Ofwat reached its totex targets, PR14 and its reliance on the econometric models developed by CEPA is now over. However, although PR19 is four years away, Ofwat will soon start to consult on the form it will take.

This paper is intended as Anglian Water's initial contribution to the discussion as to how wholesale totex should be determined in PR19. As such, it does not consider the assessment of retail costs.

2.2. Why is it important?

Setting the envelope for total expenditure has been and remains central to the water industry's regulatory framework. If a company is allowed a total expenditure figure which is higher than necessary then it may set charges which are higher than they need be. Moreover, the company will have less incentive to look for efficiency savings. Conversely, a company set too low a total expenditure may not be able to cover all necessary expenditure to maintain a stable quality of service[2] nor to deliver improvements valued by customers.

The wholesale cost threshold contributed 50% to Anglian Water's total wholesale revenue requirement at PR14.

Until PR14, capex and opex were treated separately. Following the approach pioneered in other regulated utilities over the last decade (and in line with the direction of travel signaled by Ofwat for water in PR09), Ofwat moved to a unified, totex approach to cost setting in PR14, wherein operating costs and capital costs are treated the same. Ofwat's statements since PR14 suggest it believes the totex approach is the right one for the future. Therefore, ensuring the correct targets for totex are set for each regulated company will be central to the effective and efficient future operation of the sector.

With the PR14 process fresh in people's minds, it is a good time to review what works and what needs amending in the totex-setting process. Starting the process now will allow plenty of time for any process modifications to the PR14 approach to be debated, agreed and implemented before PR19 gets underway.

2.3. The level of materiality

Before considering the approach to assessing costs, it is helpful to remind ourselves of the current make-up of expenditure across the water industry. Table 1 sets out total water industry expenditure from 2010-11 to 2013-14.

[2] This is the reason for Bristol Water rejecting its Final Determination and thus for the current CMA referral.

Table 1: Total industry cost base

First four years of AMP5 £m	Water	Waste-water	Total	Water	Waste-water	Total
Opex	6,876	5,832	12,708	45%	32%	38%
Maintenance capex	6,158	7,149	13,307	41%	39%	40%
Botex	13,034	12,981	26,015	86%	71%	78%
Enhancement capex	2,146	5,218	7,364	14%	29%	22%
Totex	15,180	18,199	33,379	100%	100%	100%

Source: Anglian Water analysis of Industry data-share

For the ten Water and Sewage Companies (WaSCs), **op**erating **ex**penditure (Opex) represents 45% of **to**tal **ex**penditure (Totex). The eight Water only Companies (WoCs) have a similar pattern of spend to the WaSC water spend: for them opex represents 48% of totex. With around 80% of opex represented by the costs of power, staff and chemicals, these proportions remain predictably steady over time.

Maintenance capex, the cost of maintaining and where necessary replacing the existing level of capital equipment, is steady year by year, at around 40% of totex for both WaSC and WoC water spend and for (WaSC only) wastewater spend.

Opex and Maintenance capex together are referred to as Base totex or Botex.

Enhancement capex, as the name suggests, represents a material extension of the existing base of capital equipment to address new requirements, such as new quality standards, higher service levels or material increases in population.

Given the generally large size of individual investments in the water industry ("lumpiness") and the wide differences of population, population density, regional requirements etc., it is not surprising that different companies have very different enhancement capex requirements year by year. Moreover, the AMP process has tended to exacerbate the lumpiness by imposing a cyclical pattern of relatively low spend at the start and end of the AMP with a peak in the middle.

Table 1 shows that over AMP5, wastewater enhancement capex was a much higher proportion of totex than for water, where WaSC and WoC proportions were of a similar level. The higher wastewater enhancement capex spend so far in AMP5 cannot be ascribed to a single factor – of the ten WaSCs the 29% share of wastewater totex represents a weighted average of the individual company proportions which vary from 14% (South West) to 49% (Thames).

2.4. Ofwat's PR14 approach to cost setting

Regardless of the efforts underway to introduce contestability into the water industry in England, it will continue to be characterised by companies displaying regional dominance in significant parts of the business for the foreseeable future. Given the approach taken towards utilities by national and EU governments over the last 30 years, this implies the continuing need for some level of *ex ante* regulatory control.

Ofwat's approach has been characterised by a five yearly price review (PR) cycle of setting permitted levels of charges and expenditure for water (and sewerage) companies. For the five PR cycles before the most recent (PR14, which has just concluded), the approach was to determine an acceptable level of operating expenditure and capital expenditure separately and to agree a specific programme of capital works for each company. The separate controls, and their respective incentives, led to a widespread perception of "capex bias": a predisposition on the part of companies to solve problems through capital projects in preference to opex solutions which might have lower whole life costs.

PR14 marked a departure from previous practice in several ways. First, all costs have been assessed similarly regardless of whether they are opex or capex (a totex approach); second, Ofwat has shifted from its previously prescriptive approach, allowing companies to propose and justify their own programmes linked to evidence of customer preferences; third, costs have been modeled on a top-down basis using a variety of econometric models. While the industry has embraced the first two of these changes, the third has been seen as being problematic.

A detailed description of the approach taken by Ofwat to cost assessment at PR14 is set out in Appendix 1.

2.5. Success of Ofwat's PR14 cost assessment approach

In order to reach a view on the success of the PR14 cost assessment process, we consider this question from several perspectives:

2.5.1. Extent to which costs changed over the course of the price review process

The aggregate industry totex set in PR14 Final Determinations in December 2014 for the ten WaSCs and the eight WoCs over AMP6 (2015 – 2020) using this new approach was £40bn. This was 2% below the totex figures in the initial Business Plans submitted by the 18 companies in December 2013. This apparently modest variation obscures two factors:

First, the range of variability: from receiving 29% less than proposed (Bristol) to getting 9% more than proposed (Yorkshire, for water).

Second, as set out in Table 2 below, the fact that 75% of the overall change was achieved by an increase in the sums allowed by Ofwat during the course of the price review process and 25% by a reduction in scope and / or an acceptance of a more stringent efficiency challenge by the companies. By comparison, at PR09, 41% of the overall closure of the gap was achieved by an increase in the allowed amounts and 59% by a reduction in scope and / or an acceptance of a more stringent efficiency challenge by the companies.

Table 2: How thresholds moved over PR09 and PR14

£bn	PR09			PR14		
	Gap reduced by	Removed from BP	Increase to threshold	Gap reduced by	Removed from BP	Increase to threshold
Water	2.8	1.6	1.2	-0.1	-0.1	-
Wastewater	2.1	1.3	0.9	2.6	0.7	1.9
Total	4.9	2.9	2.0	2.5	0.6	1.9
Percentages	100%	59%	41%	100%	25%	75%

Source: Anglian Water analysis of PR09, PR14 data

This is a striking comparison which raises the question why Ofwat had to move its cost assessment by so much at PR14 compared to PR09. A possible explanation is that the initial modeled numbers were less robust in 2014 than in 2009.

2.5.2. Views of the companies on the process.

There was a widespread feeling among companies that the models used to generate the allowed totex numbers were over-ambitious, unstable and in some cases ignored key drivers of costs. This concern has been exacerbated by the perception that the thresholds generated by the models were of over-riding importance in driving enhanced status.

In Annex 1 of Appendix A3 of Ofwat's Draft Price Control Determination Notice, published on 28 August 2014, Ofwat gave its response to a wide range of criticisms set out by the companies to its wholesale cost modeling approach. A summary of the criticisms and Ofwat's responses is set out in Appendix 2.

2.5.3. The widely differing outcomes achieved by others who attempted the same exercise as Ofwat

Other commentators have pointed out that there is a poor correlation between the PR14 efficiency conclusions and those of previous price reviews. There also appears to be poor correlation between PR14 efficiency and SIM results, water quality, environmental pollution (e.g. pollution incidents) and customer service performance.

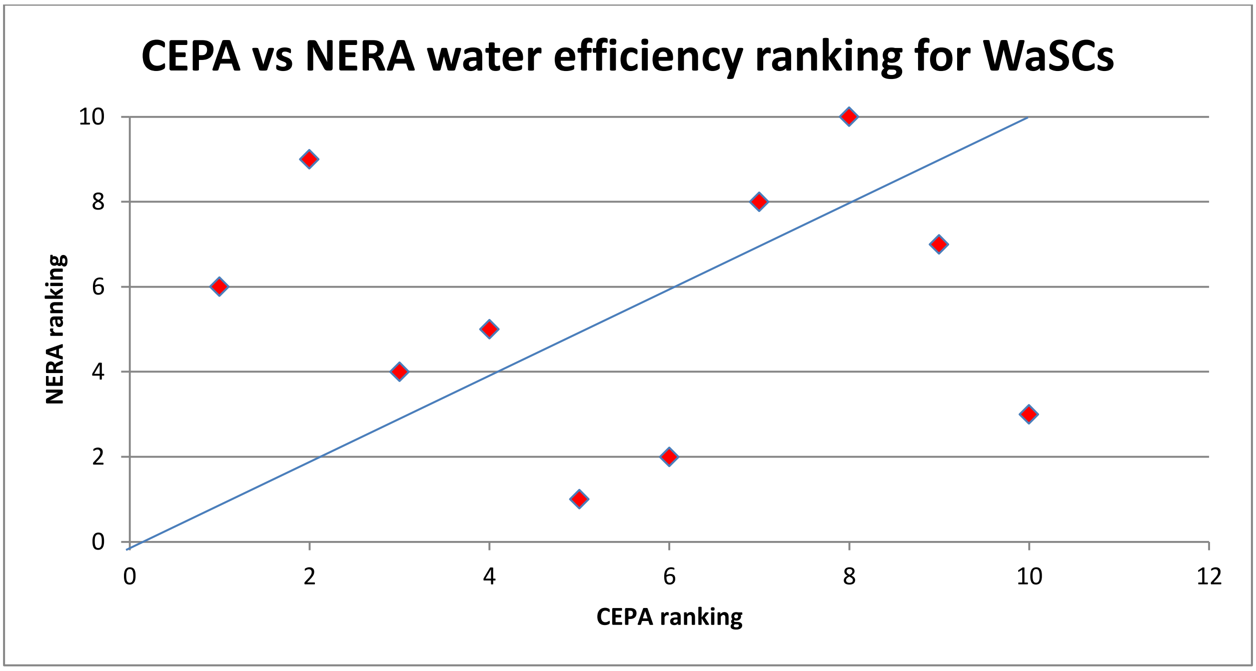
It is worth noting that NERA, which developed an SFA-based approach to determining efficiency frontiers for water and wastewater[3], reached conclusions which diverged significantly from Ofwat's PR14 conclusions. Anglian Water also understands that work carried out by Oxera on behalf of the industry also diverges from the conclusions reached by Ofwat at PR14.

Graphs 1 and 2 show the differences in the rankings of the ten WaSCs in terms of efficiency, looking at both the NERA and CEPA analysis. The blue lines represent a perfect match.

Whereas CEPA made use of both Corrected Ordinary Least Squares (COLS) and Generalised Least Squares (GLS), NERA used Stochastic Frontier Analysis (SFA). SFA explicitly aims to estimate the "frontier" or minimum achievable level of costs. By contrast, other approaches including COLS fit average costs and require a post-estimation adjustment to determine the frontier. The SFA approach also accounts directly for the panel structure of the data, rather than treating the annual company observations as separate companies as is the case in COLS. Both NERA and CEPA used June Return data to estimate outputs from multiple models which each company then averaged into a single representative figure.

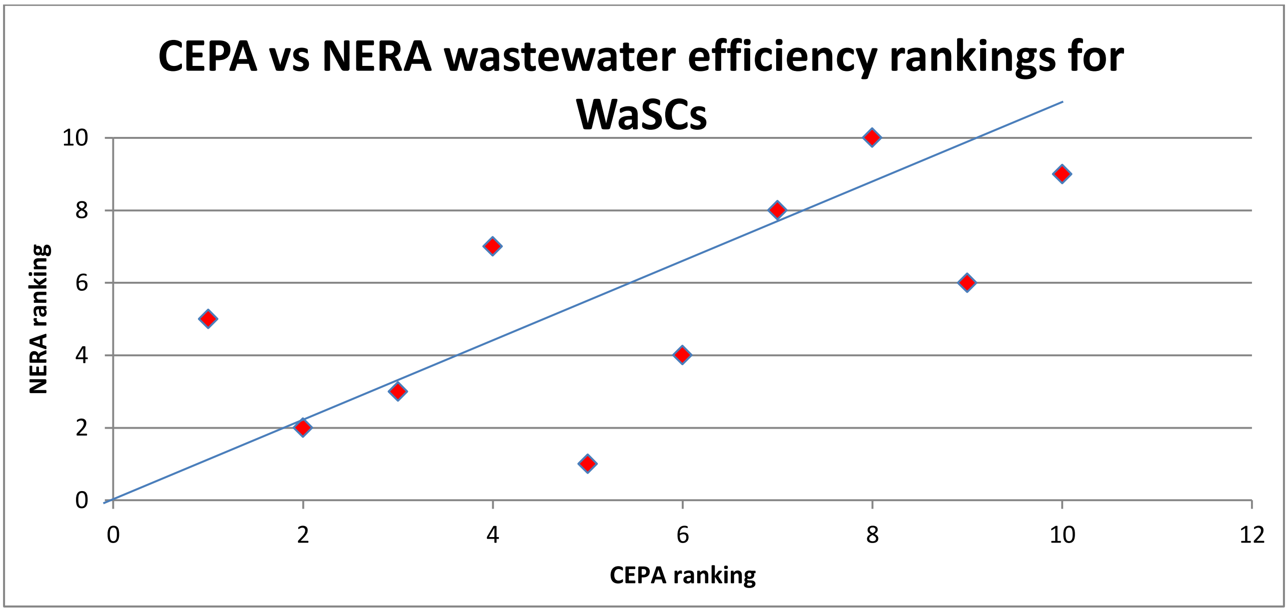
[3] On behalf of Anglian Water

Graph 1: Water efficiency ranking comparisons for WaSCs



Source: CEPA, NERA report for Anglian Water

Graph 2: Wastewater efficiency ranking comparisons for WaSCs



Source: CEPA, NERA report for Anglian Water

Out of the 13 topics addressed by the WaSCs and WoCs to Ofwat in their various critiques of the cost assessment process (see Appendix 2), only one, the failure to use the finalised WRMP results as inputs to the model, does not directly touch on the development and use of the econometric models. As has already been observed, PR14 represented a significant departure from the approach followed in previous price reviews. The much greater emphasis on customer interaction during the business plan development programme; the move to companies owning and developing their own business plans without the level of prescription from Ofwat which accompanied the process previously; the move to a cost type neutral (totex) approach to cost assessment; all of these were big changes.

But by far the most controversial element of the whole PR14 package was the new cost assessment process. Although cost definition was the subject of protracted consultation, the detailed mechanism by which costs would be assessed was not known until the RBR in March 2014.

3. Alternative approaches

This section considers whether there are alternative ways of assessing costs.

3.1. Alternative approaches considered by Ofwat

Before concluding that it should follow a totex approach to cost assessment in PR14, Ofwat undertook a lengthy consultation to consider a range of different ways of disaggregating for the purpose of assessing costs.

This paper aims to build on the cost definition work at PR14 with a focus on the form of approach which should be taken to different cost areas. It is our hope that this may contribute to the debate and ultimately to the smooth running of the PR19 process.

3.2. Alternative approaches followed by other UK regulators

Table 3 sets out the approaches taken by other UK regulators towards assessing costs required by utilities in recent years.

Table 3: Cost assessment approaches followed by other UK regulators

Regulator	Period	Approach
Ofgem – DPCR5	2010-15	Opex: OLS (4 years pooled) Capex: Bottom up engineering analysis
Ofgem – GDPCR1	2008-13	Opex: OLS (single year pooled) Capex: Bottom up engineering analysis
Ofgem – RIIO-GD1 **Ofgem – RIIO-ED1**	2013-21 2015-23	Totex using OLS, includes 2 years' forecast data & 4 years' historic data Econometric activity based models Technical assessment to take account of population density Functional benchmarking of IT, Finance & HR TFP benchmarking for assessing potential efficiency gains The econometric model results were averaged; benchmarking adjustments made subsequently

Regulator	Period	Approach
Ofcom – Openreach	2010-14	SFA, cross-checked with COLS to estimate operational efficiency compared to EU & US comparators Functional benchmarking of employment costs, IT costs, fleet costs & corporate overheads Time series review of Openreach's efficiency performance Expert review by Ofcom of BP assumptions for efficiency
ORR- PR13	2014-19	SFA of maintenance & renewals costs using data from12 EU comparators Cross-checks of SFA analysis OLS formulated econometric approach Functional benchmarking of employment costs Expert review of BP by both ORR & consultants, focusing particularly on efficiency assumptions Time series analysis of unit cost reductions for other UK regulated industries & UK TFP growth
CAA- BAA Q6	2014-18	Functional benchmarking of finance, Facilities management, IT Process benchmarking
CAA- NATS CP3	2011-14	Functional benchmarking of employment costs & back office functions Cost performance benchmarking on a unit cost basis with EU comparators

Source: Anglian Water analysis of published data

In the context of RIIO-ED1, Ofgem commented:

> *"We also intend to use two more disaggregated benchmarking models. The first model will be based on unit cost benchmarking of individual assets and activities. The second model will combine regression and technical/qualitative analysis on defined groups of costs. The model is similar to the disaggregated model used in RIIO-GD1. We consider that disaggregated model allows a less constrained and more intuitive specification of costs and cost drivers. "*[4]

Ofgem put a great deal of time and effort into the development of its suite of econometric models. These models were very detailed and highly complex. They also commanded widespread acceptance by the industry protagonists.

[4] Ofgem Strategy decisions for RIIO-ED1 – Tools for cost assessment, March 2013, Para 1.11, page 6

Despite all of this, Ofgem used these models as just one element in its overall approach to cost assessment which comprised a range of other techniques. Looking at Table 3, both Ofcom and ORR have taken a similarly multi-technique approach to cost assessment.

3.3. Alternatives canvassed in academic studies

3.3.1. UKWIR 2011 alternative approaches to efficiency report (by First Economics - FE)

This report was published at an early stage in the run-up to PR14, before Ofwat had committed to a totex approach to cost threshold setting. As such, it focused largely on the approach to opex cost assessment.

From reviewing other sectors' regulatory approaches, FE focused upon five approaches. These are set out in Table 4 below.

Table 4: Candidate efficiency approaches

Option	Description
1. Econometric models	Comparisons of total opex, or component parts of total opex, incurred by multiple companies in the same industry via OLS regressions or other statistical techniques
2. Cost base analysis	Comparisons of standardised unit costs for key opex activities
3. Network modelling	A bottom-up build-up of efficient costs, using process benchmarking, salary benchmarking, support cost benchmarking and expert challenge as appropriate
4. Roll forward chain rules	Mechanistic ex post pass-through of revealed efficiencies with a pre-determined lag
5. Menu based	Up-front revelation of efficient costs via a truth-telling incentive mechanism

Source: First Economics

The study concluded:

On incentives, Ofwat should:

- Consider carefully the alignment of capex and opex incentives when it calibrates its CIS. An increase or reduction in CIS incentive rates is by far the simplest, most effective and most transparent tool that Ofwat can bring to bear on opex and capex biases; and
- In the longer term consider how its assessment of opex comparative efficiency may be integrated – or at least better aligned – with its assessment of capex comparative efficiency. This may entail the construction of alternative econometric models or the use of Options 2 & 3.

On efficiency Ofwat should:

- Seek first and foremost to make its econometric models as accurate and reliable as possible

- Consider using either a cost base approach or the other alternative benchmarking techniques described in this study in areas of expenditure where its econometric models perform poorly
- Consider, in particular, isolating indirect support costs from other opex and benchmarking these costs using cost base techniques
- View incentives-based approaches, and especially the combination of an menu and a rolling incentive mechanism, as viable alternatives to ex ante efficiency assessment; and
- Consider using menu-only approaches in parts of the value chain that are being exposed to competition.

In short, Ofwat's focus should be on harmonising opex and capex incentives, on a mix of econometric and unit cost modeling and on improving the quality of the econometric modeling.

In two respects, this reflects the approach Ofwat ultimately followed. It did accept econometric modeling as being the first best approach; and it did look to supplement econometric models with a cost based approach where the models performed poorly. However, Ofwat did not follow other regulators in benchmarking support costs such as HR, IT or facilities management.

3.3.2. UKWIR 2012 totex options report (Reckon)

By the time UKWIR published this report, totex was firmly on the agenda. Once again, it put forward five options, A to E. Table 5 provides an overview of these five options, summarising the changes to cost assessment they entail as well as complementary changes to other parts of the price control framework.

Table 5: Totex options canvassed by Reckon

Option	Cost assessment	Other parts of regulatory framework
A	• Single industry-wide trend for opex; no opex comparative efficiency or catch-up • Capex assessment similar to current approach	New rolling incentive scheme for opex IQI retained for capex and recalibrated to better align opex and capex incentives
B	• Ofwat assessment of companies' total expenditure requirements drawing on business plans and other analysis • Avoid as far as possible using each company's historical expenditure for its cost assessment; instead make extensive use of detailed benchmarking analysis and relatively resource-intensive cost assessment tools	• IQI applied to total expenditure, same incentive rate for opex and capex • Remove opex incentive allowance • Apply "totex" approach to the RCV, with a fixed proportion of total expenditure capitalised for the purposes of updating the RCV in light of forecast and actual expenditure (drawing on approach adopted by Ofgem)

Option	Cost assessment	Other parts of regulatory framework
C	• Ofwat assessment of companies' total expenditure requirements drawing on business plans and other analysis • Avoid as far as possible using each company's historical expenditure for its cost assessment; instead place emphasis on estimates of total expenditure requirements from econometric models	As for B
D	• Ofwat assessment of companies' total expenditure requirements drawing on business plans and other analysis • No restrictions on the use of historical expenditure data for cost assessment	As for B
E	• Roll-forward approach to total base service expenditure (opex plus capital maintenance), using single industry-wide cost trend and other adjustments; no use of comparative efficiency analysis for base service • Separate assessment of capital enhancement expenditure, drawing on tools currently used	• New rolling incentive scheme designed to avoid distortions between different expenditure categories and over time; scheme replaces current incentive schemes applied to opex and capex • Capital maintenance expenditure would no longer affect RCV; instead remunerated through annual base service expenditure allowances and adjustments • RCV would grow in line with Ofwat assessment of capital enhancement expenditure, with adjustments for over- and under-spend made outside RCV

Source: Reckon

Options B and C contain large elements of the approach subsequently followed by Ofwat at PR14. Interestingly, option E is based on a botex / enhancement capex approach. As set out later in this paper, we consider that this basic division of costs has considerable merit as opposed to alternatives which focus on comprehensive unified totex models.

3.4. Competition Commission (CC) recommendations after the 2009 Bristol Water referral

The two general recommendations made by the CC which have relevance to the current paper were broadly supportive of Ofwat's PR09 stance[5]:

- *First, we expect efficient companies to have relatively smooth maintenance profiles, so that past expenditure should be a guide to efficient future expenditure. However, a proportion of such past expenditure should be exposed to challenge.*
- *Second, any increase should be challenged more vigorously (than the base level of past expenditure) although we had doubts about the 'double the difference' multiplier that Ofwat applied, which might unduly penalize companies which have good reasons for increases in expenditure.*

[5] Competition Commission report presented to Ofwat 4 August 2010 Section 13.4 p75

4. Analysis

4.1. The predictive efficiency of CEPA's modeling

4.1.1. Botex

To begin with, it would be helpful to test the CC's contention (set out in section 3.4 above) that botex is, or ought to be, predictable in efficient companies. A brief glance at the graphs in Appendix 6 gives a sense that botex should be forecastable. More detailed analysis supports this.

An entry-level measure of predictive efficiency of any econometric model is its ability to mimic historic performance. For the CEPA models, given they were based on historic data for WaSCs and WoCs (including the first two years of AMP5), it would be disappointing if they were unable to predict the past reasonably accurately

As part of the PR14 process, Ofwat has made available the models developed by CEPA which it used to compute the totex cost thresholds. Anglian has taken the AMP5 explanatory variables set out by all companies in the 2013 and 2014 August submissions and used them to re-run the CEPA models so as to generate "forecasts" for AMP5 botex for each company. These figures could then be compared with each company's "actual" botex costs also set out in the August submissions.

Appendix 4 sets out the results for botex only. This was straightforward in the case of wastewater as the models developed by CEPA for wastewater were botex only. For water, this meant using only the triangulated value for models E and F (which exclude enhancement capex).

If one compares the actual AMP5 botex[6] to the figure predicted by the model, as set out in the graphs in Appendix 4, the models in aggregate have forecast botex (assuming UQ efficiency) for the WaSCs which is 20% or £2,587m below the actual figure. For the WoCs the models forecast £351m less than actual (-13%). The comparable figures against average (instead of UQ) performance were £1,841m (-14%) for WaSCs and £183m (-5%) for WoCs. For wastewater at UQ, the undershoot of forecast compared to actual was £2,063m (-15%) or £684m (-5%) at average performance. This is set out in Table 6 below.

Table 6: "Actual" AMP5 vs forecast AMP5 botex using Ofwat models

Cost Category	Actual AMP5 £m	UQAMP5 forecast £m	UQ vs Actual	Median AMP5 forecast £m	Median vs Actual
WaSC water	13,255	10,668	-20%	11,414	-14%
WoC	2,763	2,412	-13%	2,580	-7%
Total water	16,019	13,080	-18%	13,994	-13%
WaSC wastewater	13,944	11,881	-15%	13,260	-5%
Overall total	29,963	24,961	-17%	27,254	-11%

Source: Anglian Water analysis

[6] Using August submission data with actual figures for 2013-14 (which were not available when the submission was made in August 2013. At the time of writing (June 2015), the 2014-15 are not yet available for the whole industry.

It would appear that while botex is predictable and thus forecastable, the Ofwat models are biased downwards by between 13%-20% when compared to the UQ. However, when compared to the median, the bias is lower but still significant - between 5%-14%. So part of the gap appears to be the UQ assumption. During AMP5 it seems that not every company achieved the stretching target set for AMP6.

As far as the rest of the gap is concerned, it appears that a reason may be an inaccurate estimate of capex split between base and enhancement in the August submission. Comparing the August Submission forecasts for 2013-14 with the outcomes for the year gives an indication of the reliability of the August Submission figures. These are set out in Table 7 below.

Table 7: 2013-14 August Submission costs compared to Regulatory Account costs for all WaSCs and WoCs

+: Forecast > Actual	Water	Wastewater	Total
Opex	0.3%	0.2%	0.3%
Maintenance capex	-7.7%	-13.3%	-10.5%
Enhancement capex	11.5%	19.6%	17.1%
Overall capex	-1.9%	3.4%	1.2%
Totex	-0.9%	2.3%	0.8%

Source: Anglian Water analysis

Table 7 suggests that the totex figures derived from the August Submissions for 2013-14 were in aggregate a good estimation of what transpired. However, the split of capex between maintenance and enhancement in the forecasts was not delivered in reality. Maintenance capex, and hence botex, were lower in the August Submissions for 2013-14 than proved to be the case. So the August Submission figures for 2013-14 were indeed biased downwards.

In conclusion, there is strong evidence that botex is forecastable and can be modeled.

In Appendix 3, we have gone on to look at the extent to which companies' AMP5's botex is a good predictor of what Ofwat's models predict companies will spend in AMP6. For water at upper quartile the key findings were:

- Actual AMP5 botex is a good predictor of the CEPA model AMP6 forecast
- For WaSCs only, y = 0.94x - 94; ; R^2 = 0.99 using company inputs
- For all companies, y = 0.90x - 24; ; R^2 = 0.99 using company inputs
- The fit is marginally better when comparing actual AMP5 against the average performance for forecast AMP6.

For wastewater, the fit is less good than for water but once again the average efficiency assumption is a better fit than the UQ assumption.

It might be thought that, given the CEPA models had used historic data, there should be a good fit. It should be noted that Jacobs data used runs over the five years to 2012-13 for water and the seven years to 2012-13 for wastewater. Hence the data covered both AMP4 and the first part of AMP5. However, consideration of the shape of the graphs in Appendix 3 (and Appendix 6) reinforces the impression that botex is predictable.

4.1.2. Enhancement capex

The picture is rather different in the case of enhancement capex. In the case of wastewater, enhancement capex was only computed outside the econometric models by using a range of unit cost models, supplemented by an unmodelled uplift to take account of other categories of enhancement cost other than those covered by the unit cost models. Graphs A7.5 and A7.6 in Appendix 7 demonstrate a good fit between actual AMP5 wastewater enhancement capex and that forecast by the CEPA unit cost models.

At UQ efficiency, the models have a general tendency to underestimate actual enhancement capex for wastewater. In aggregate across all WaSCs, the undershoot was 13% (see Appendix 7, Table A7.3). At average efficiency, the picture was more varied. Four companies would have received more than they required (Yorkshire an additional 30%) while six companies received less (Southern would have received only 45% of its requirement.). However, in aggregate, the model undershoot at average efficiency was only 2% (see Appendix 7, Table A7.4).

By comparison to wastewater, the position for water is much more variable. It should be noted that the analysis here looks only at the water unit cost and unmodeled allowances as it is not possible to disaggregate the totex econometric models developed by CEPA for water into the constituent elements of cost: consequently for the totex models it is not possible to separate out the enhancement capex element.

In aggregate, across the 18 WaSCs and WoCs, the forecast UQ costs match what was spent. But this masks a very high degree of variability. Some companies received much more than actually spent while others received only a fraction of what was spent. The standard deviation of the forecast to actual ratio for the UQ was 46% for WaSCs and a startling 180% for all companies, reflecting the extremely high variability for the WoCs. This once again points to the lumpier nature of WoC enhancement capex given their (generally) smaller size.

The figures can be seen in Tables A7.1 and A7.2 in Appendix 7.

4.2. The predictive ability of botex

We have gone on to test the predictive ability of botex by analysing trends over the period since 2000 (see Appendix 6).

The first impression of the graphs in Appendix 6 is the high level of overall predictability: for water, of the 18 companies, 14 have an $R^2 > 0.90$, 5 of which > 0.95. For wastewater, 8 out of 10 have an $R^2 > 0.90$.

The greater variability for wastewater can be ascribed to the high level of spend since the millennium on new wastewater assets, especially in sludge treatment, which have shorter asset lives than is general for water: this in turn leads to a more rapid (and lumpy) replacement cycle.

In addition, there are specific instances where local conditions (e.g. Thames' wastewater) lead to marked changes in the trend. This suggests that incorporating a forward-looking element into any modeling of botex would improve the predictive power of the model.

4.3. Enhancement capex

Given the potential for capital bias inherent in the pre-PR14 Ofwat regulatory regime, and given the widespread acceptance that capital bias can lead to inefficiency, there appears to be a general acceptance that combined opex/capex control is the way forward. This, however, does not translate into an acceptance by WaSCs and WoCs of integrated totex modeling. We make this point on a pragmatic basis.

Given the longevity of capital assets in the water industry, there is no conceptual reason why any company's capital enhancement programme should move in lock-step with others'. Even where there are factors impinging on all companies at the same time (e.g. climate change, population growth, new regulatory requirements), differing base circumstances will lead to widely differing capex impacts.

This is demonstrated by the graphs in Appendix 3 showing the variability of capital enhancement per property for WaSCs and WoCs. Looking at Graphs A3.1, A3.3 and A3.5 one can see that there is a high level of intra-year and inter-year variability. Comparing A3.1 and A3.3, there are also significant differences in average levels and range between WoC and WaSC for water. Graphs A3.2, A3.4 and A3.6 show the extent to which Ofwat's approach of using 5 year rolling averages to smooth out the unsynchronized cycles was successful. Table 10 helps show how this can be interpreted.

Table 8 below shows the variability in tabular form. Inter-year variability is encapsulated by the ratio of maximum to minimum annual average figures (the green squares on the Appendix 3 graphs). The intra-year variability is defined for this table as the average of the (maximum - minimum) for each year.

Table 8: Effectiveness of capital enhancement smoothing

	WaSC			WoC		
	Un-smoothed	**Smoothed**	**Variability Reduction**	**Un-smoothed**	**Smoothed**	**Variability Reduction**
Inter year						
Water	2.3x	1.8x	-22%	2.2x	1.4x	-35%
Wastewater	2.1x	1.5x	-29%			
Intra year						
Water	4.6x	3.1x	-33%	6.3x	3.1x	-51%
Wastewater	5.8x	3.8x	-34%			

Source: Anglian Water analysis

A key finding from Table 8 is that even after smoothing, there remains a high level of inter-year and intra-year (i.e. inter-company) variability. The WoCs' smaller size appears to exacerbate the unsmoothed comparisons – smoothing reduces the variability from a significantly higher level when unsmoothed to a similar level to the WaSCs when smoothed.

None of the above suggests that enhancement capex cannot be modeled. Our observations regarding the wastewater unit cost models in Section 4.1.2 above support the contention that if one identifies the drivers of major programmes, one can develop effective models. What it does suggest is that attempting to derive econometric models which cover all aspects of totex may be a bridge too far.

The implication we draw is that when it comes to assessing totex for water, it would be better to mirror much of the approach followed for wastewater. In particular, Ofwat should limit the econometric models to forecasting levels of botex for both water and wastewater and use alternative approaches to address the less predictable issues related to enhancement capex.

5. Recommendations

Logically, there are two decisions which need to be taken when deciding how cost allowances for the following AMP should be set by the regulator at the regular price review. The first decision involves defining costs – how should they be sliced up and assessed. The second involves agreeing which techniques should be used for the different categories of cost.

In Table 9, we illustrate graphically the different combinations of cost definitions and approaches used at PR09. Tables 10 and 11 set out the combinations at PR14. Finally, in Table 12 we set out an outline of our proposal for how costs should be dealt with at PR19.

In all of the following Tables, the unshaded boxes (e.g. Botex, Totex and Unmodeled allowance in Table 9) represent options which are not chosen.

Table 9: PR09 Water & Wastewater[7]

<table>
<tr><th colspan="3">Cost definition</th><th>Approach</th></tr>
<tr><td>Base opex</td><td rowspan="4">Botex</td><td rowspan="8">Totex</td><td>Modified roll-forward</td></tr>
<tr><td rowspan="3">Maintenance capex</td><td>Econometric modeling</td></tr>
<tr><td>Unit cost modeling</td></tr>
<tr><td>Challenged roll-forward</td></tr>
<tr><td colspan="2" rowspan="4">Enhancement (capex+opex)</td><td>Unmodelled allowance</td></tr>
<tr><td>Baseline based on BPs ('cost base)</td></tr>
<tr><td>Project justification</td></tr>
<tr><td>Capital estimating scorecard</td></tr>
</table>

Source: Anglian Water analysis based on Ofwat PR09 methodology

Clearly, PR14 marked a significant break from previous practice in terms of both cost definition and the approach followed to cost assessment. Ofwat and CEPA clearly put in considerable effort to develop robust econometric totex models for both water and wastewater. However, at a late stage in PR14, the decision was taken to abandon the effort so far as wastewater was concerned. In moving to a stance where enhancement capex was solely to be assessed using unit cost models, Ofwat inadvertently excluded enhancement opex from its wastewater assessment. It appears to Anglian Water that enhancement opex was omitted from all the Ofwat models. Ofwat disputes this, saying that the totex econometric models take it into account.

[7] See Appendix 8 for a brief overview of the PR09 cost assessment methodology

Table 10: PR14 Water

Cost definition			Approach
Base opex	Botex	Totex	Modified roll-forward
			Econometric modeling
Maintenance capex			Unit cost modeling
Enhancement capex (+opex?)			Challenged roll-forward
			Unmodelled allowance
			Baseline based on BPs
			Project justification - Deep Dive
			Capital estimation scorecard

Source: Anglian Water analysis

Table 11: PR14 Wastewater

Cost definition			Approach
Base opex	Botex	Totex	Modified roll-forward
			Econometric modeling
Maintenance capex			Unit cost modeling
Enhancement capex			Challenged roll-forward
			Unmodelled allowance
			Baseline based on BPs
			Project justification - Deep Dive
			Capital estimation scorecard

Source: Anglian Water analysis

So the approaches not carried forward from PR09 to PR14 were roll-forward for opex and base capex and companies' own BP figures for enhancement capex. So far as roll-forward is concerned, while the graphs in Appendix 6 show why a roll-forward would be a straightforward simple approach to cost assessment for opex and base capex, the analysis set out above shows that botex can realistically be modeled using econometric techniques.

Table 12: AWS PR19 Proposal: Water & Wastewater

Cost definition			**Approach**
Base opex	**Botex**	**Totex**	**Modified roll-forward**
			Econometric modeling
Maintenance capex			**Unit cost modeling**
Enhancement (capex + opex)			**Challenged roll forward**
			Unmodelled allowance
			Baseline based on BPs
			Project justification - Deep Dive
			Capital estimation scorecard

Source: Anglian Water

It is important to note that Anglian Water not only accepts but has embraced the totex approach to cost recovery. We believe that there are many operational benefits to be realized from adopting this approach.

Up to and including PR09, relative opex efficiency levels for WaSCs and WoCs in the forthcoming AMP were set using a suite of econometric and unit cost models of variable quality plus a strong reliance on roll-forward. Notwithstanding the widespread perception that the specific approach followed has its shortcomings, the approach in essence was feasible, producing results which could be justified.

We have taken that finding and built on it. Our analysis set out in section 4.2 above demonstrates the predictability of botex, both for water and for wastewater. As we have also shown, CEPA's PR14 models illustrate that, by adding maintenance capex to opex, botex can be modeled using econometric techniques (albeit in that case, with an apparently systematic downward bias).

As far as botex is concerned, we feel that the initial good econometric modeling work done during PR14 can and should be refined. Both water and wastewater should use an econometric modeling approach to arrive at botex cost levels for PR19. We believe that this can be further improved through incorporating forward looking data in the model development as well as unit cost botex modeling.

For enhancement capex, we consider that the attempts in PR14 to develop comprehensive totex models should be dropped. Instead, for both water and wastewater, it would be better to combine a mix of unit cost models (which were shown to have merit for wastewater – see section 4.1.2 above) with analysis from project-specific deep dives into the major programmes of each company. The following two tables quantify the scale of the task for Ofwat if it aimed to assess all of the largest capital enhancement programmes.

Tables 13 and 14 show that for Anglian Water a third of the capital enhancement projects account for 80% of capital enhancement expenditure. Assuming Anglian Water's distribution of programme sizes is representative of the industry as a whole, then scaling up from Anglian to the industry as a whole suggests that around 200 projects industry-wide accounts for about 80% enhancement capex. This is a sizeable - but by no means unmanageable – task.

Table 13: Anglian PR14 Business Plan

	# programmes	% by value
Capital Maintenance	191	52%
Capital Enhancement	84	48%
Total	275	100%

Source: Anglian Water analysis

Table 14: Anglian PR14 Business Plan

	80% CE by value accounted for by
Water	18 programmes
Wastewater	10 programmes

Source: Anglian Water analysis

The most straightforward way of handling the remaining two thirds of capital enhancement projects, which account for around 20% of capital enhancement spending (which from Table 1 represents around 5% of total expenditure), would be through an unmodeled allowance. This could be modulated using an adjustment based on the perceived quality of the major projects reviewed.

The Anglian Water approach is summarised below in Table 15. By taking the approach we suggest, 95% of totex (that is, the botex plus the major capital enhancement projects) would be assessed in ways which have been shown to produce predictable and defensible results.

Table 15: Proportion of totex modeled in AWS proposal

Cost definition	Share of total costs
Botex	77%
Major enhancement capex projects	18%
Small enhancement capex projects	5%
Totex	100%

Source: Anglian Water analysis

Prior to PR14, Ofwat and the industry had worked closely on cost and efficiency assessment for many years. The June Return (JR) process, though arguably unwieldy, produced input data of high quality.

At PR14, Ofwat appears to have been reluctant to explain to the industry the form of the models to be used so as to avoid companies 'gaming' the system.

Alongside this, because Ofwat had reduced the data collected about the market after PR09, and had dismantled the panoply of assurance which accompanied

JRs, the quality of the inputs to the models at PR14 was not as high as had been the case in previous PRs.

Given our analysis, which indicates that Ofwat can and should build on the approach taken at PR14, Anglian believes that Ofwat should once again work with the industry to define both the form of assessment and the inputs needed at PR19. In this way, the quality of the inputs can move back to the previous high standard and the confidence of all parties in both the process and the outcomes can be enhanced.

Appendix 1: Ofwat's PR14 approach

Ofwat used CEPA to prepare econometric models for totex.

CEPA was able to create models which it felt adequately described water. For the purpose of its overall modelling of the water sector, Ofwat used five of these econometric models. In figure 1, these are referred to as Models B, C, D, E and F. Models B, C and D are full totex models; that is to say, they cover all opex as well as maintenance and enhancement capex. The other two models, models E and F, model only opex and maintenance capex. These are referred to as botex (i.e. base totex) models.

CEPA was unable to create models which it felt adequately described wastewater in its entirety. However, CEPA felt comfortable with the quality of models developed to take account of opex and maintenance capex. These models were described as base totex - botex - models. These were augmented by Ofwat with unit cost models and unmodeled allowances to take account of enhancement capex.

Ofwat's approach to modelling was to combine the results from multiple models through an approach referred to as "triangulation". In terms of the approach followed by Ofwat, triangulation can be described as a process of taking arithmetic averages of the outputs of the separate models. Where it relied on econometrics for deriving base opex and maintenance capex ('botex') in the bottom-up strand of water modelling, then enhancement capex was dealt with through unit cost models where robust relationships between volume drivers and costs could be found. Where robust relationships could not be found, an uplift to deal with this remaining enhancement capex was added in, where the uplift percentage was based on experience in AMP5.

As all of the wastewater econometric models focused on botex, enhancement capex was dealt with through unit cost models where robust relationships between volume drivers and costs could be found. Where robust relationships could not be found, an uplift to deal with this remaining enhancement capex was added in, where the uplift percentage was based on experience in AMP5.

The modelling approaches for water and wastewater are shown in Figures A1.1 and A1.2 below.

Figure A1.1: Ofwat water modelling approach

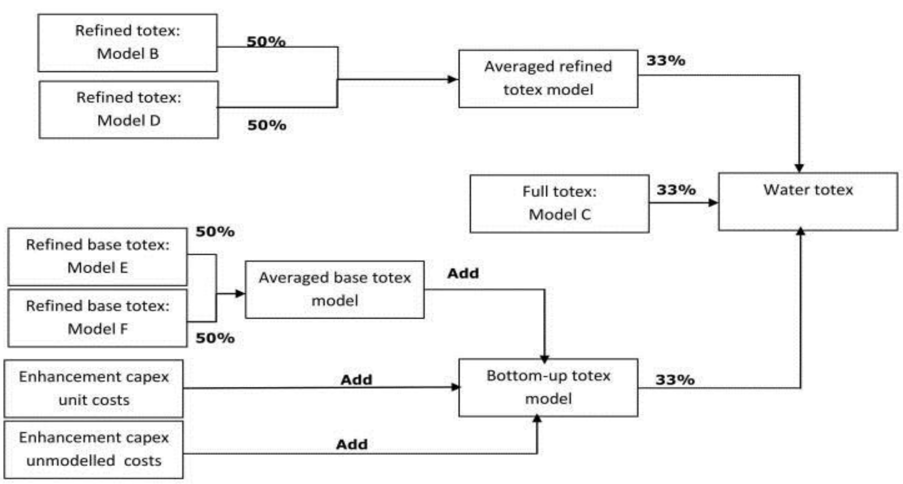
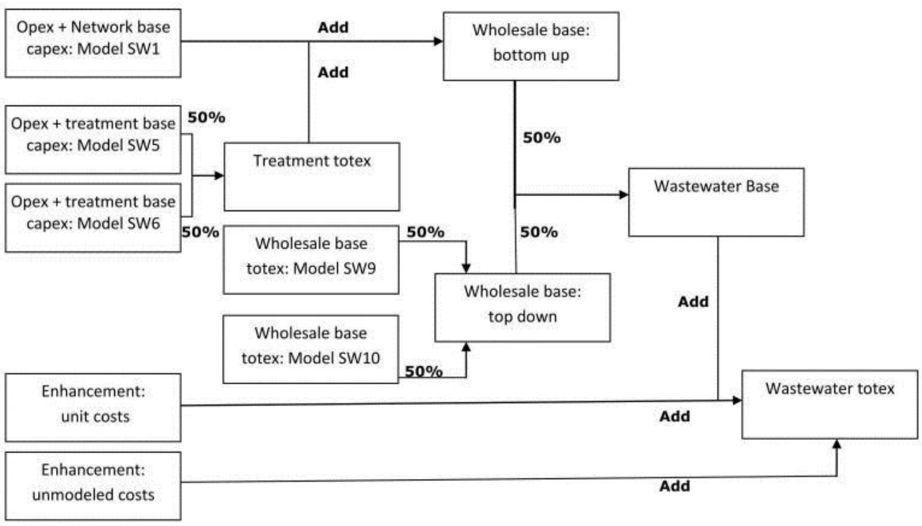


Figure A1.2: Ofwat wastewater modelling approach



The use of arithmetic averages (i.e. equal weights for each of the models used) would appear to suggest that CEPA and Ofwat have equal confidence in each of the models.

Ofwat commissioned Jacobs to produce a set of forecast figures for the variables used in the econometric and unit cost models across AMP6. These numbers, rather than the numbers used in companies' Business Plans, were used. These forecasts were based on the AMP5 figures for these variables. Where the figures across AMP5 were monotonic (i.e. all increasing or decreasing year on year), then Jacobs used Excel's trend function to generate the forecasts. If the AMP5 numbers were not monotonic, then Jacobs used the arithmetic average of the AMP5 figures, as reported in the August Submission, as the forecast for the annual change across AMP6. The implicit assumption in taking this approach is that AMP6 will be a continuation of AMP5.

The rest of this report looks at the outputs of the econometric models, the unit cost models and the unmodelled approach in more detail, highlighting issues with the approach which make the outputs an unreliable basis for assessing our expected requirements for AMP6. Suggestions are made as to how the approach could be improved.

The econometric models

CEPA started off by developing 10 water and 10 wastewater models. These were all evaluated on three criteria:

- Theoretical correctness
- Statistical performance
- Robustness.

In each case, the models were rated for each criterion as Good, Acceptable or Rejected.

Table A1.1 below summarises the results of CEPA's own evaluation of its water models. The emboldened lines are the models taken forward for use by Ofwat.

Table A1.1. Water models

Model	Theoretical correctness	Statistical performance	Robustness
W1: Totex all variables	Good	Rejected	Acceptable
W2: Totex all variables	Good	Rejected	Acceptable
W3: Totex all variables. Model C	**Good**	**Acceptable**	**Acceptable**
W4: Totex refined.	Acceptable	Acceptable	Rejected
W5: Totex refined. Model D	**Good**	**Good**	**Good**
W6: Totex refined. Model B	**Good**	**Good**	**Good**
W7: Totex refined.	Good	Rejected	Good
W8: Botex refined.	Good	Rejected	Good
W9: Botex refined. Model F	**Good**	**Acceptable**	**Good**
W10: Botex refined. Model E	**Good**	**Good**	**Good**

Source: Ofwat cost assessment - advanced econometric models. CEPA 20/03/2014

Table A1.2 below summarises the results of CEPA's own evaluation of these wastewater models. The emboldened lines are the models taken forward for use by Ofwat.

Table A1.2 Wastewater models

Model	Theoretical correctness	Statistical performance	Robustness
SW1: Network opex, base capex	**Good**	**Good**	**Good**
SW2: Network opex, base capex	Good	Rejected	Rejected
SW3: Treatment & sludge opex, base capex	Acceptable	Rejected	Rejected
SW4: Treatment & sludge opex, base capex	Acceptable	Good	Rejected
SW5: Treatment & sludge opex, base	**Good**	**Good**	**Good**

capex			
SW6: Treatment & sludge opex, base capex	**Good**	**Good**	**Good**
SW7: Wholesale opex, base capex	Good	Acceptable	Acceptable
SW8: Wholesale opex, base capex	Good	Acceptable	Acceptable
SW9: Wholesale opex, base capex	**Good**	**Good**	**Acceptable**
SW10: Wholesale opex, base capex	**Good**	**Good**	**Acceptable**

Source: Ofwat cost assessment - advanced econometric models. CEPA 20/03/2014

Appendix 2: Summary of industry critiques to Ofwat's PR14 cost assessment approach along with Ofwat's responses

A2.1 Enhancement capex in water totex models

Several companies put forward critiques which could be summarized as follows:

- Companies can be at different phases in investment cycle.
- Cost driver and cost relationships may change between periods.
- Enhancement is driven by unique factors.
- Enhancement drivers missing from refined models[8]

Ofwat's response was:

a) It had used a highly reputable consultancy (CEPA) to develop its models;
b) Four year smoothing of capex data had mitigated the problem; and
c) It had recognized the point regarding unique factors in its special factor approach

So, in essence, Ofwat accepted the thrust of the critique and claimed it had put mitigation measures in place. However, it should be noted that special factors only mitigate to the extent that companies put forward cases which Ofwat accepted.

A2.2 Enhancement opex

One company (Anglian) pointed out that the opex related to enhancement capex was not captured in the unit cost models and unmodeled cost categories.

Ofwat's response was to agree and then contend that it was not necessary to deal with this omission.

A2.3 Triangulation

Companies suggested that variable weights should be used to take account of the differing levels of statistical robustness of the different econometric models developed by CEPA and used by Ofwat.

Ofwat could not see any compelling evidence that different weights should be used.

A2.4 Use of the Upper Quartile (UQ) efficiency target

Several companies questioned whether the UQ efficiency target was too stringent for setting cost baselines given the inherent uncertainties in

a) Cost modeling; and
b) Identifying UQ efficiency

Ofwat's response was to concede that the wastewater models were less robust than the water models. However, as other regulators used an UQ target, Ofwat considered this to be appropriate.

A2.5 Service quality & treatment

Some companies, Bristol Water included, highlighted that water treatment costs are handled through the econometric models principally through the inclusion of mains length as a variable. Companies with higher costs of treatment (such as Bristol) are thus disadvantaged.

[8] Taken from a report by Oxera for Southern Water, as reported by Ofwat

Ofwat retorted that one of its models included Quality of Service and complexity of treatment variables. It went on to accept that to the extent that these factors impact the baseline, they are attenuated by 67% through triangulation. Ofwat went on to point out that the special factor route was always open to companies.

A2.6 Real Price Effects

Several companies (including Anglian) raised the concern that RPEs are not taken into account and that the time trends statistically insignificant in five out of the six models.

Ofwat's response is that it sees no compelling evidence that its approach is flawed as RPEs could as well be positive as negative over the next AMP.

A2.7 Specification of exogenous variables

Two companies were concerned that including the length of mains as a variable could create a perverse incentive to extend the network unnecessarily also as to increase totex.

Ofwat replied that while this is indeed a theoretical perverse incentive, in reality the practical requirement to be totex efficient would trump the theoretical perverse incentive.

A2.8 Implicit allowances

Several companies raised detailed specific problems with Ofwat's process of computing implicit allowances.

Ofwat conceded one of the raised issues and rejected a second.

A2.9 Robustness of coefficients in econometric models

Several companies highlighted the fact that many of the modeled variables in the econometric models are not statistically significant and/or do not display the expected sign (positive or negative) or magnitude.

Ofwat's response was that it was open for companies to make a special factor claim to address their concern, which indeed one company had done.

A2.10 Model specification

Companies highlighted perceived problems of omitted variables, over-specification of the models and the type of estimation technique used.

Ofwat conceded that Multi-collinearity is a risk, but goes on to say that it will not impact the predictive ability of the model. In relation to the concerns about the estimation techniques used and to omitted variables, Ofwat points out that two companies supported its stance.

A2.11 Use of Jacobs numbers instead of companies' numbers

It is unsurprising that companies preferred their own estimates as companies generated their own forecasts based on their own specific requirements, whereas Jacobs used historic data to either predict a trend (where the historic data were monotonic) or an average figure where the data moved up and down.

Ofwat responded that Jacobs approach was preferable as:

a) Companies may have exaggerated the changes in exogenous variables; and

b) Jacobs approach was more homogenous than the companies, which had been required to produce their Business Plans without the guidance Ofwat had previously given.

A2.12 Updating for final WRMP

Ofwat used the draft WRMP to inform the initial evaluation of companies' Business Plans. Where companies

i) Had their WRMP confirmed;
ii) Had demonstrated to Ofwat's satisfaction that the adjustments from the draft WRMP were valid; and
iii) Had asked for the WRMP to be taken into account

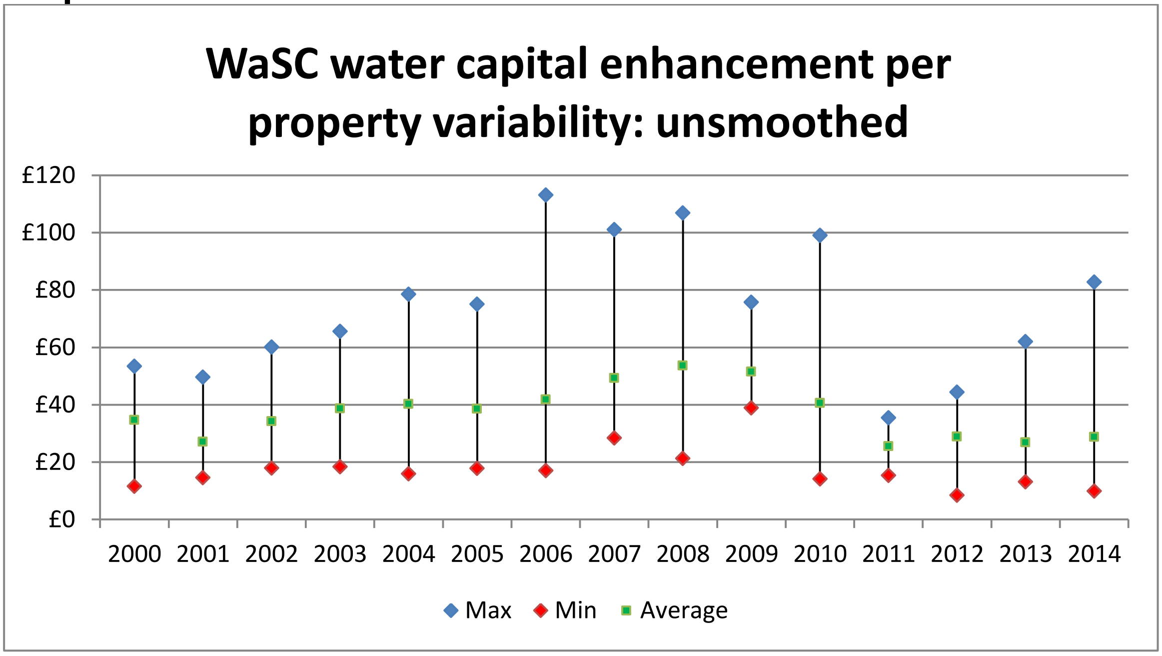
Ofwat accepted that the data from the WRMP should be used.

A2.13 Use of population estimates and census data

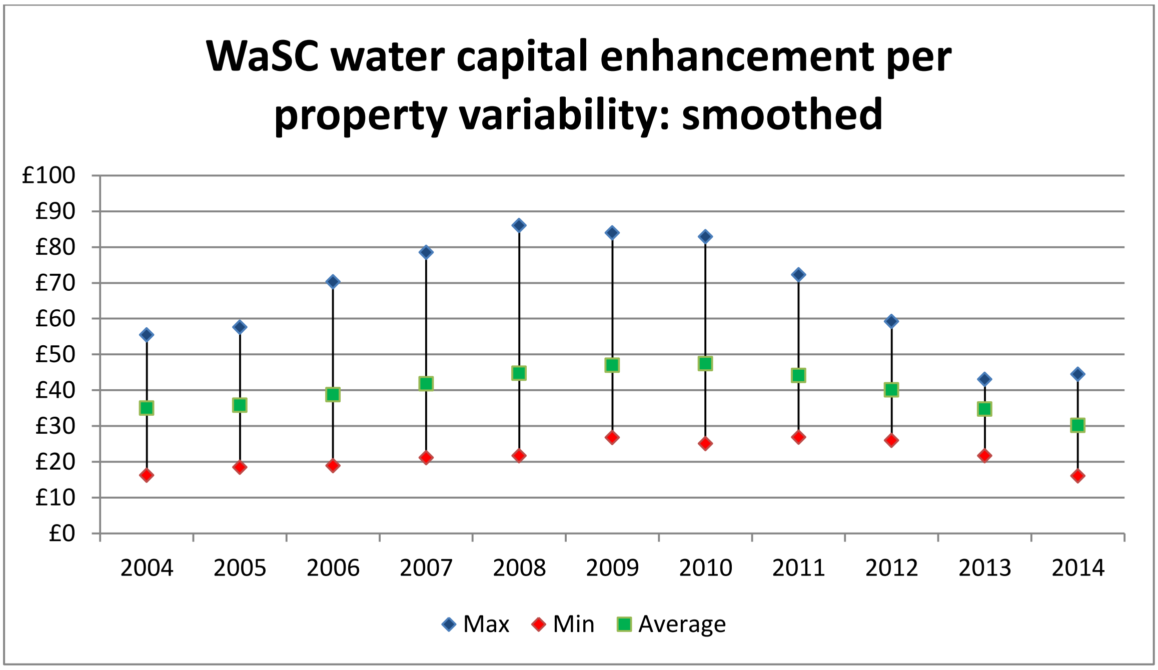
Ofwat accepts that it has not used the most up-to-date census data in its analysis. It also accepts that these new data show a step change in projections. Ofwat considered that using the new data would "not necessarily produce more reliable projections of costs".

Appendix 3: Capital enhancement variability

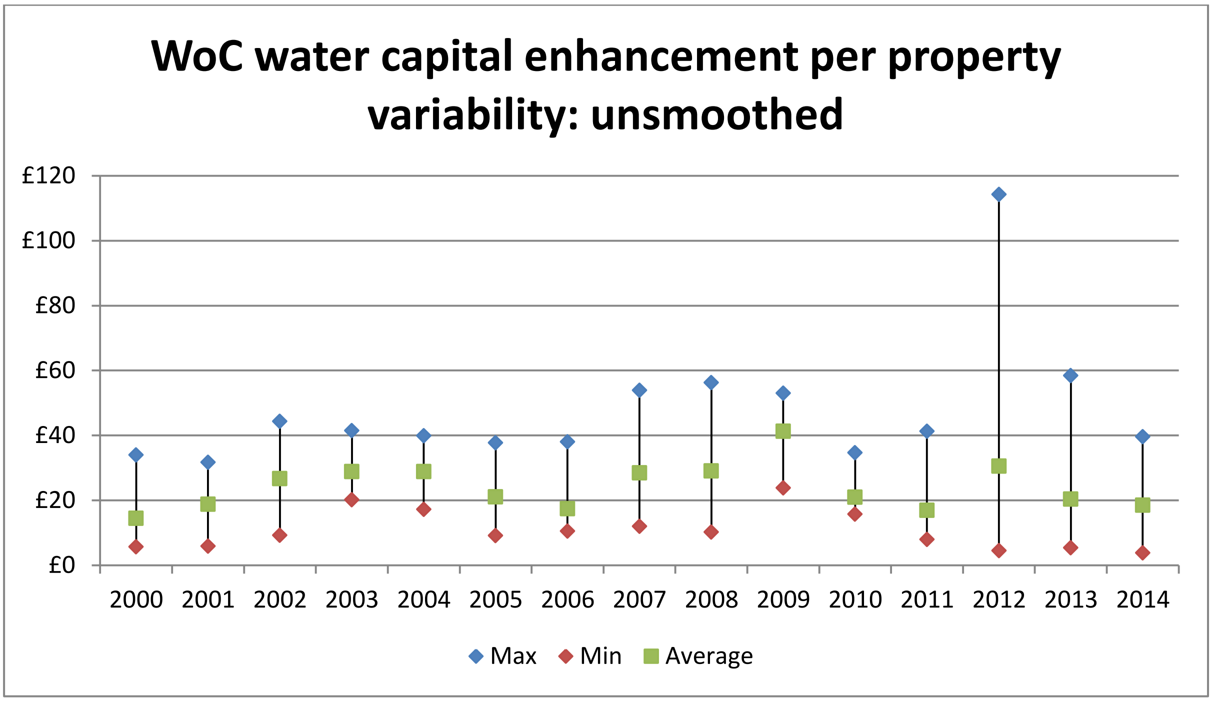
Graph A3.1



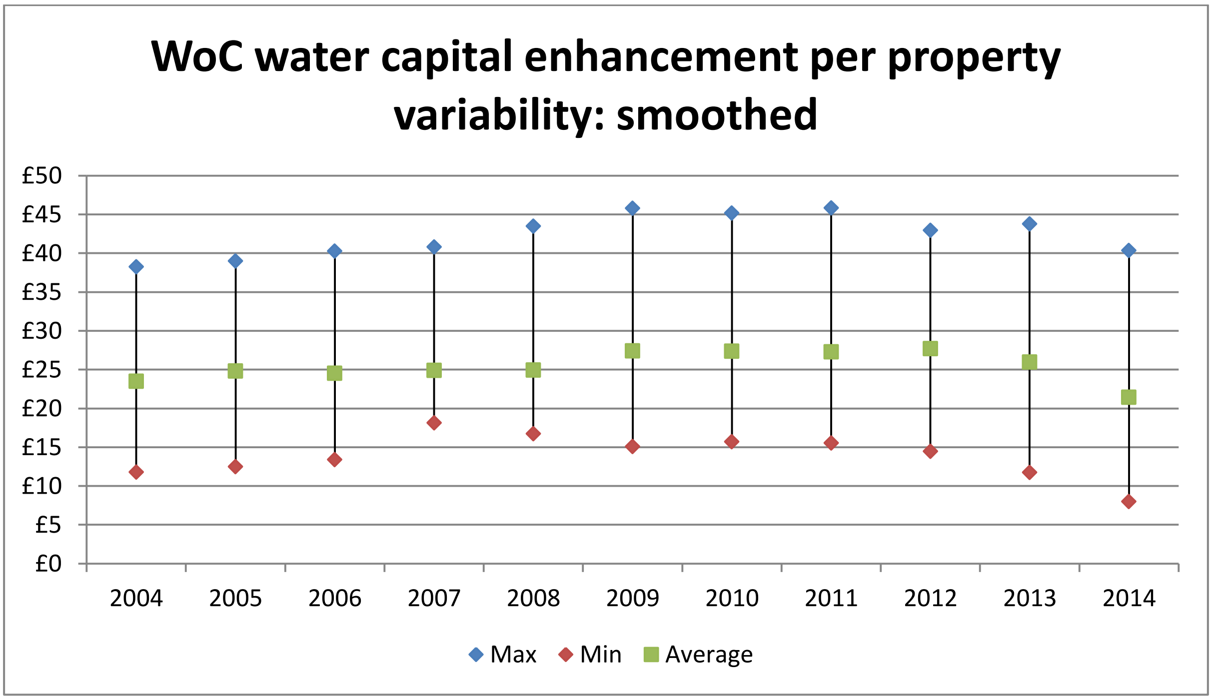
Graph A3.2



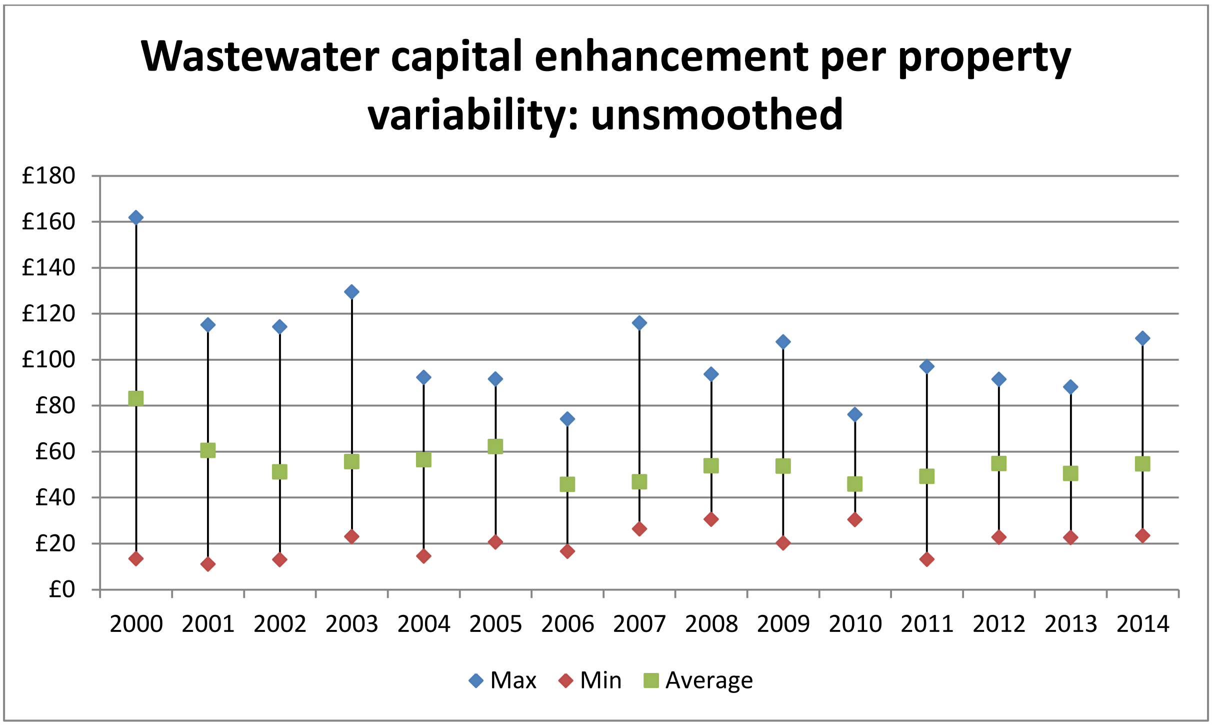
Graph A3.3



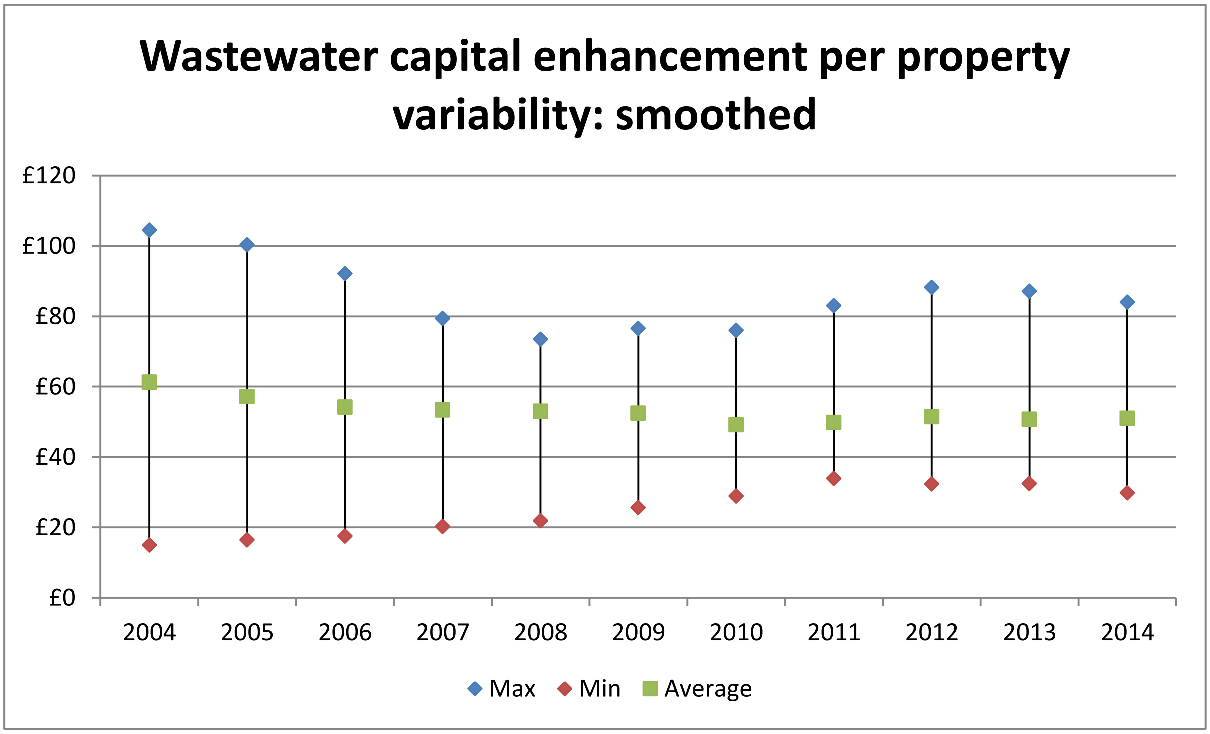
Graph A3.4



Graph A3.5

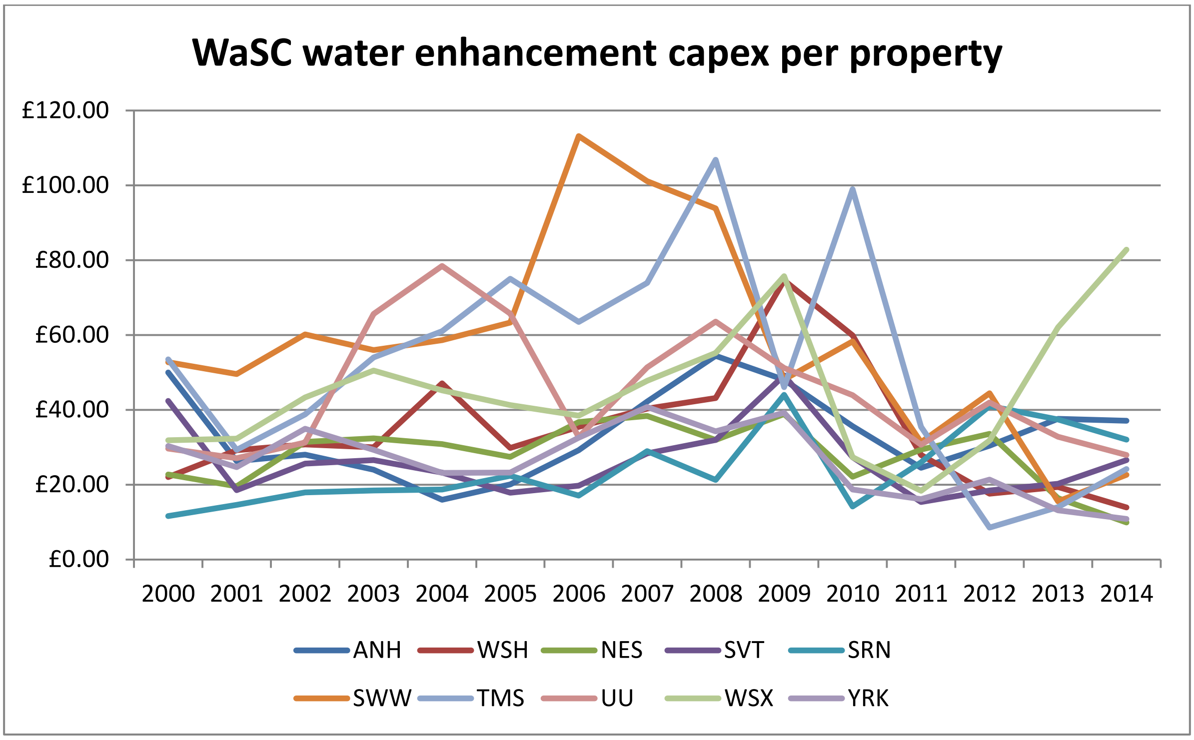


Graph A3.6

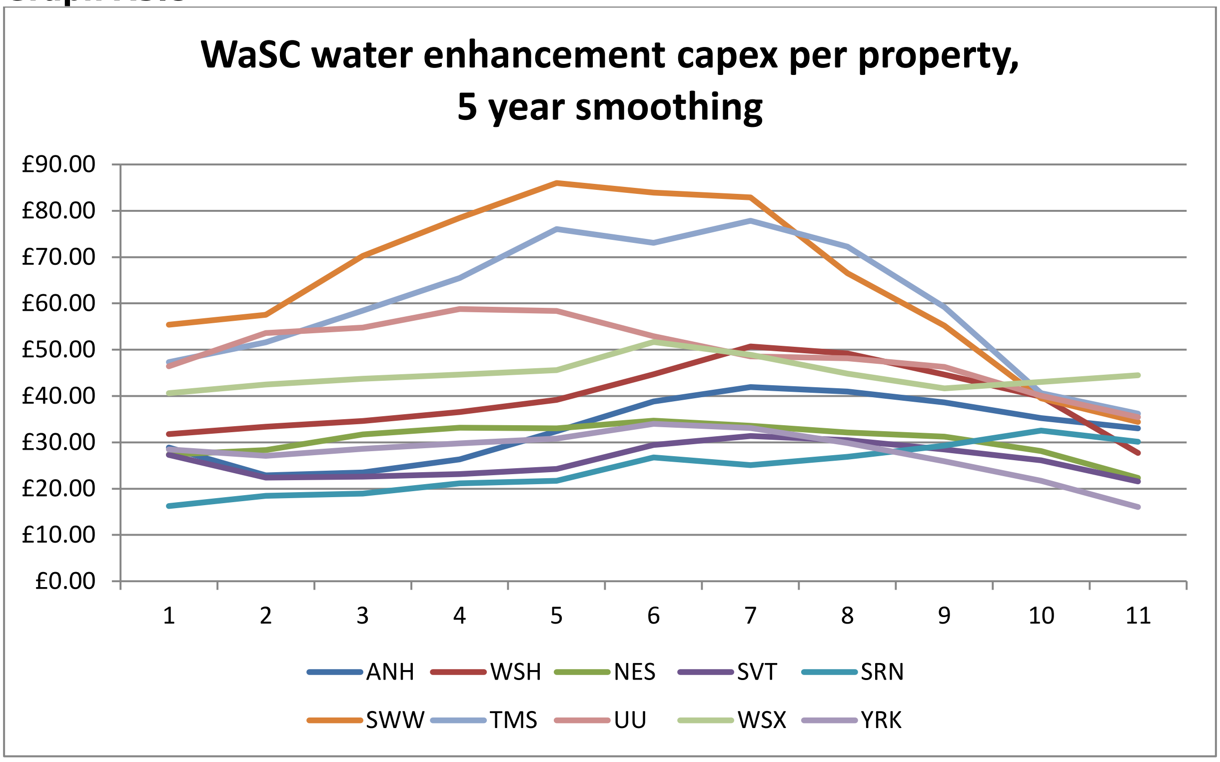


ANH: Anglian Water
WSH: Welsh Water
NES: Northumbrian Water
SVT: Severn Trent Water
SRN: Southern Water
SWW: South West Water
TMS: Thames Water
UU: United Utilities
WSX: Wessex Water
YRK: Yorkshire Water

Graph A3.7

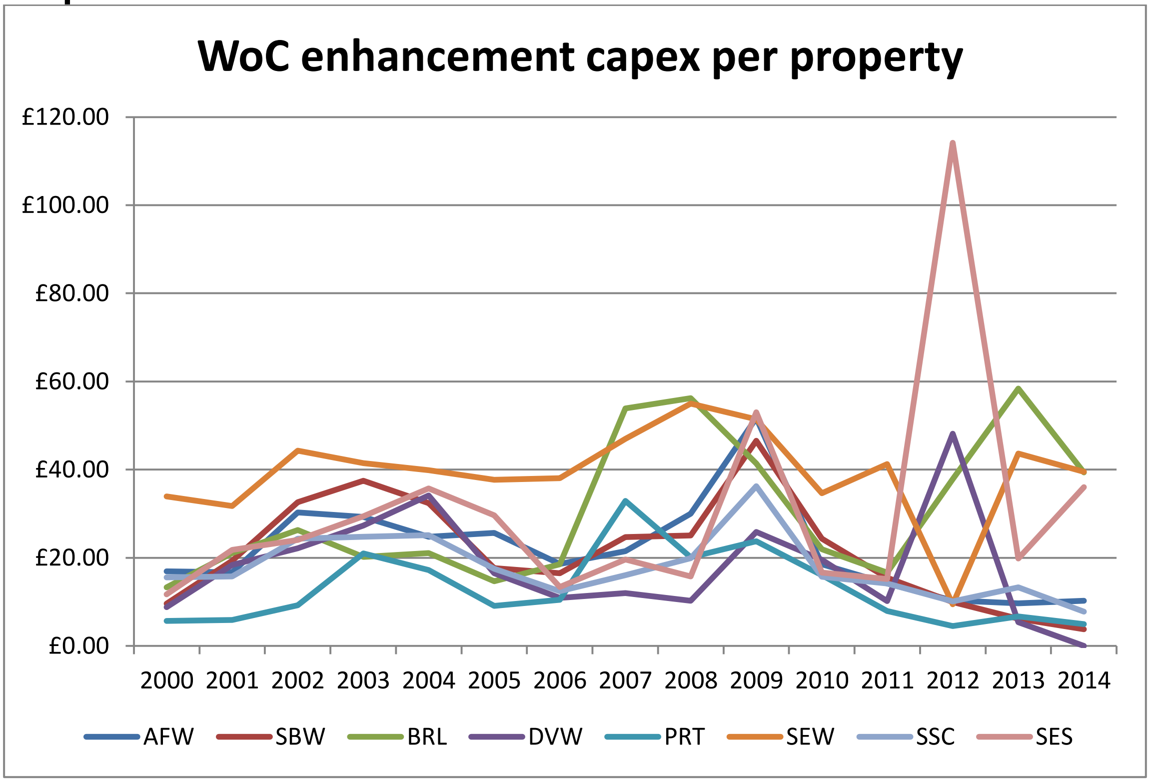


Graph A3.8

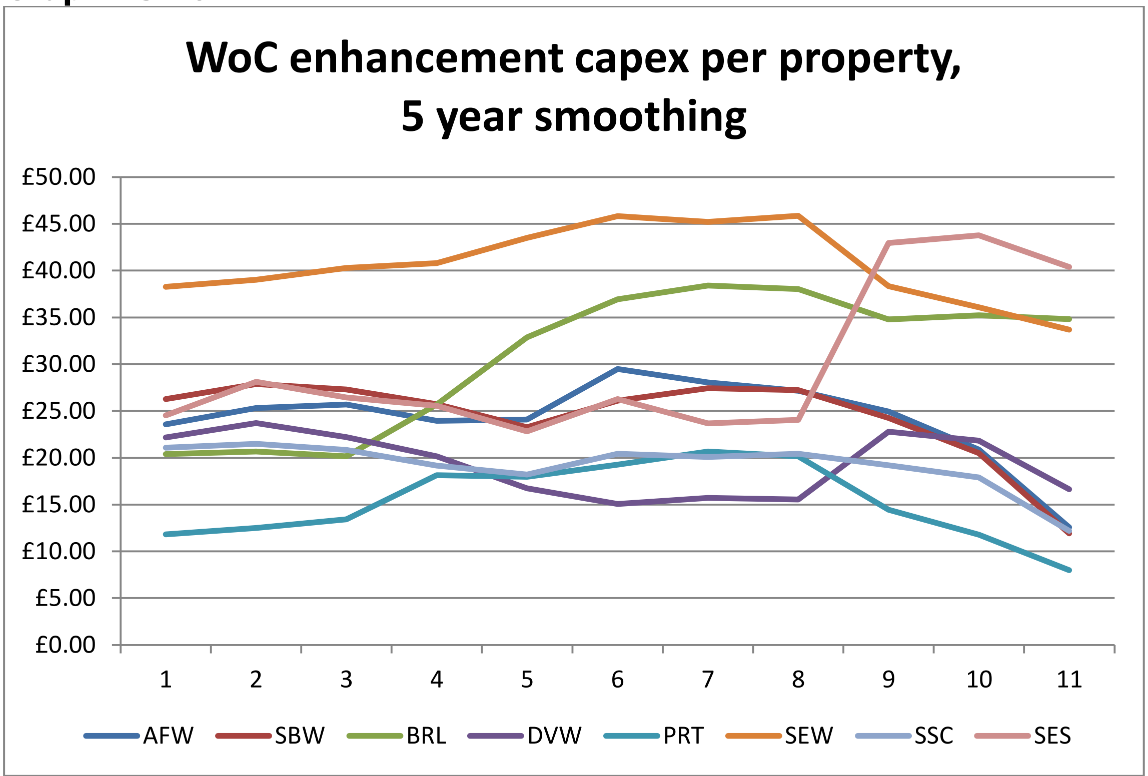


AFW: Affinity Water
SBW: Bournemouth Water
BRL: Bristol Water
DVW: Dee Valley Water
PRT: Portsmouth Water
SEW: South East Water
SSC: South Staffs Water
SES: Sutton & East Surrey Water

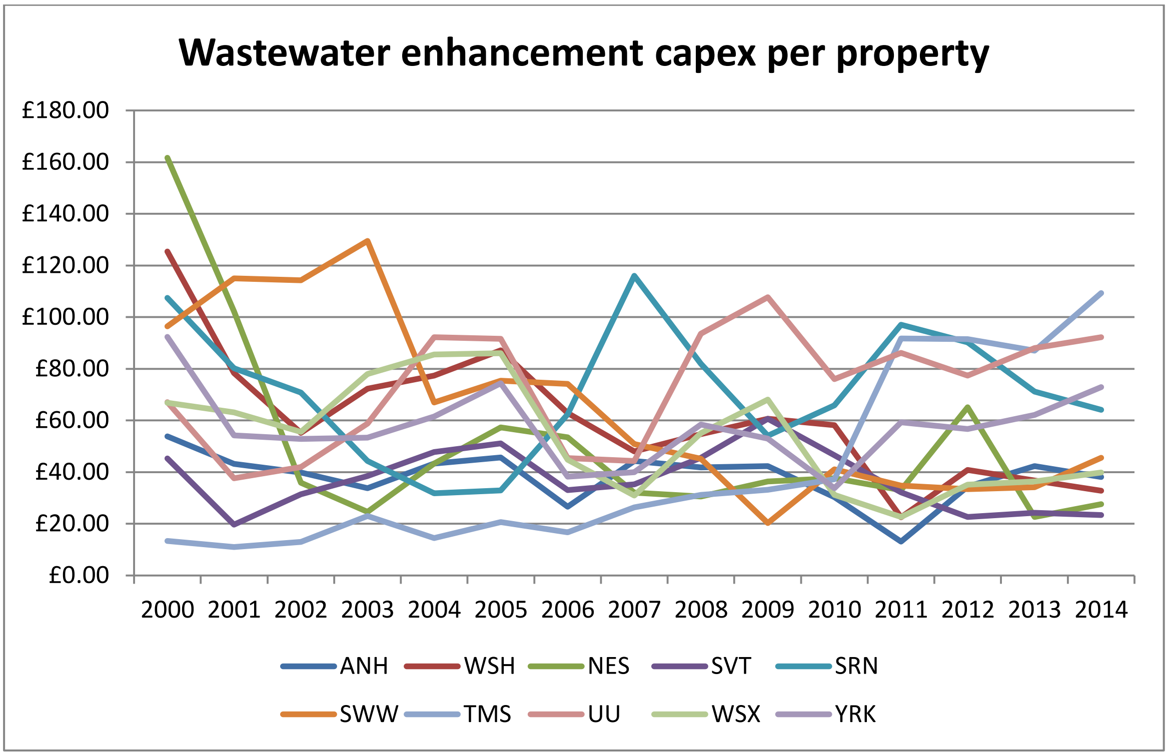
Graph A3.9



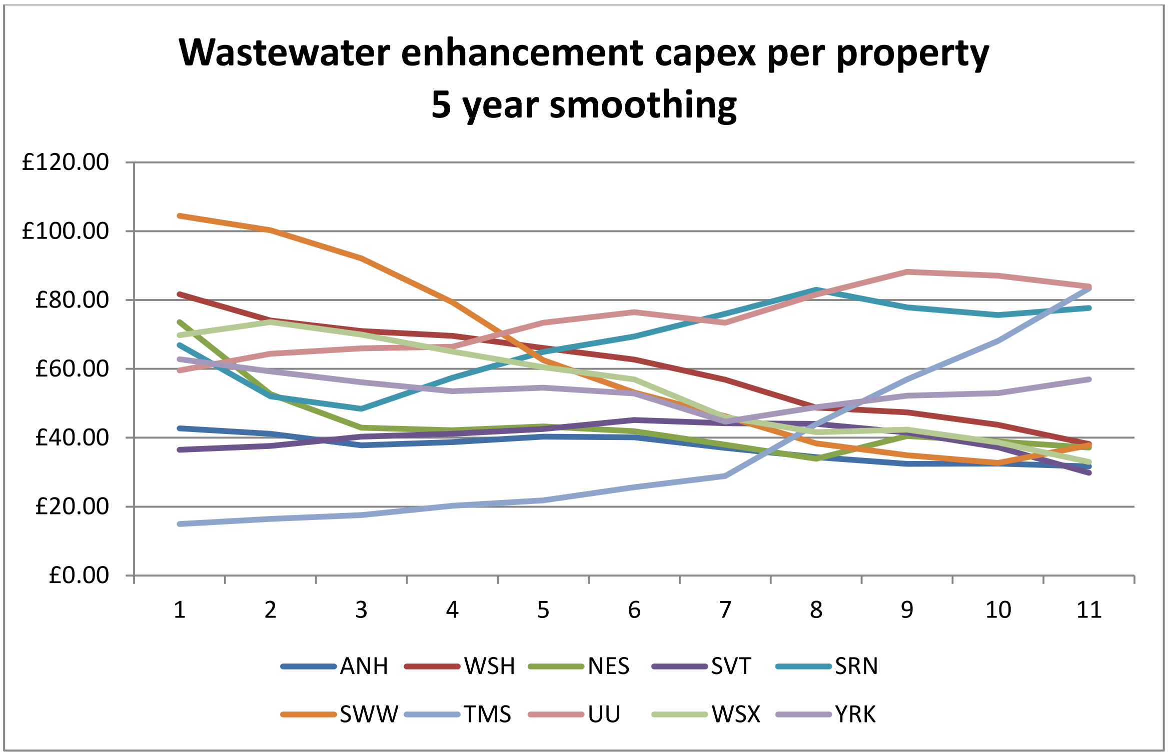
Graph A3.10



Graph A3.11



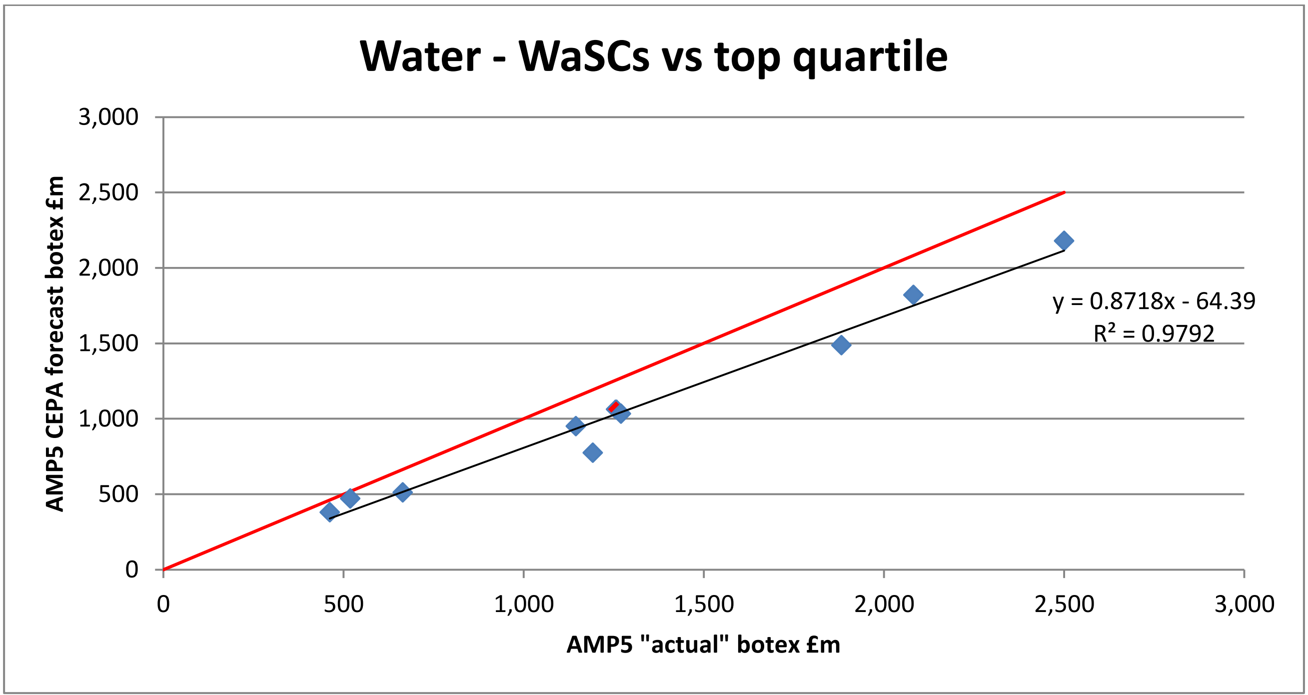
Graph A3.12



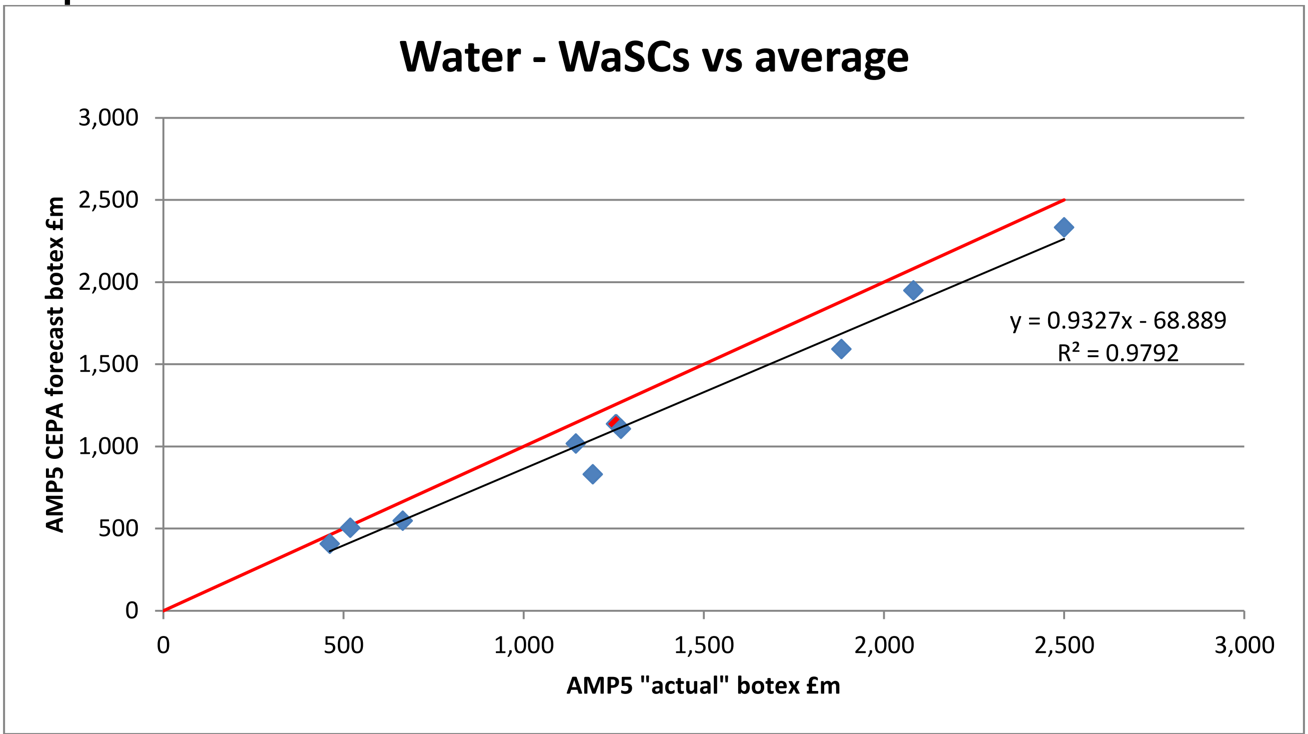
Appendix 4: CEPA AMP5 forecasts vs AMP5 outcomes for botex

In the following graphs, the actual botex figures were taken from the 2013 and 2014 August Submissions.[9] These data were all supplied to Ofwat by all WaSCs and WoCs in 2012-13 prices. Similarly, the forecast botex figures are all in real (2012-13) terms.

Graph A4.1

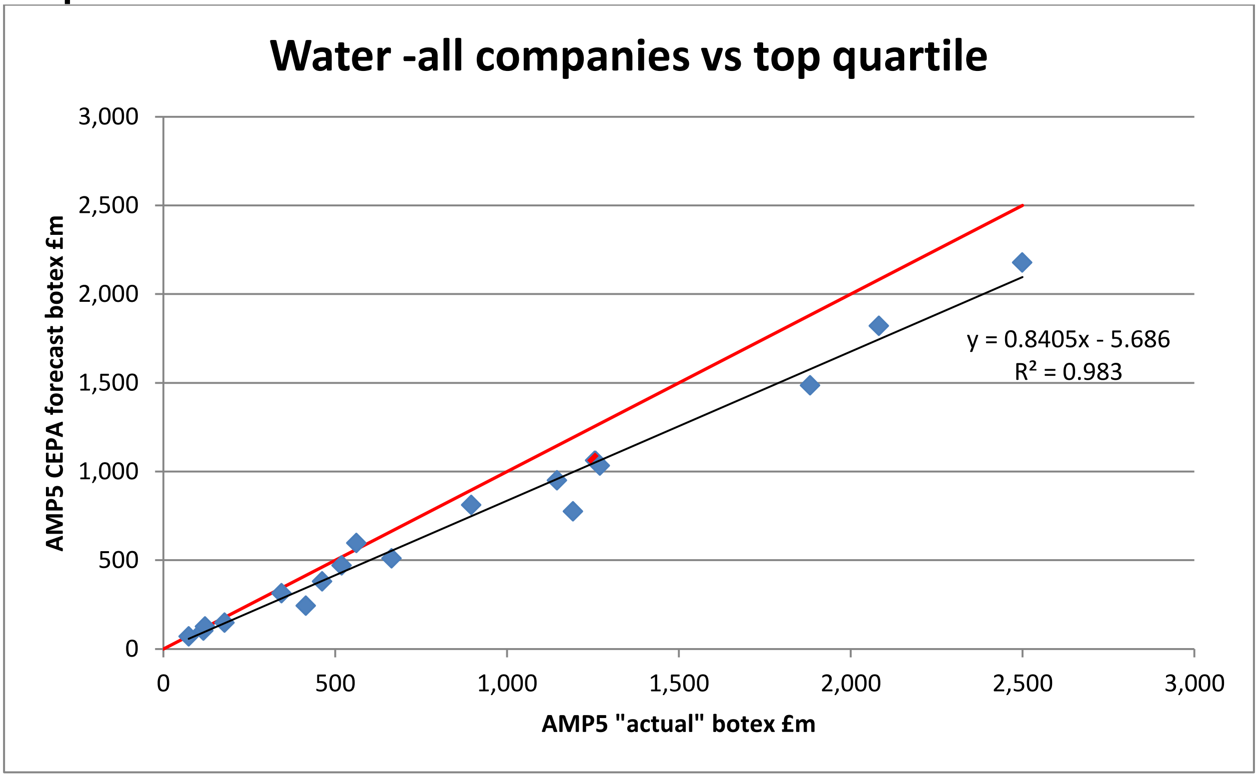


Graph A4.2

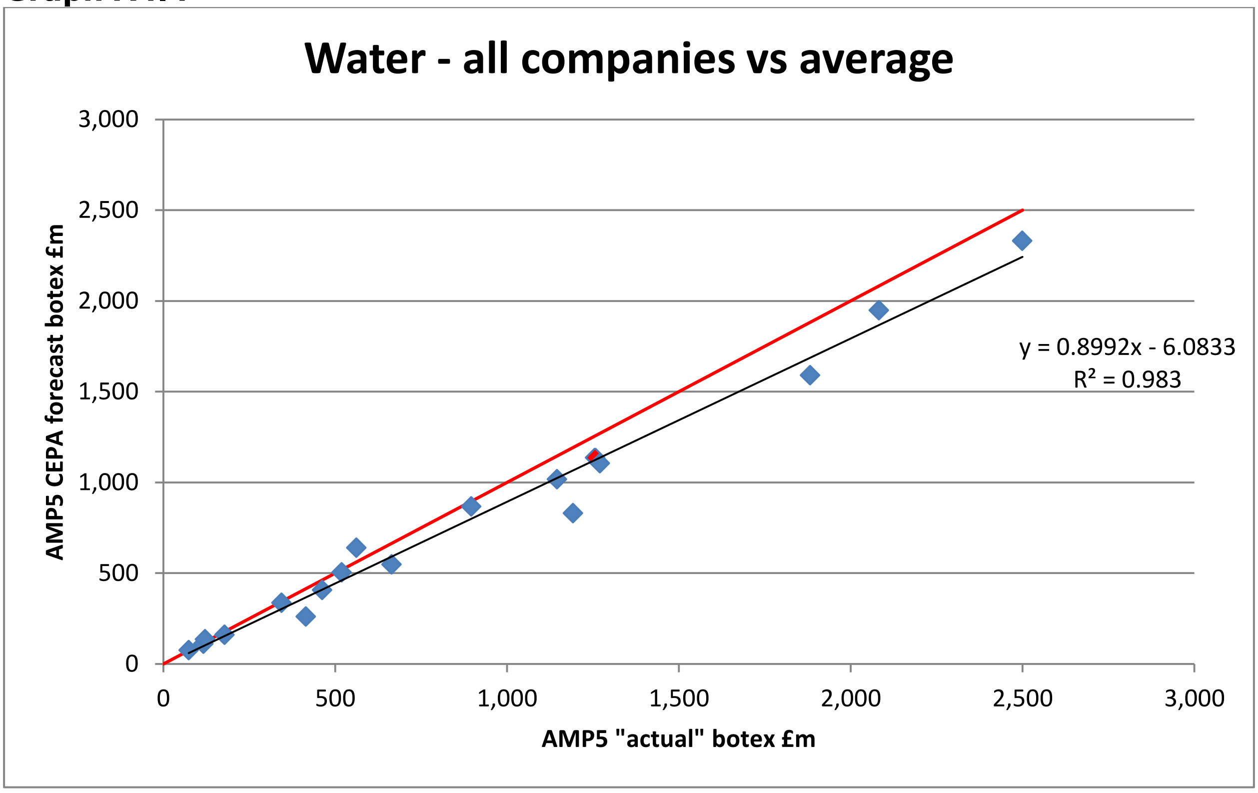


[9] The 2013-14 actuals were used in place of the August submission forecasts

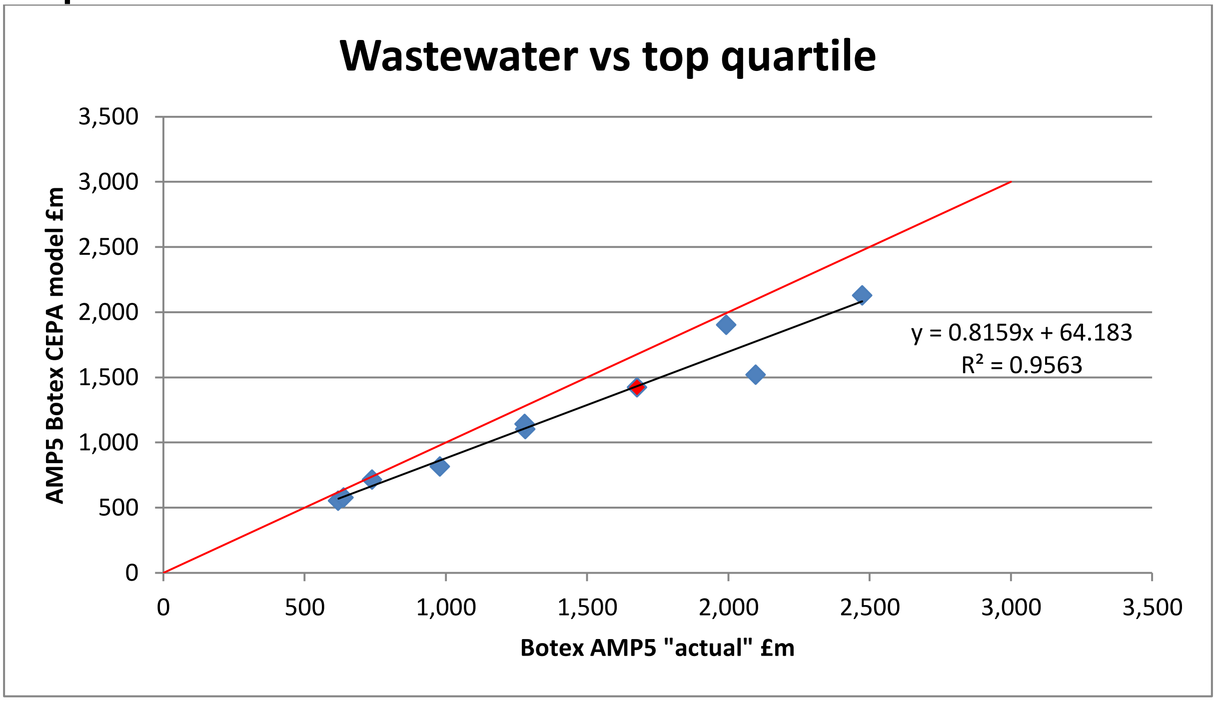
Graph A4.3



Graph A4.4



Graph A4.5



Graph A4.6

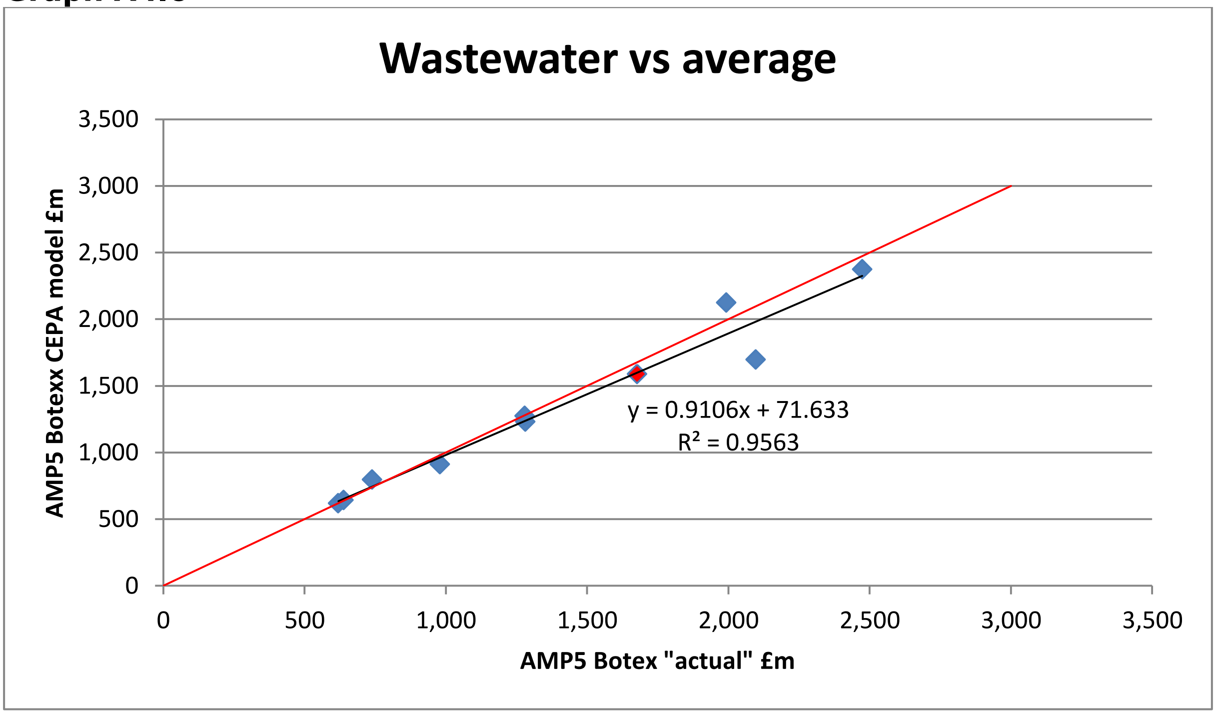


Table A4.1

AMP5	Actual	Forecast: top quartile	A/F
ANH	1,256.26	1,062.73	118%
WSH	1,192.56	775.20	154%
NES	1,145.42	950.11	121%
SVT	2,082.41	1,820.44	114%
SRN	664.75	511.10	130%
SWT	519.40	470.29	110%
TMS	2,500.16	2,178.87	115%
NWT	1,882.59	1,486.61	127%
WSX	461.91	379.77	122%
YRK	1,270.46	1,033.12	123%
AFF	896.45	810.56	111%
BRL	414.96	242.73	171%
BWH	117.09	103.16	114%
DEV	74.04	69.74	106%
PRT	121.35	125.66	97%
SES	178.18	148.67	120%
SEW	562.09	596.85	94%
SSC	344.34	314.46	110%
Total	15,684.42	13,080.06	120%
Standard Deviation			18%

Table A4.2

AMP5	Actual	Forecast: average	A/F
ANH	1,256.26	1,136.97	110%
WSH	1,192.56	829.36	144%
NES	1,145.42	1,016.48	113%
SVT	2,082.41	1,947.62	107%
SRN	664.75	546.80	122%
SWT	519.40	503.15	103%
TMS	2,500.16	2,331.09	107%
NWT	1,882.59	1,590.47	118%
WSX	461.91	406.30	114%
YRK	1,270.46	1,105.29	115%
AFF	896.45	867.19	103%
BRL	414.96	259.69	160%
BWH	117.09	110.36	106%
DEV	74.04	74.61	99%
PRT	121.35	134.44	90%
SES	178.18	159.05	112%
SEW	562.09	638.55	88%
SSC	344.34	336.43	102%
Total	15,684.42	13,993.85	112%
Standard Deviation			17%

Table A4.3

AMP5 Wastewater	Actual	Model: top quartile	F/A
ANH	1,676.37	1,424.11	85%
WSH	978.89	816.06	83%
NES	739.47	714.17	97%
SVT	1,992.72	1,903.47	96%
SRN	1,280.94	1,102.59	86%
SWT	619.38	553.95	89%
TMS	2,473.60	2,128.12	86%
NWT	2,096.67	1,520.15	73%
WSX	638.32	576.71	90%
YRK	1,279.10	1,141.98	89%
Total	13,775.46	11,881.29	86%
Standard Deviation			7%

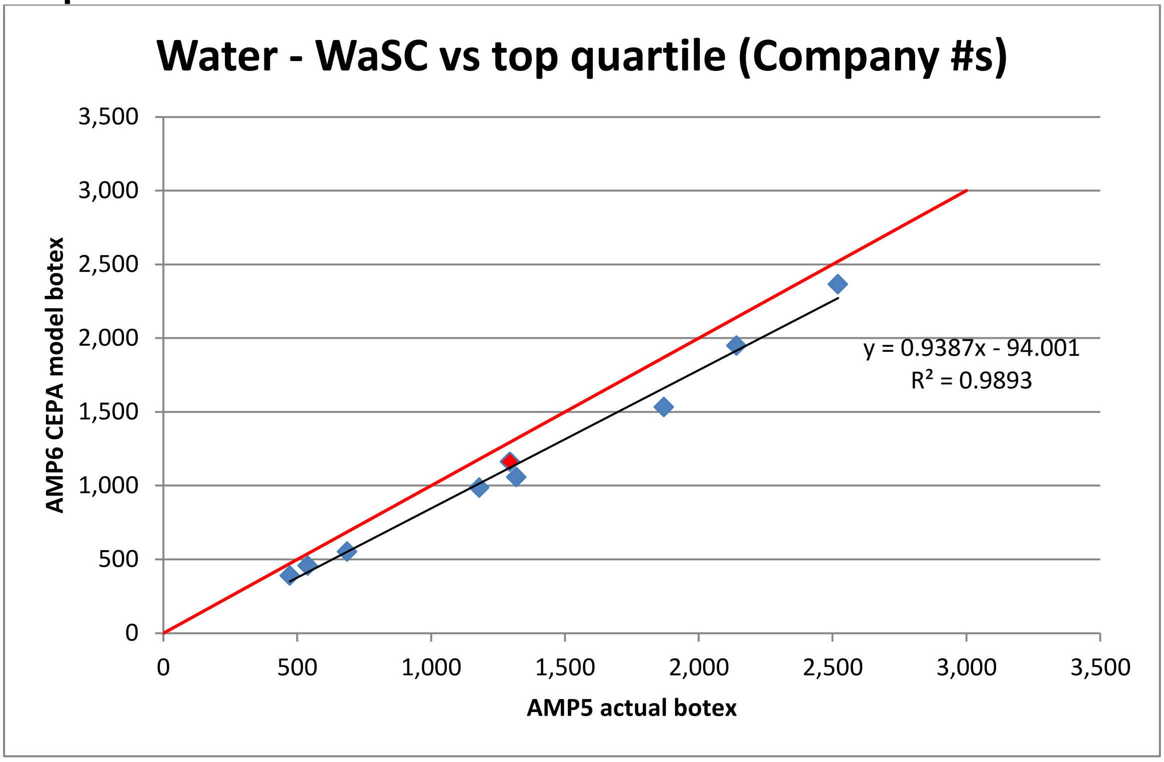
Table A4.4

AMP5 wastewater	Actual	Model: average	F/A
ANH	1,676.37	1,589.40	95%
WSH	978.89	910.78	93%
NES	739.47	797.06	108%
SVT	1,992.72	2,124.41	107%
SRN	1,280.94	1,230.56	96%
SWT	619.38	618.24	100%
TMS	2,473.60	2,375.13	96%
NWT	2,096.67	1,696.60	81%
WSX	638.32	643.65	101%
YRK	1,279.10	1,274.53	100%
Total	13,775.46	13,260.37	96%
Standard Deviation			8%

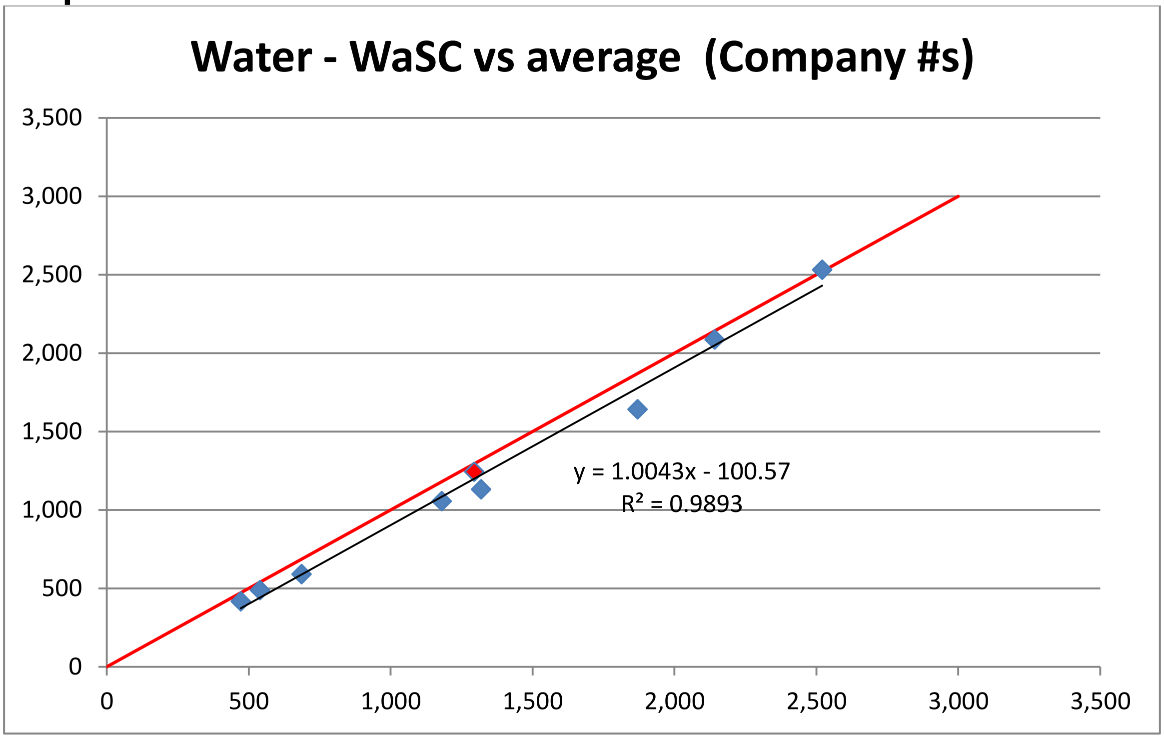
Appendix 5: CEPA AMP6 forecasts vs AMP5 outcomes for botex

In the following graphs, "actual" botex shows the August Submission data (3 years actual, 2 years forecast)

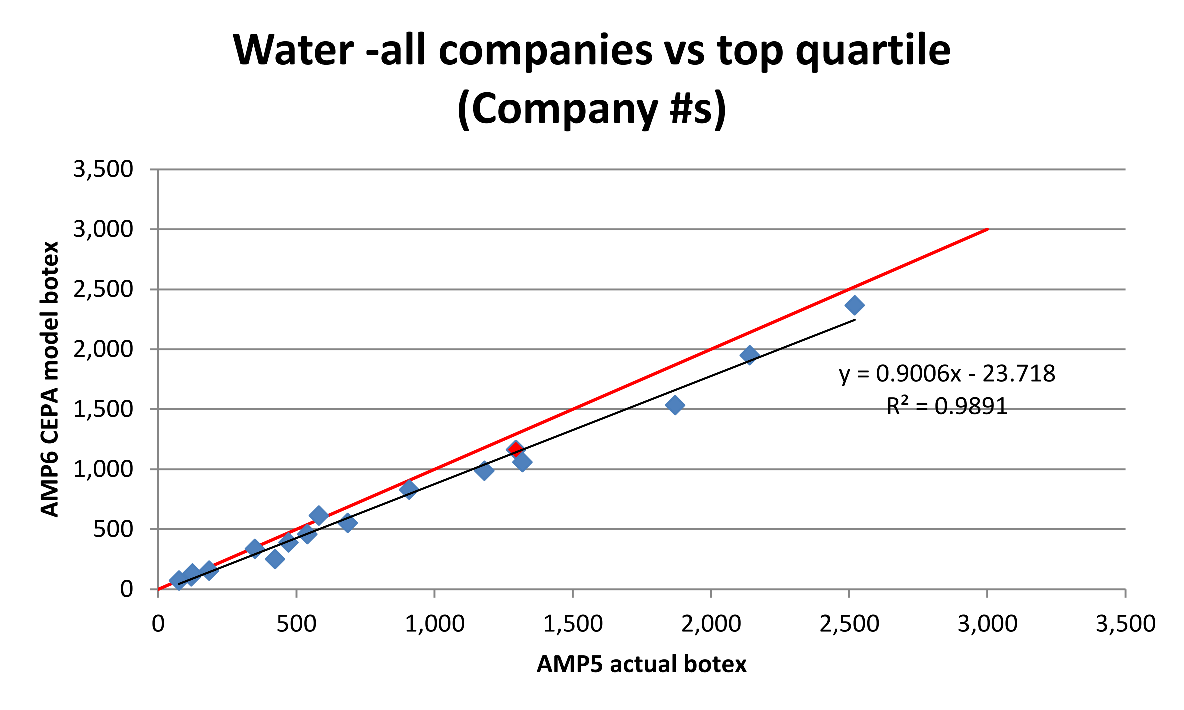
Graph A5.1



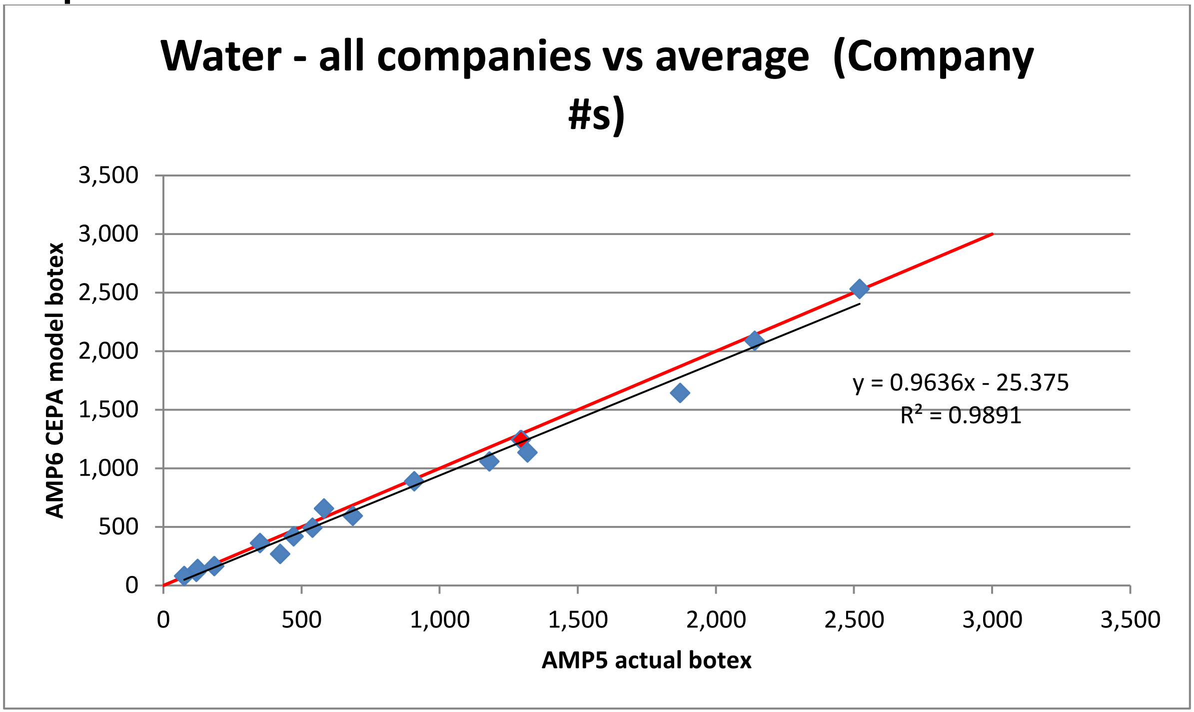
Graph A5.2



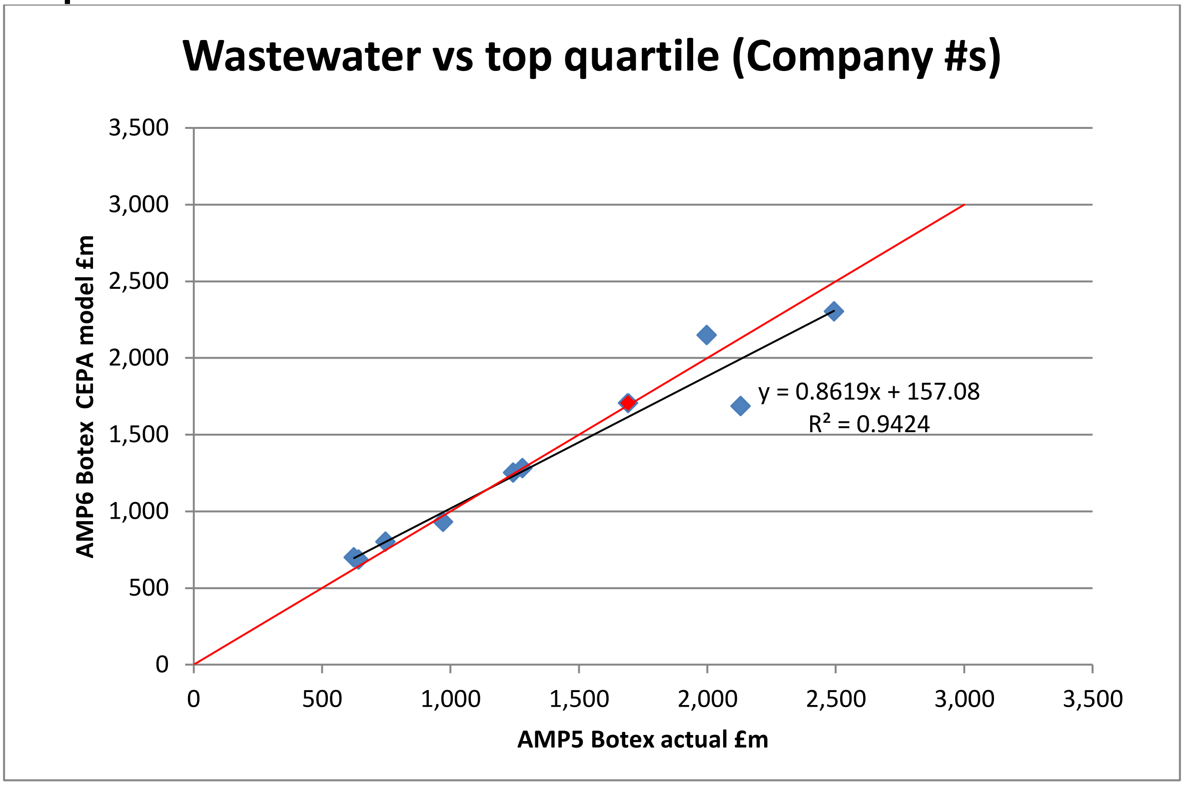
Graph A5.3



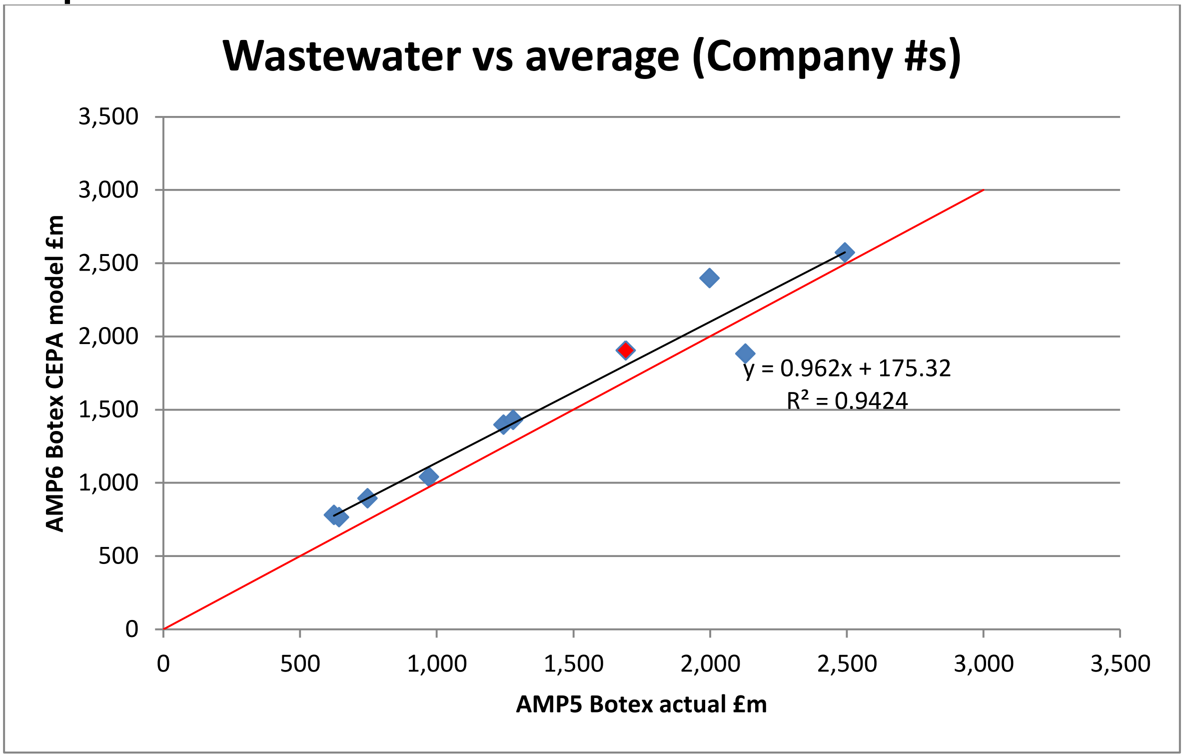
Graph A5.4



Graph A5.5



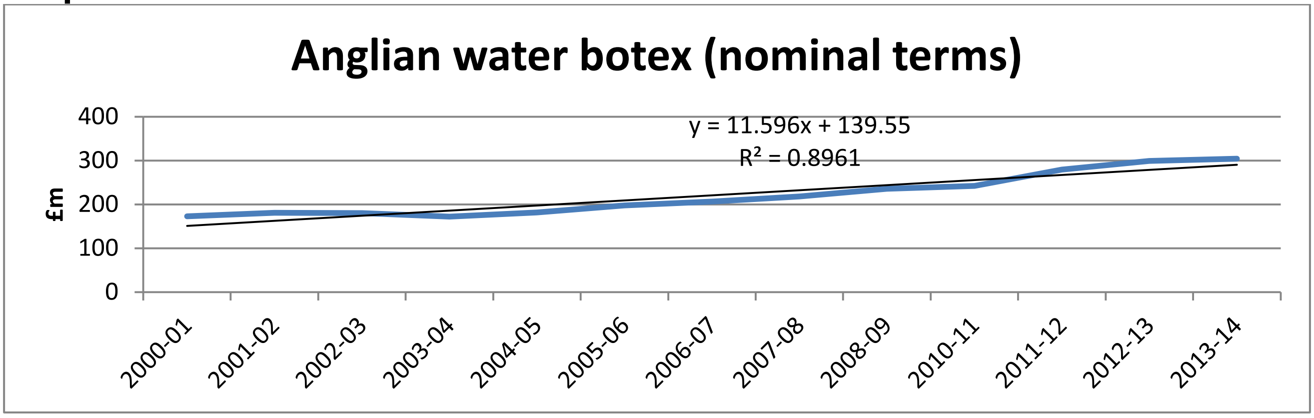
Graph A5.6



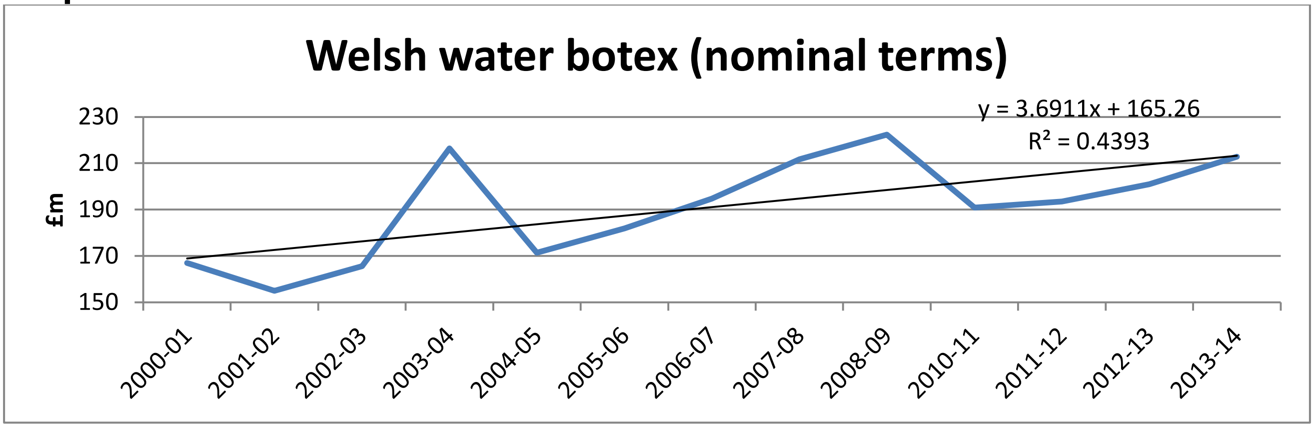
Appendix 6: Botex trends

The following graphs are all based on published cost analysis of Regulatory Account data

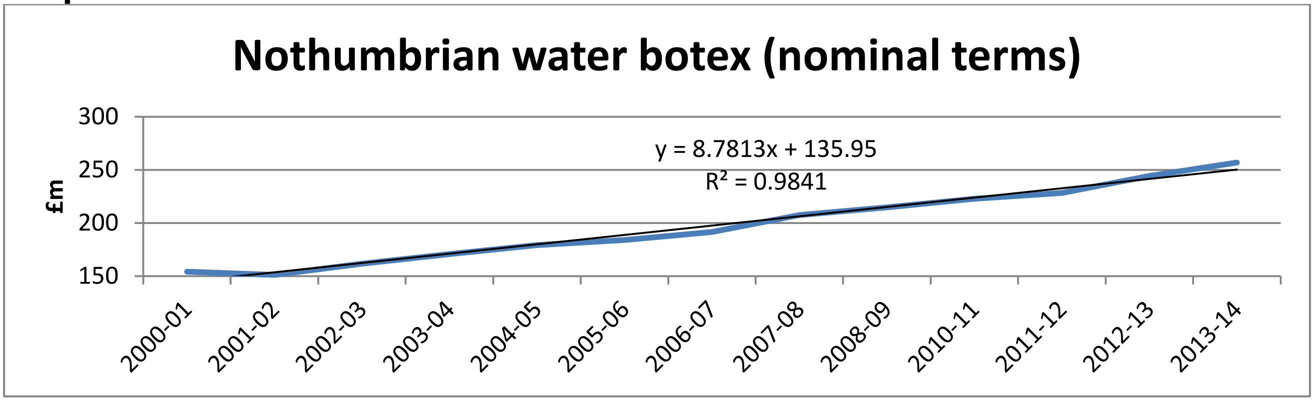
Graph A6.1



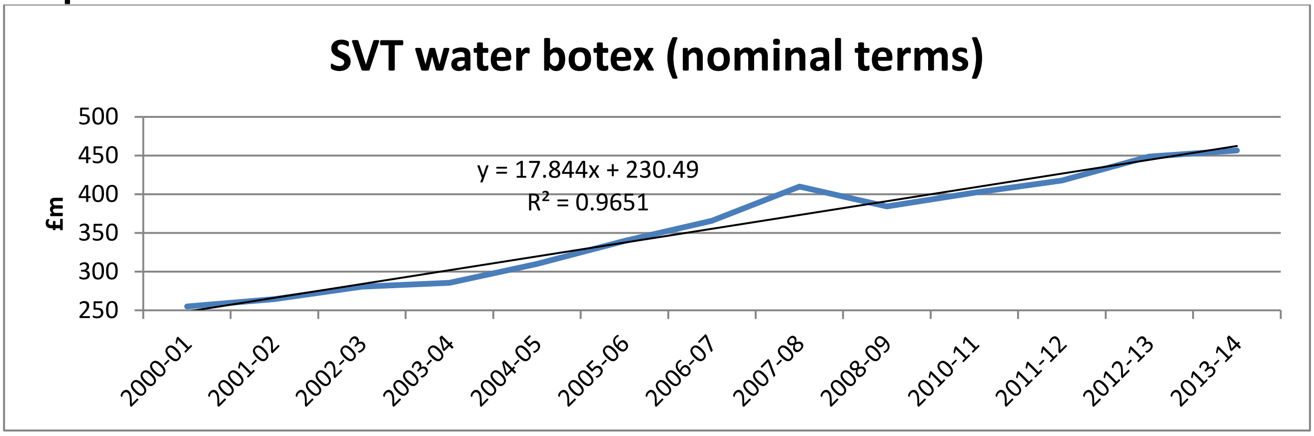
Graph A6.2



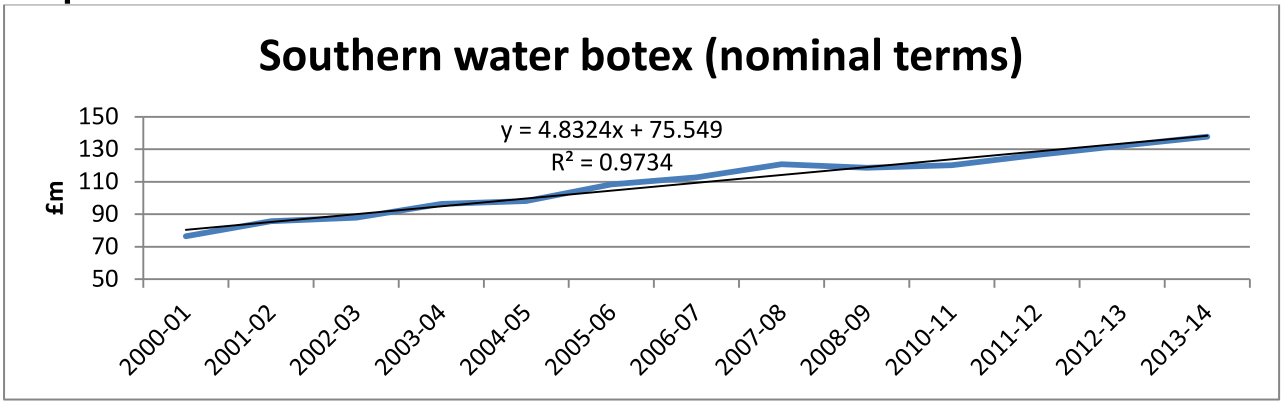
Graph A6.3



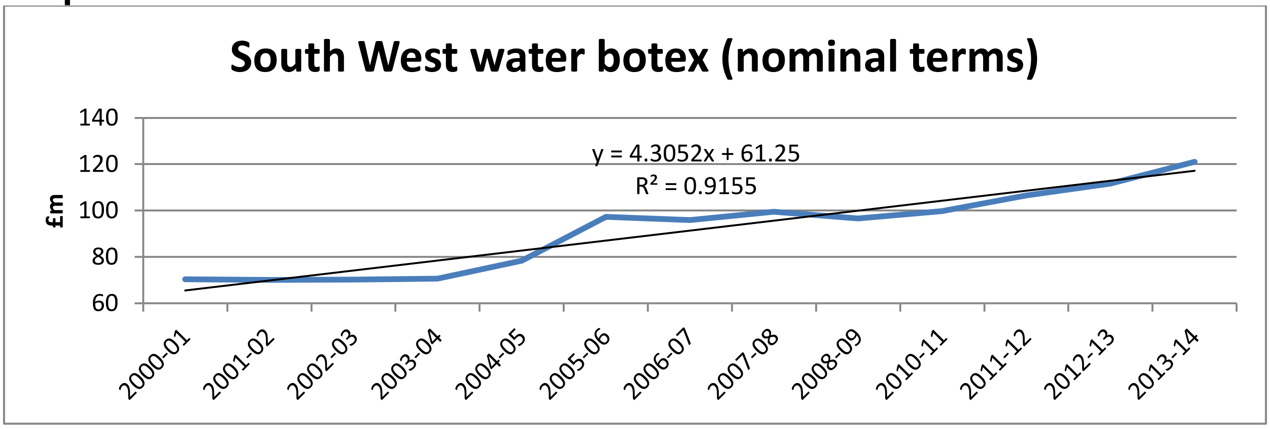
Graph A6.4



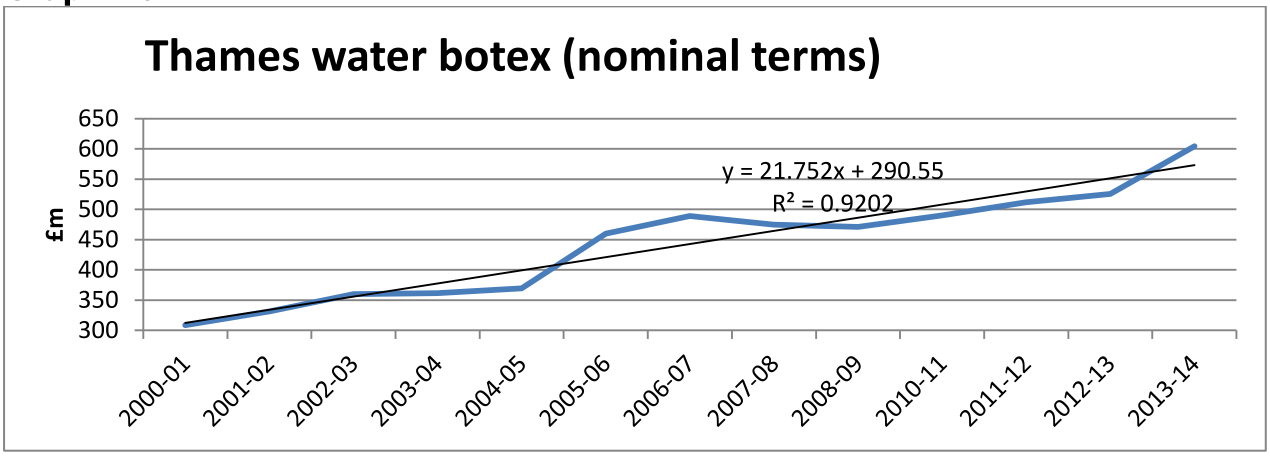
Graph A6.5



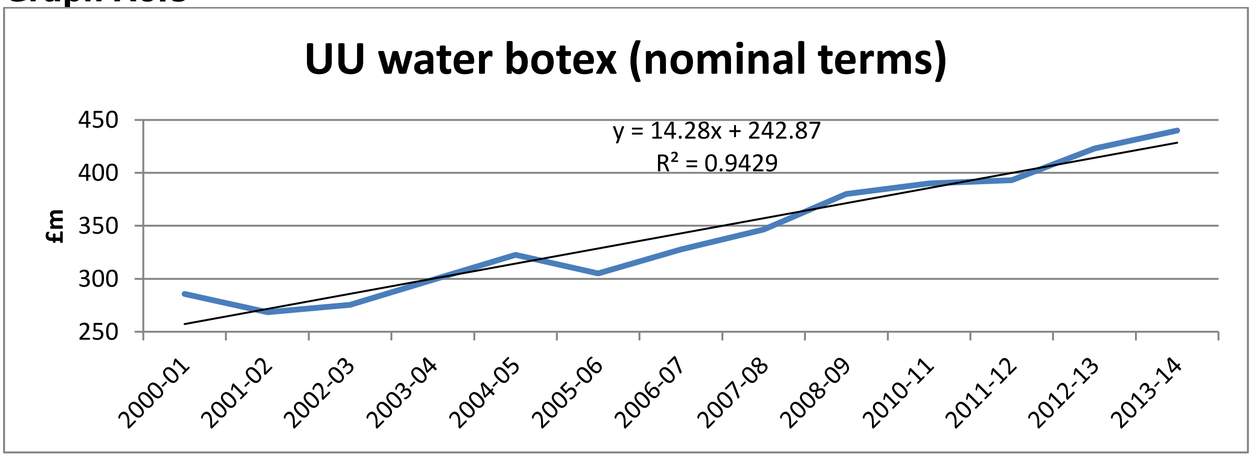
Graph A6.6



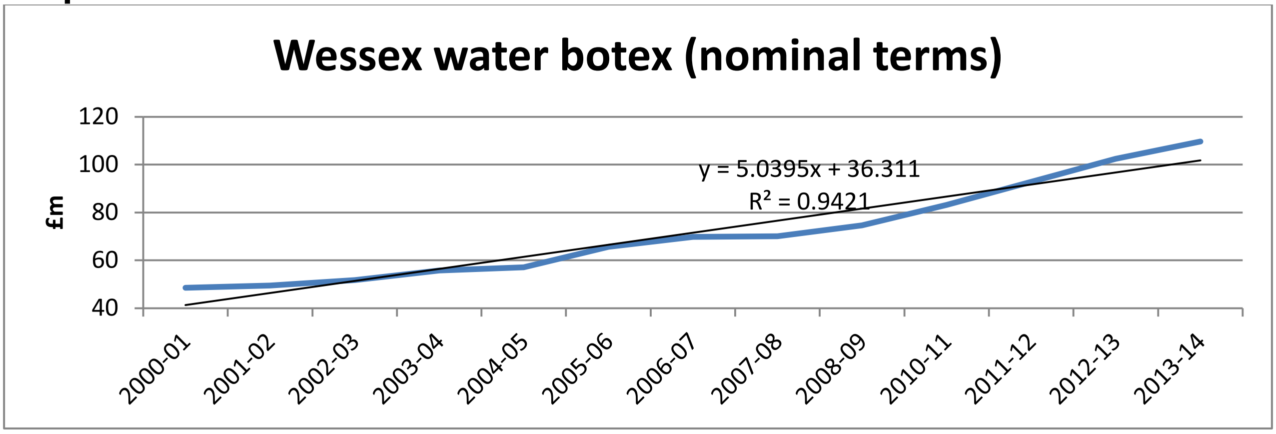
Graph A6.7



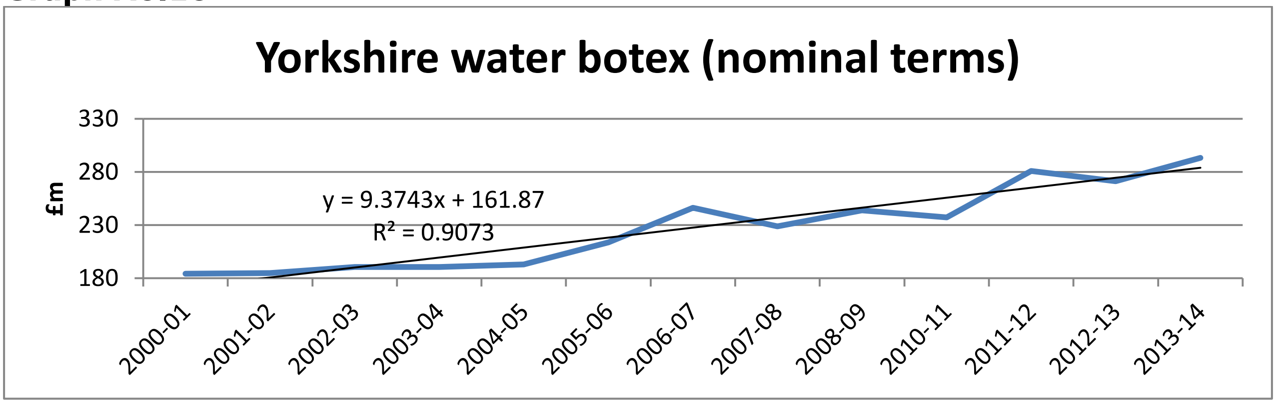
Graph A6.8



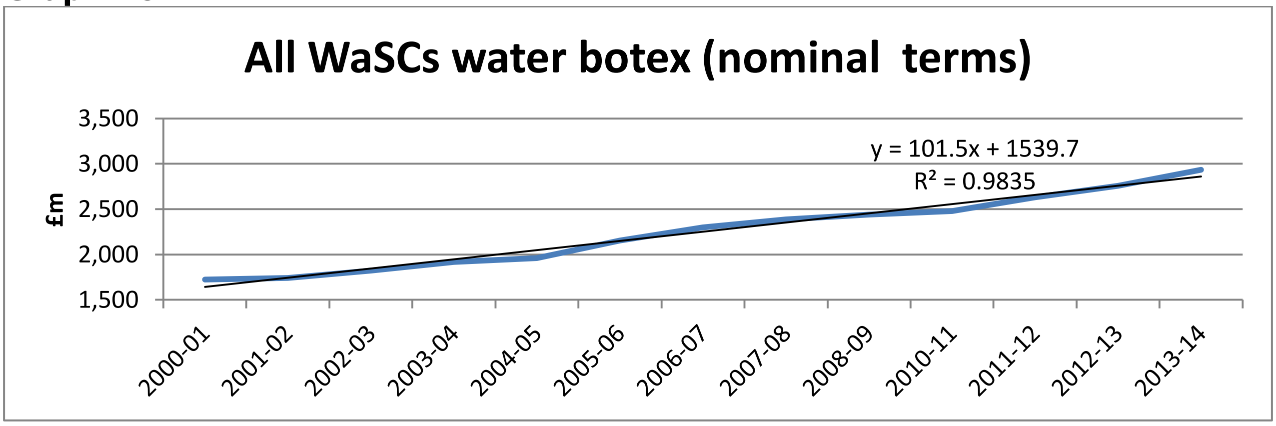
Graph A6.9



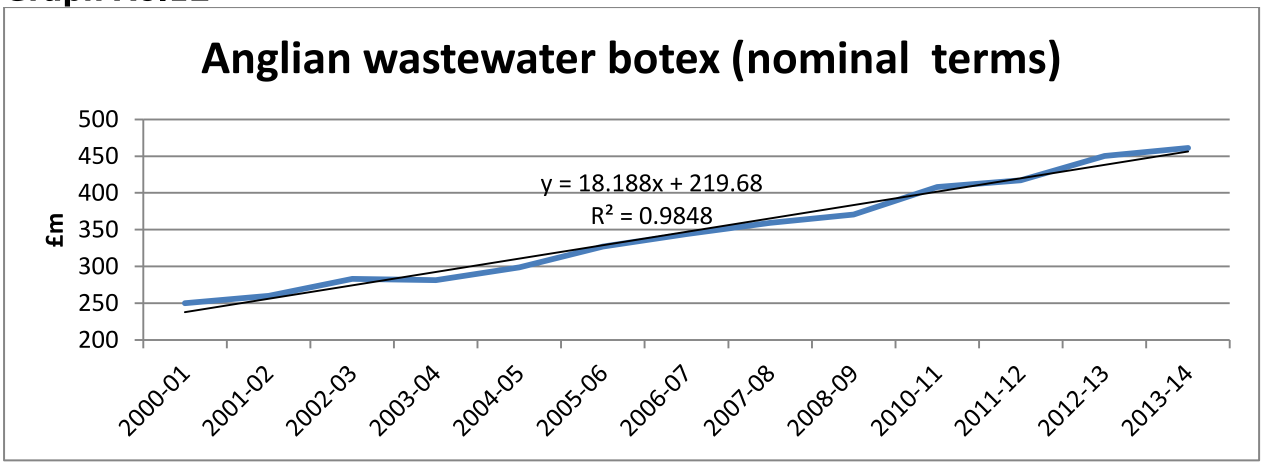
Graph A6.10



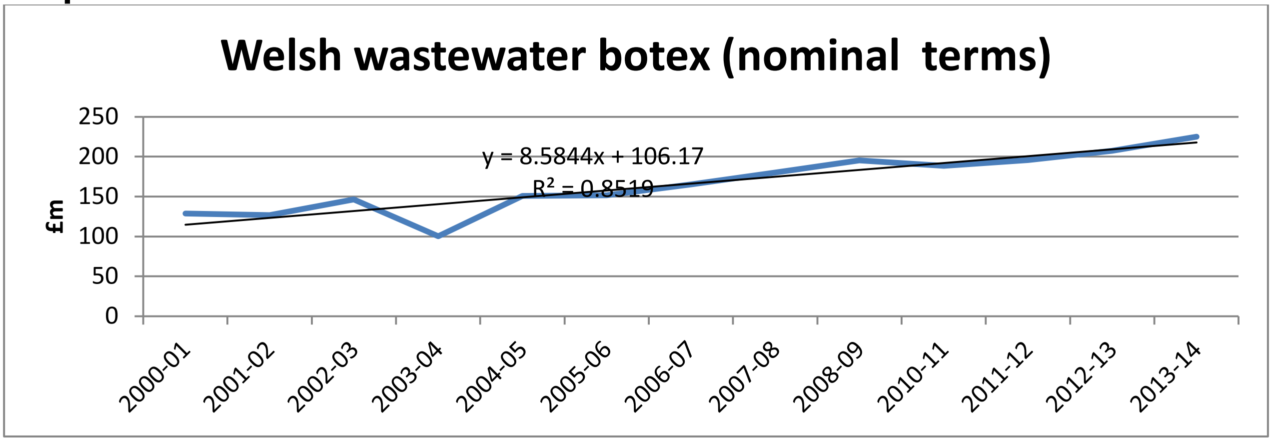
Graph A6.11



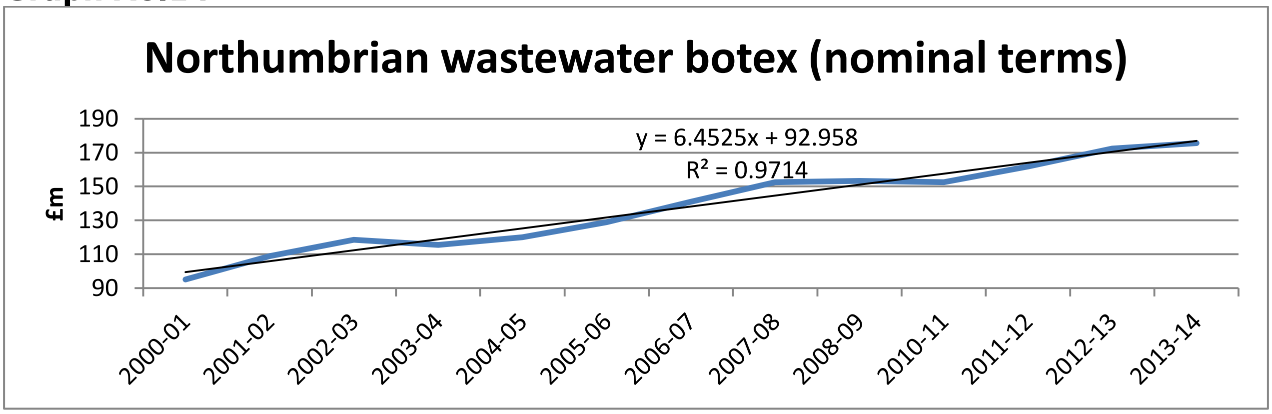
Graph A6.12



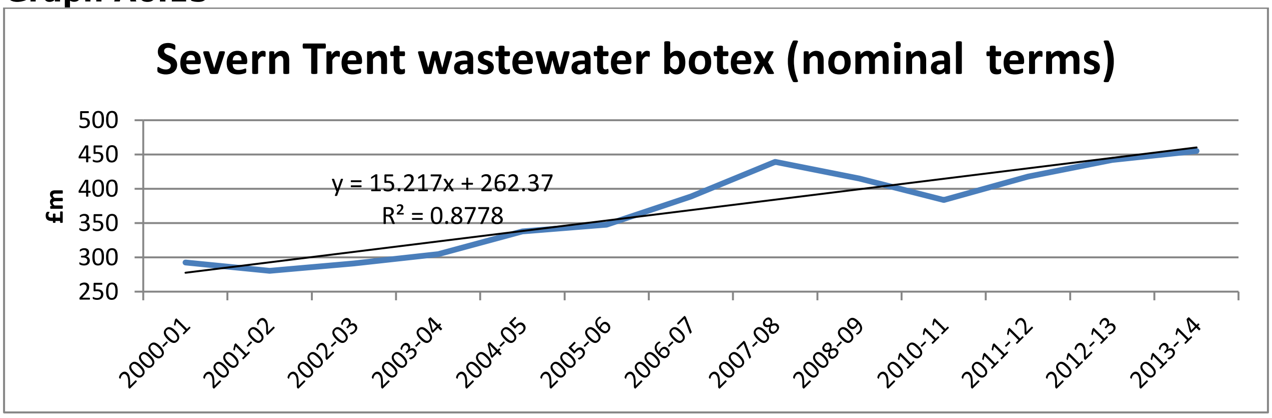
Graph A6.13



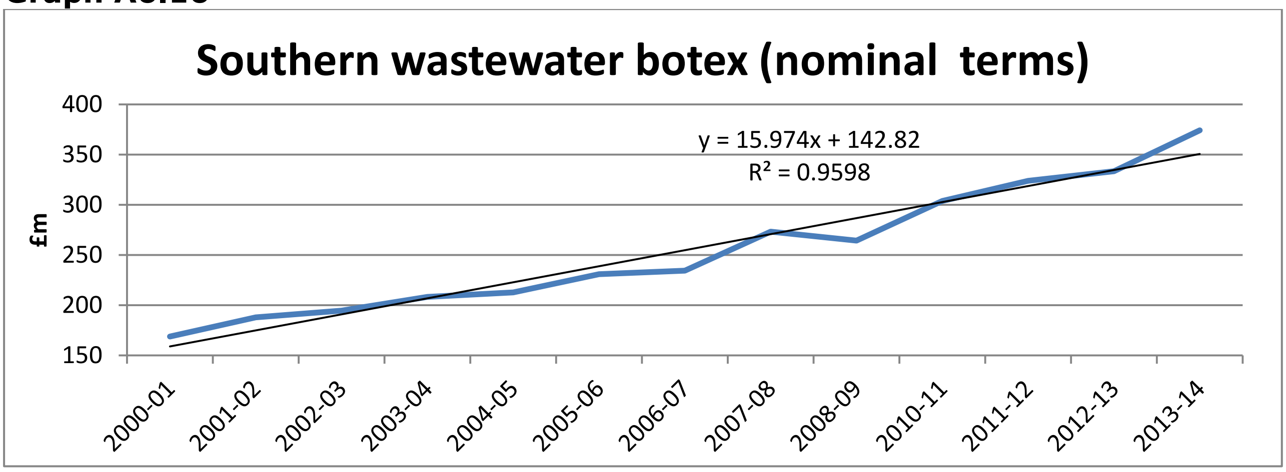
Graph A6.14



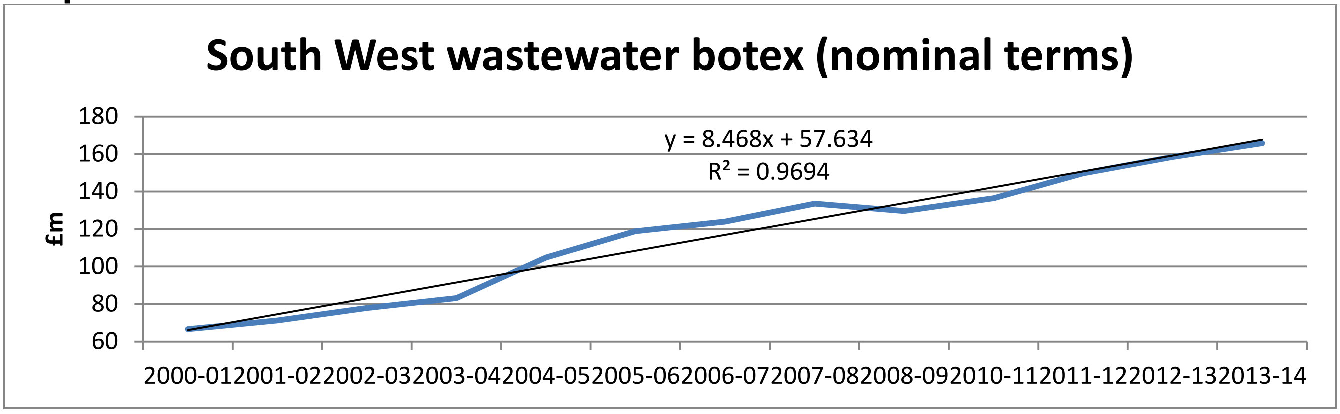
Graph A6.15



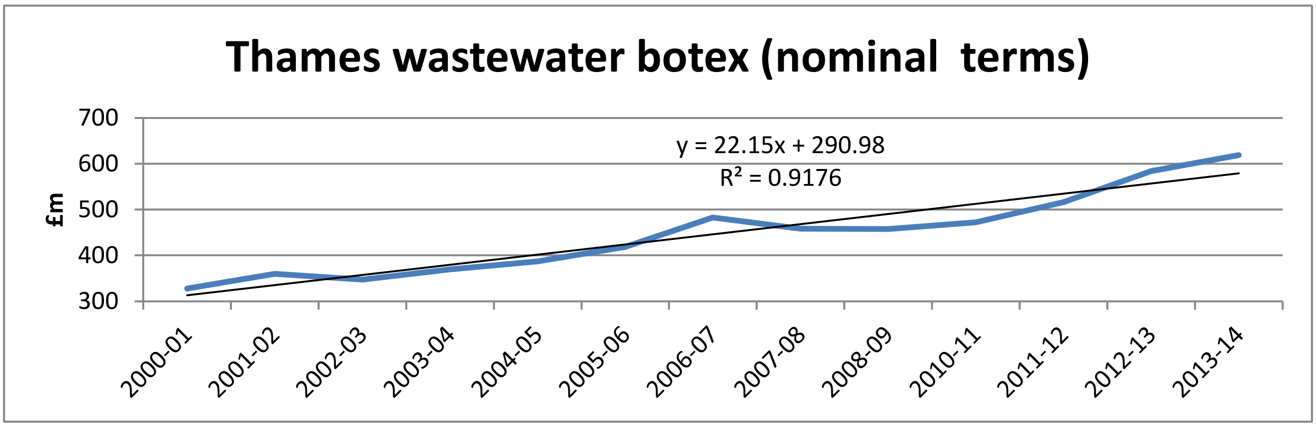
Graph A6.16



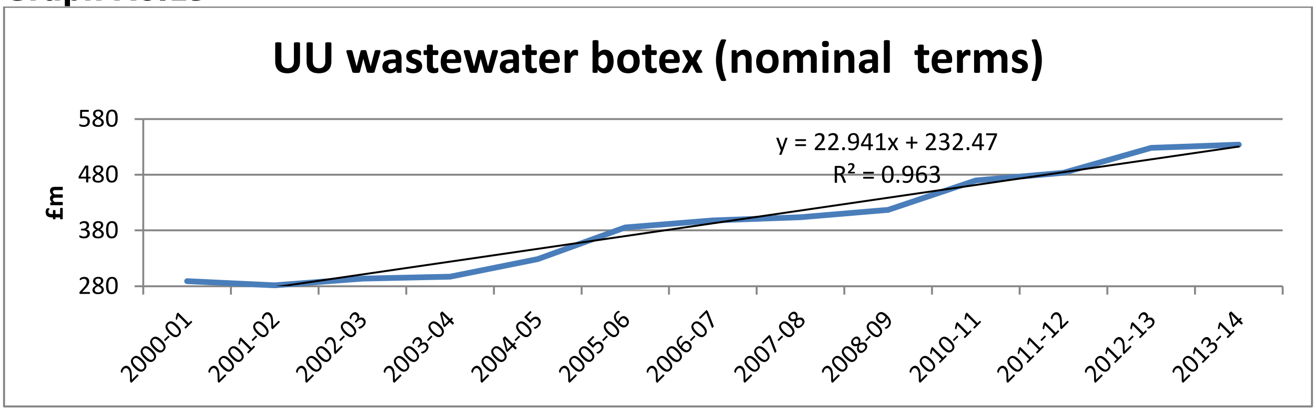
Graph A6.17



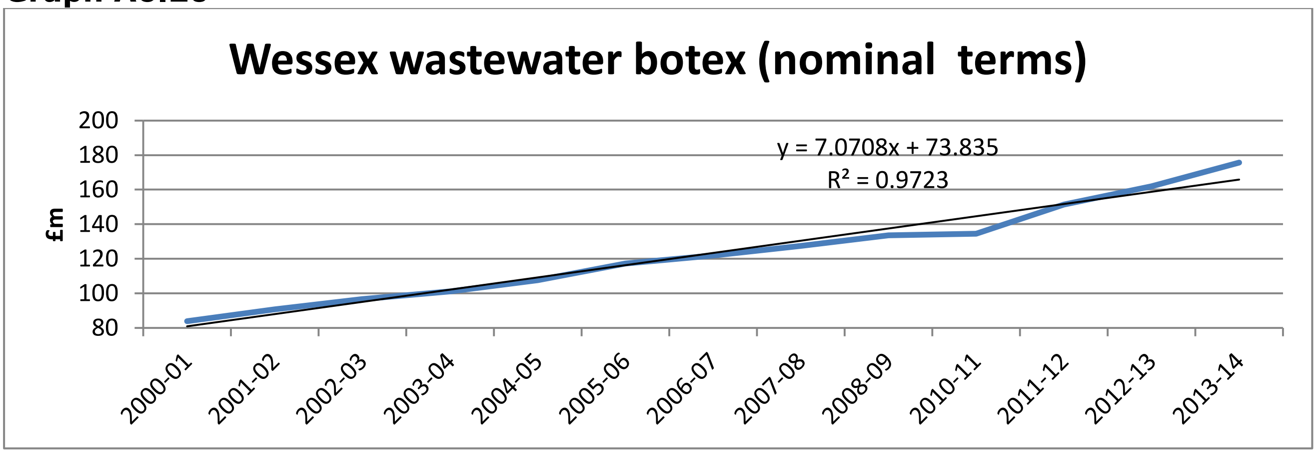
Graph A6.18



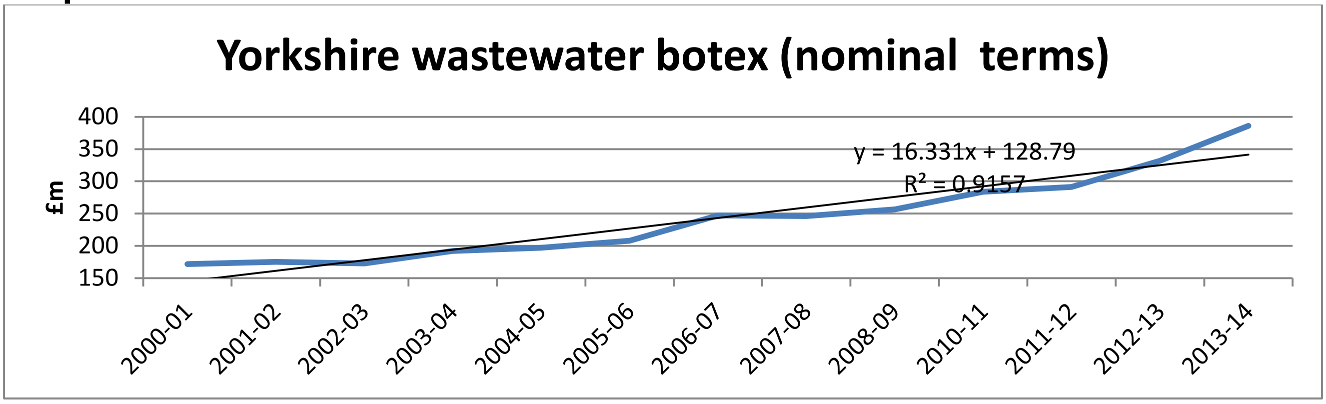
Graph A6.19



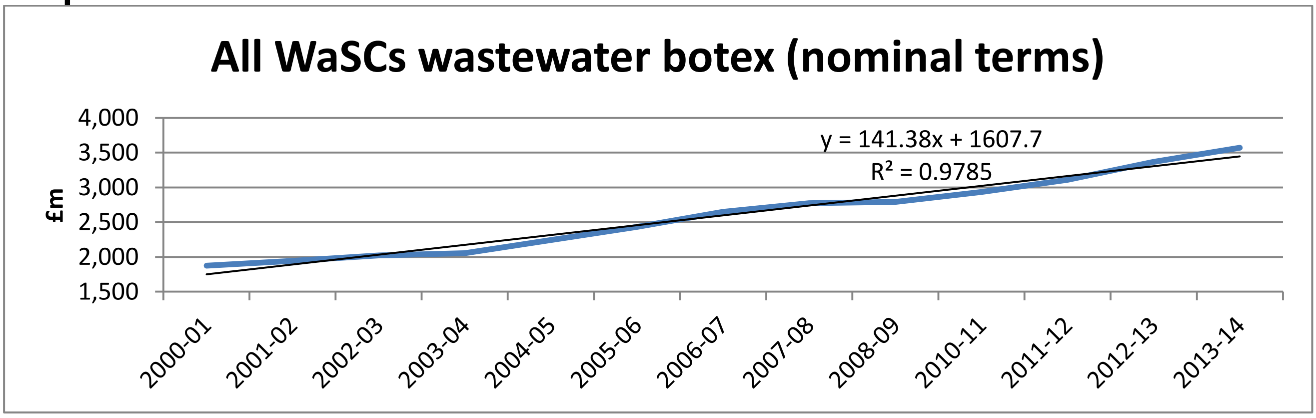
Graph A6.20



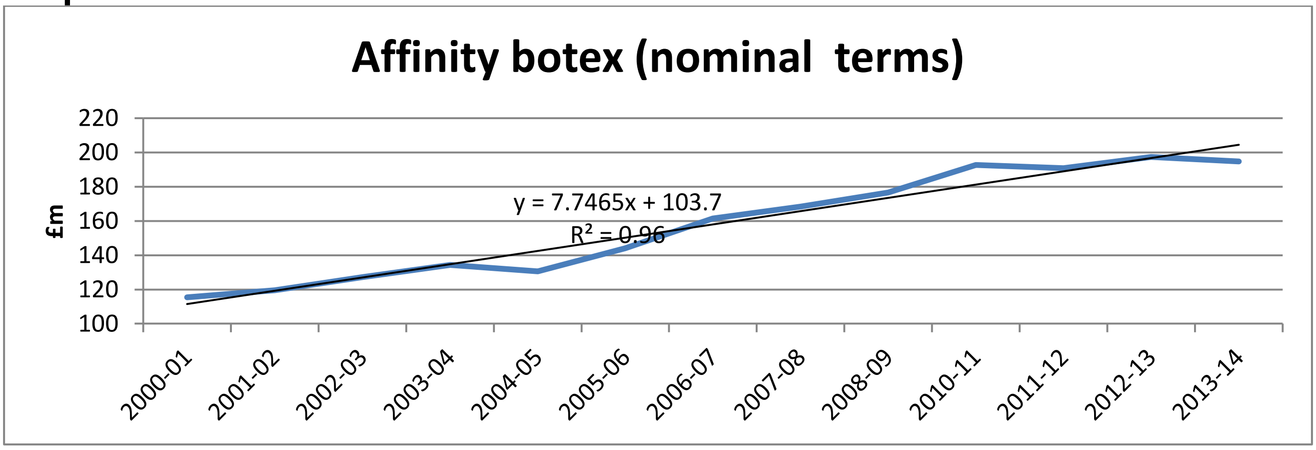
Graph A6.21



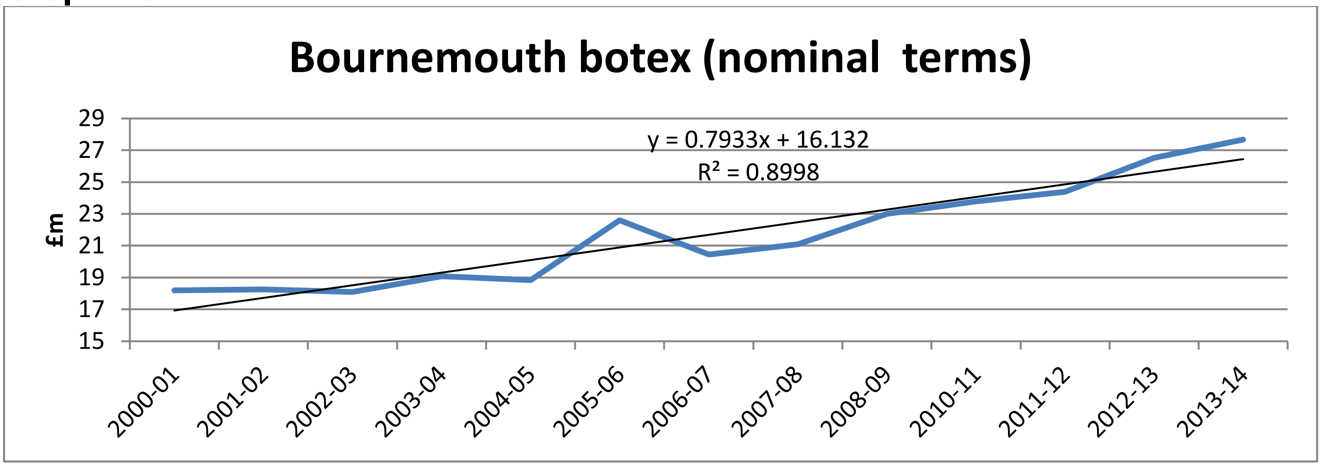
Graph A6.22



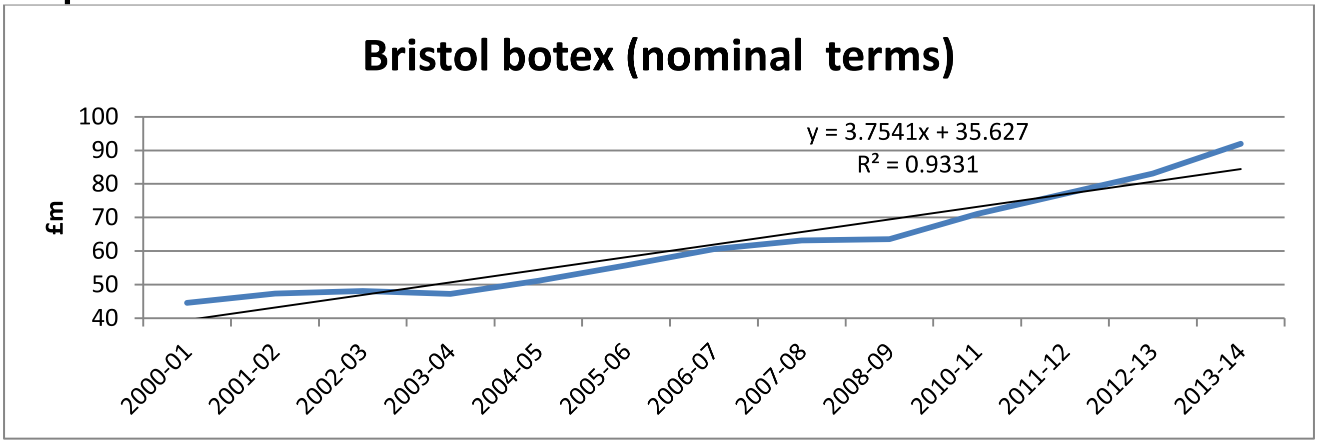
Graph A6.23



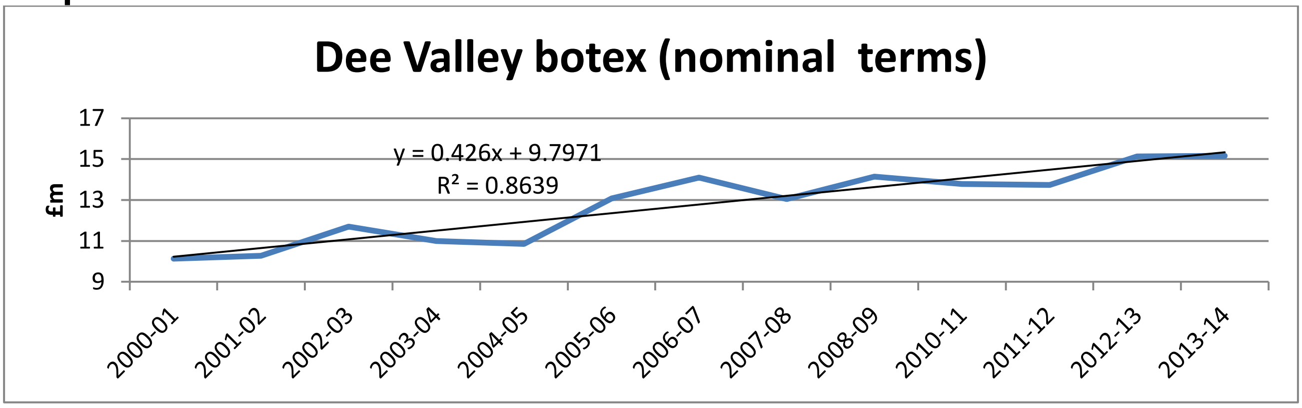
Graph A6.24



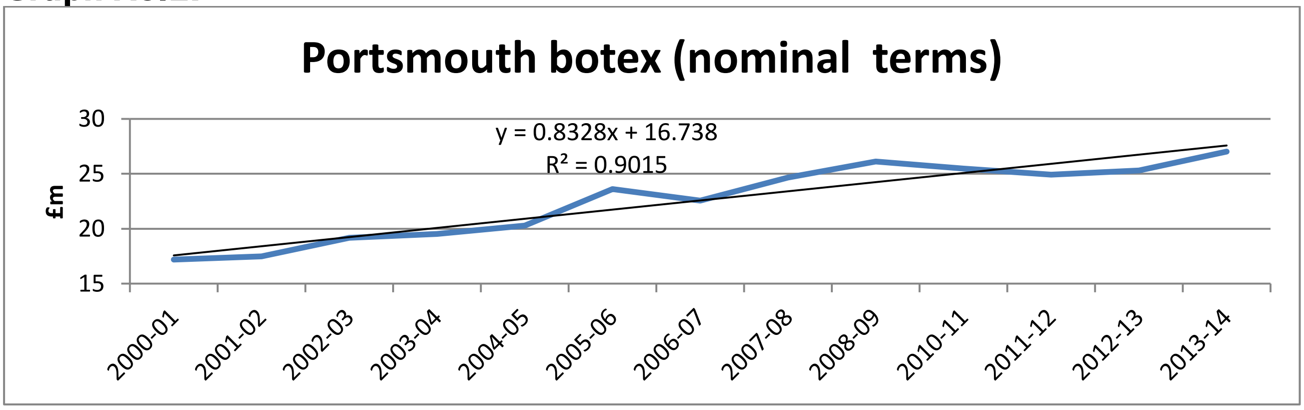
Graph A6.25



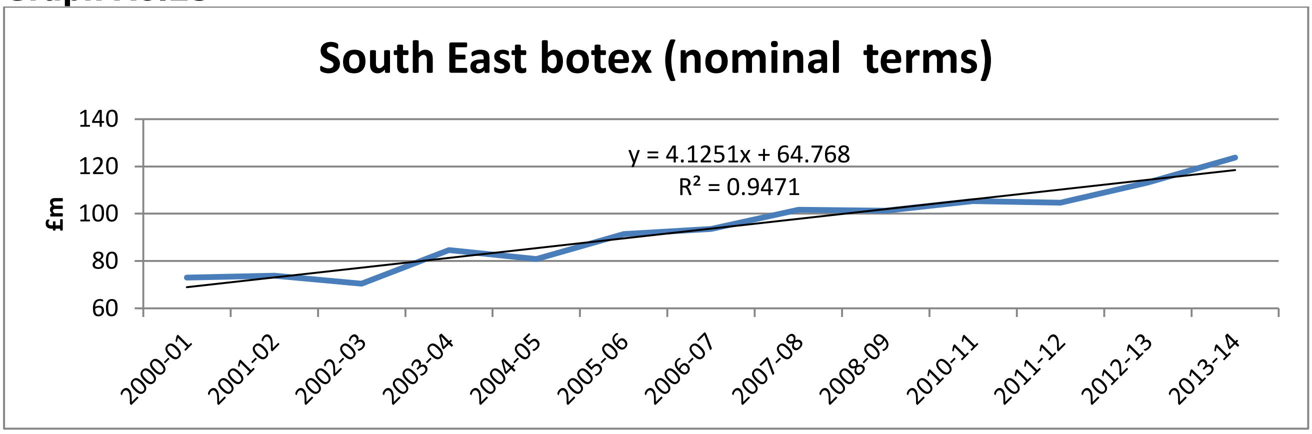
Graph A6.26



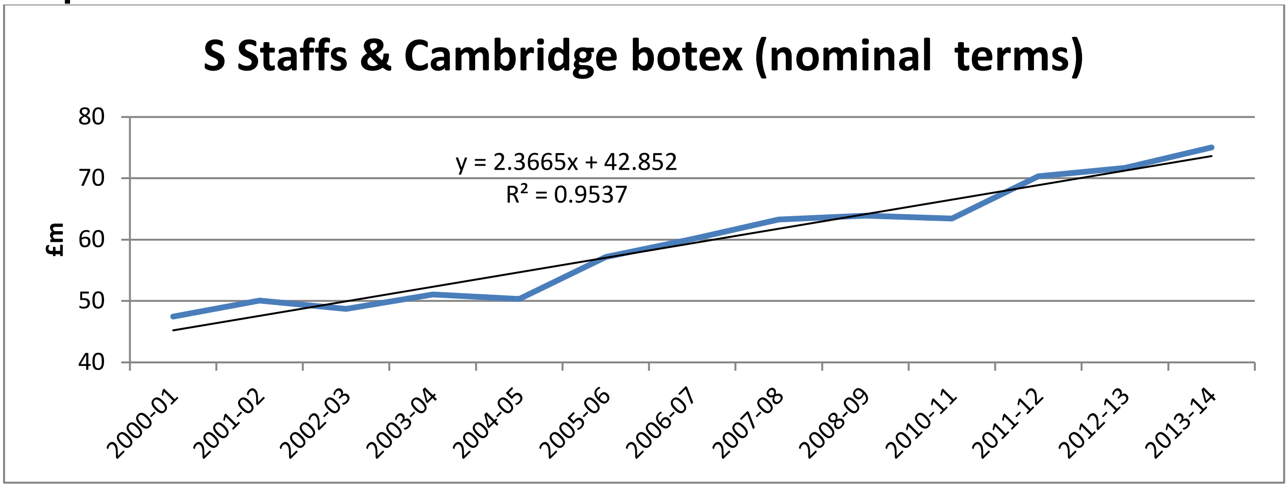
Graph A6.27



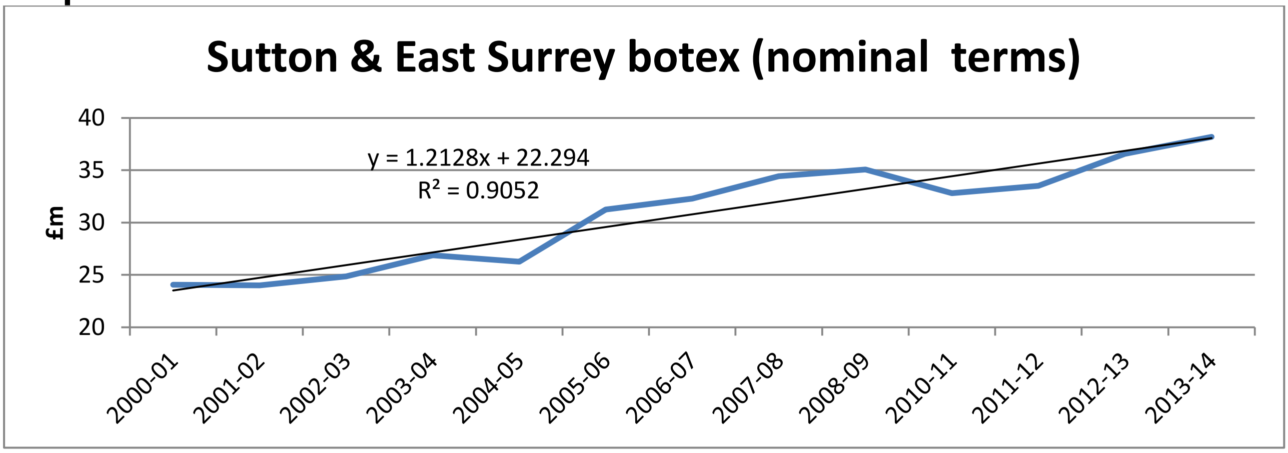
Graph A6.28



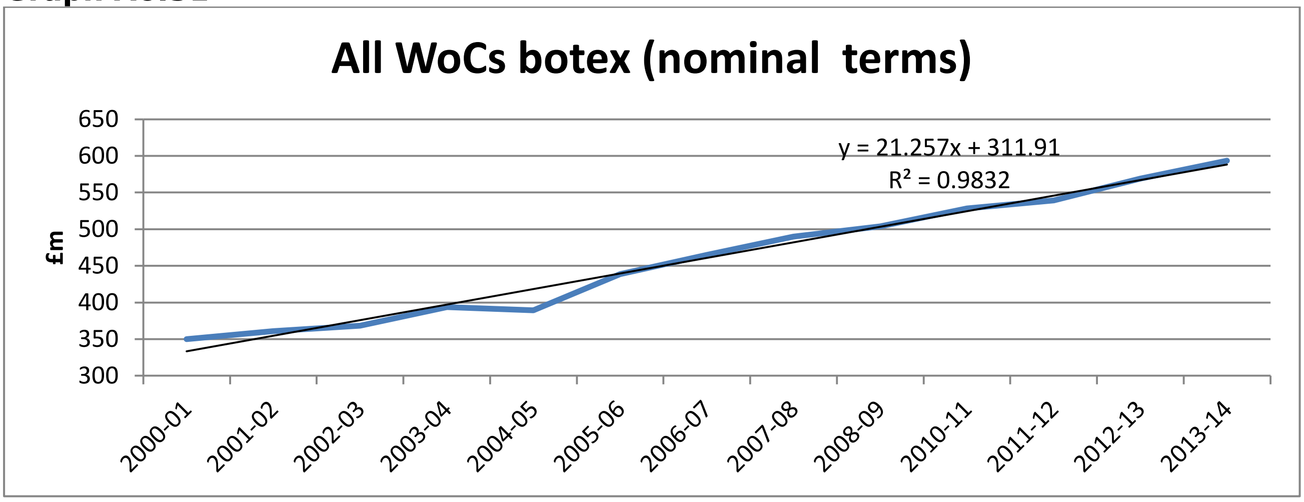
Graph A6.29



Graph A6.30

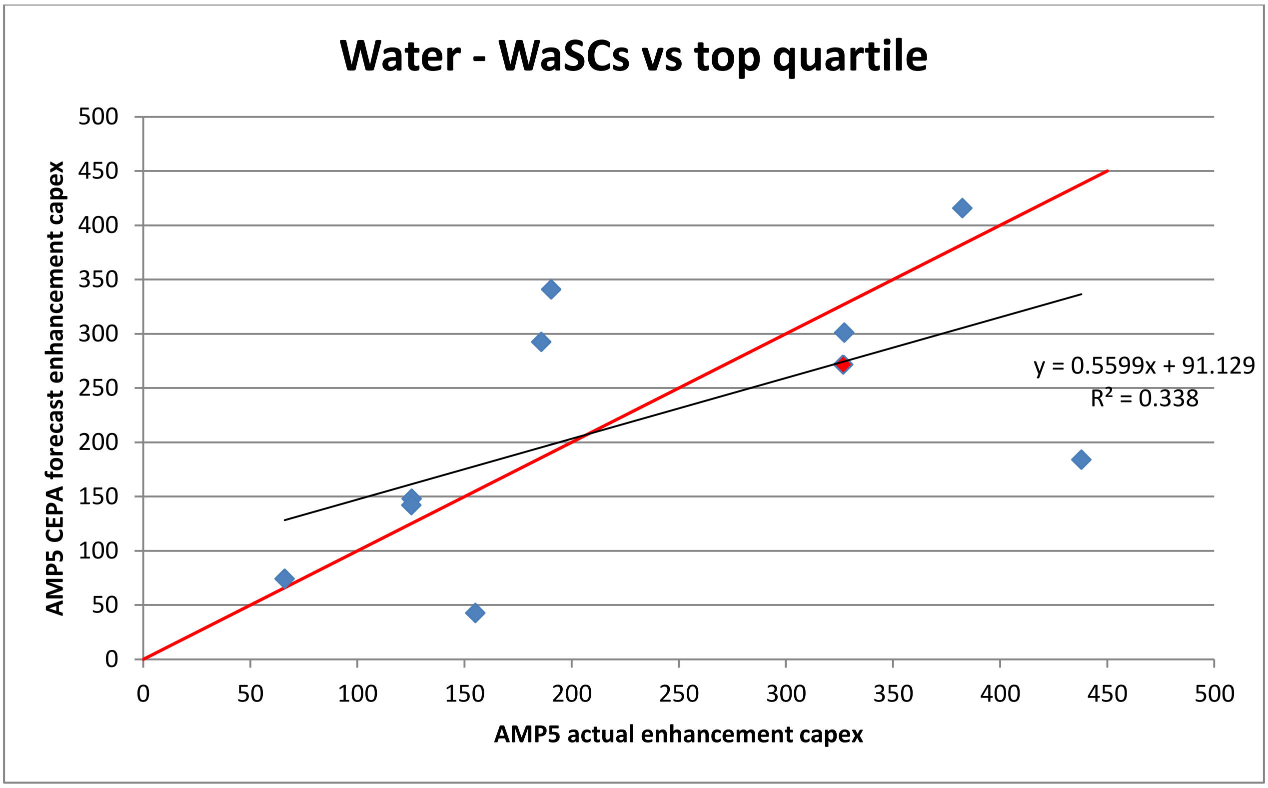


Graph A6.31

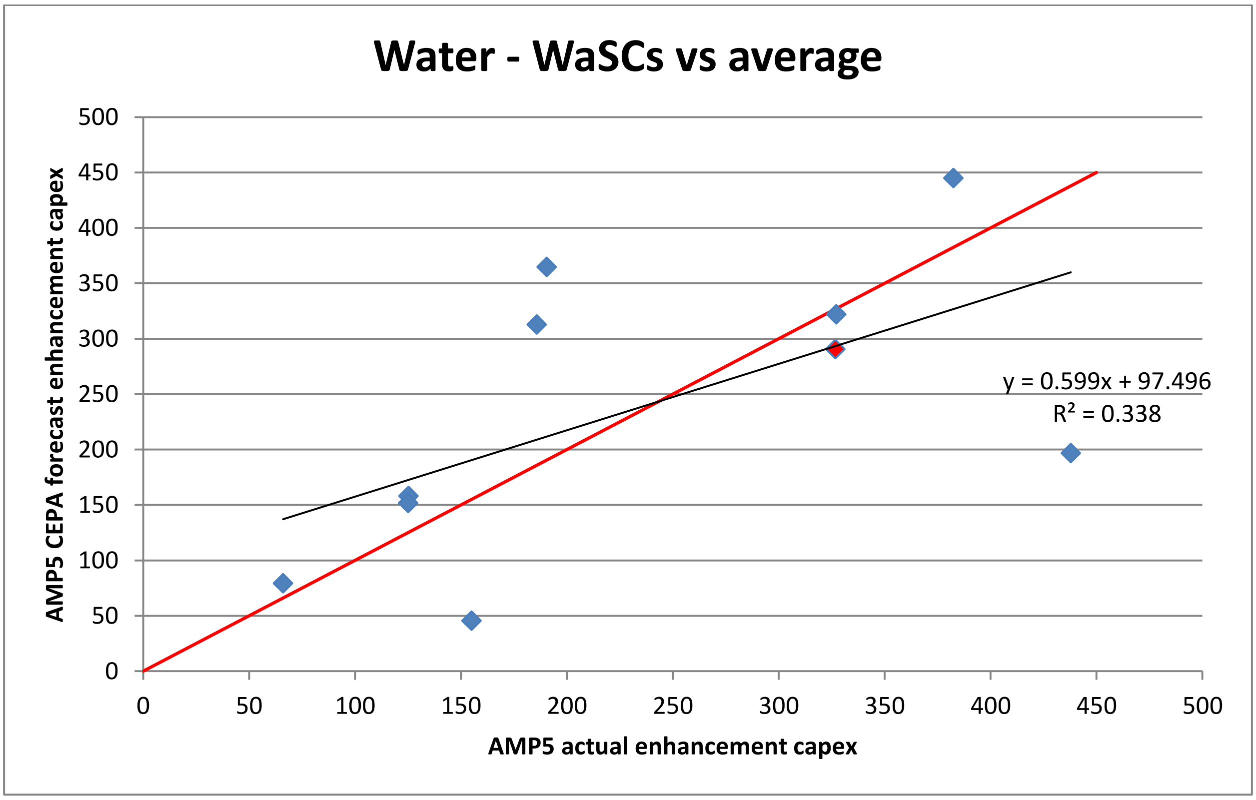


Appendix 7: CEPA AMP5 forecasts vs AMP5 outcomes for Enhancement capex

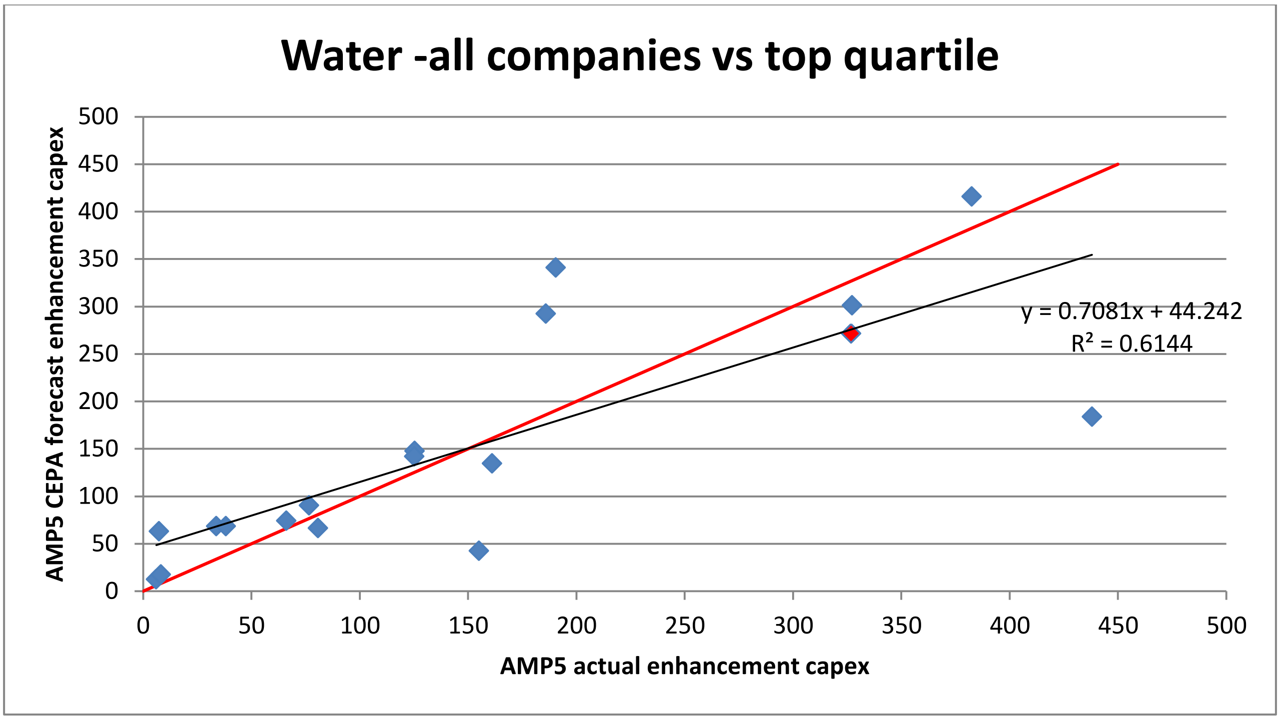
Graph A7.1



Graph A7.2



Graph A7.3



GraphA7.4

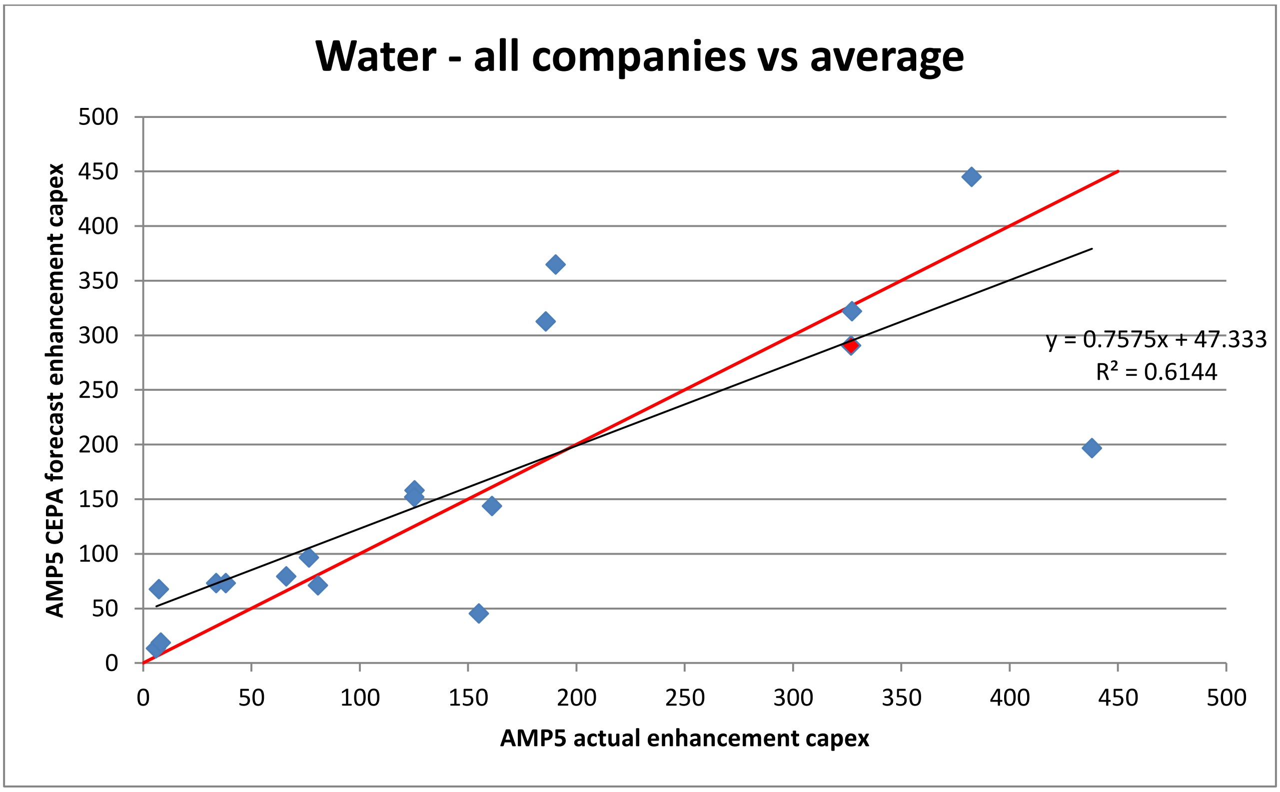


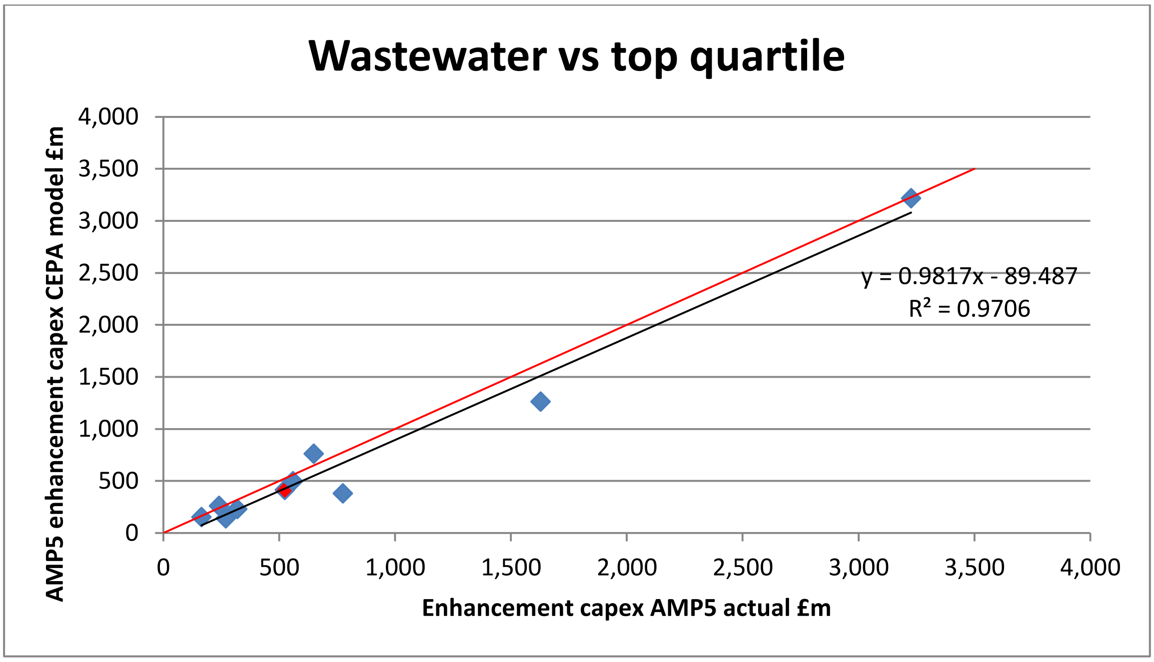
Table A7.1

AMP5 water	Actual £m	Forecast: top quartile £m	F/A
ANH	326.75	271.70	83%
WSH	125.33	147.78	118%
NES	190.54	340.91	179%
SVT	327.27	300.92	92%
SRN	185.89	292.32	157%
SWT	66.10	74.12	112%
TMS	382.50	415.82	109%
NWT	437.99	183.86	42%
WSX	155.06	42.46	27%
YRK	125.23	141.93	113%
AFF	76.60	90.34	118%
BRL	80.76	66.47	82%
BWH	7.39	63.05	853%
DEV	6.03	12.44	206%
PRT	8.14	17.43	214%
SES	33.82	68.28	202%
SEW	161.04	134.44	83%
SSC	38.19	68.39	179%
Total	2,734.63	2,732.66	100%
Standard Deviation			180%

Table A7.2

AMP5 water	Actual £m	Forecast: average £m	F/A
ANH	326.75	290.68	89%
WSH	125.33	158.11	126%
NES	190.54	364.72	191%
SVT	327.27	321.94	98%
SRN	185.89	312.74	168%
SWT	66.10	79.30	120%
TMS	382.50	444.87	116%
NWT	437.99	196.70	45%
WSX	155.06	45.43	29%
YRK	125.23	151.85	121%
AFF	76.60	96.65	126%
BRL	80.76	71.12	88%
BWH	7.39	67.46	912%
DEV	6.03	13.31	221%
PRT	8.14	18.65	229%
SES	33.82	73.05	216%
SEW	161.04	143.83	89%
SSC	38.19	73.16	192%
Total	2,734.63	2,923.57	107%
Standard Deviation			193%

Graph A7.5



Graph A7.6

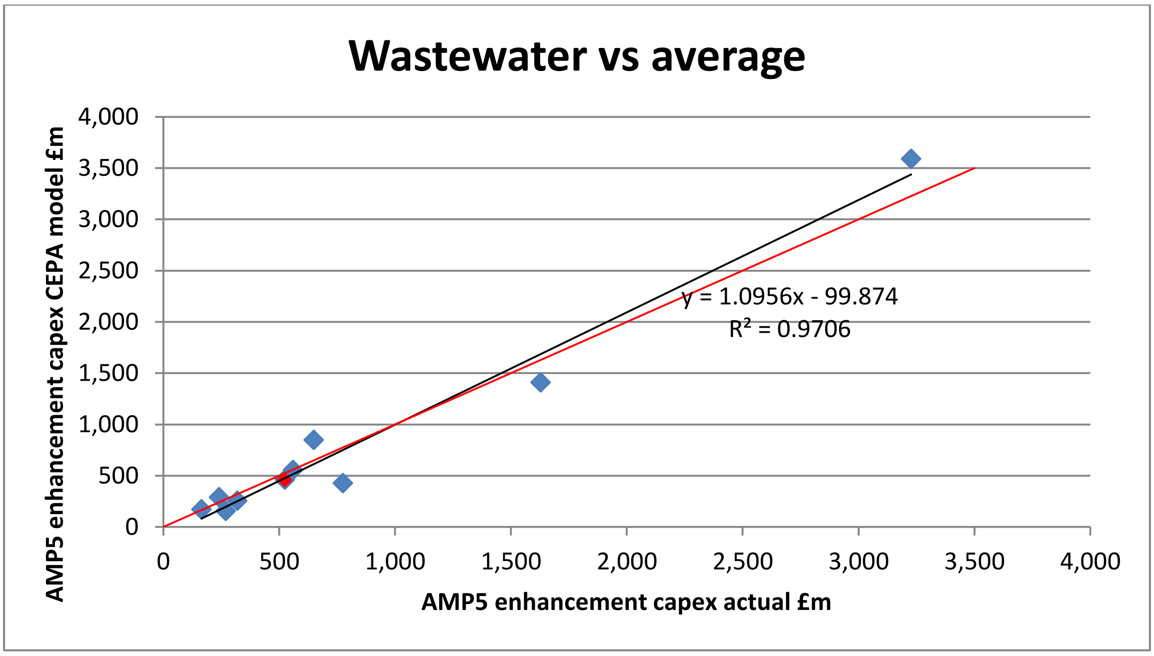


Table A7.3

AMP5 wastewater	Actual £m	Model: top quartile £m	F/A
ANH	523.9	413.9	79%
WSH	319.2	229.7	72%
NES	269.6	139.6	52%
SVT	560.7	497.3	89%
SRN	775.0	380.9	49%
SWT	164.9	153.8	93%
TMS	3,227.4	3,216.4	100%
NWT	1,629.4	1,261.7	77%
WSX	241.	258.5	107%
YRK	649.1	760.3	117%
Total	8,360.3	7,312.2	87%
Standard Deviation			22%

Table A7.4

AMP5 wastewater	Actual £m	Model: average £m	F/A
ANH	523.9	462.0	88%
WSH	319.2	256.3	80%
NES	269.6	155.8	58%
SVT	560.7	555.1	99%
SRN	775.0	425.1	55%
SWT	164.9	171.6	104%
TMS	3,227.4	3,589.8	111%
NWT	1,629.4	1,408.2	86%
WSX	241.1	288.5	120%
YRK	649.1	848.6	131%
Total	8,360.3	8,160.9	98%
Standard Deviation			25%

Appendix 8: PR09 cost assessment approach

Opex

For opex, Ofwat:

- Started from the opex in year 4 of the AMP (at PR09, this was 2008-09);
- Applied company-specific challenges based on Ofwat's year 4 assessment of the company's relative efficiency (this is how econometric and unit cost modeling impacted the opex cost assessment approach); and
- Made allowance for additional opex needed to meet increases in:
  - Quality standards;
  - Demand for water;
  - Quality of customer service.

Maintenance capex

For capital maintenance, Ofwat took into account evidence put forward in company DBPs and FBPs. This involved:

- Analysing the previous seven years of expenditure. Ofwat stressed that previous levels of spending would not be rolled forward. Companies needed to make a compelling case for all future expenditure;
- Reviewing the quality of the asset management planning and evidence that each company has used to justify future expenditure levels, making use of common framework principles. Strong evidence for large deviations from past levels of expenditure was expected;
- Using other evidence where relevant, for example drawn from the asset inventory submissions or cost comparisons, to inform judgements.

Enhancement capex

Ofwat assessed enhancement capital expenditure baselines by challenging BPs:

- For scope, using CBA and other relevant tests;
- For cost, using cost base and a new capital estimating scorecard assessment.

The capital estimating scorecard was designed to reveal the robustness of project specific estimates and to demonstrate the link between project specific estimate robustness and each company's overall approach. Each company reveals expenditure projection robustness by:

- Identifying a sample of individual projects that represent major projects (by value) and/or projects that typically represent the robustness of the capital cost estimates. The sample could be altered at FBP to achieve a representative sample;
- Assessing its estimates against a set of criteria that reflect best practice principles in cost estimating using a scorecard approach. The scorecard will take into account project management, scope definition, approach to risk and value, robustness of cost and management and systems;
- Showing that its strategic policies and approach to forecasting capital expenditure are evident at a project specific level; and
- Demonstrating its ability to deliver the capital programme in line with the projected profile.

Appendix 9: Glossary

AMP:	Asset Management Period. The most recent, AMP6, runs from April 2015 to March 2020
Botex	Base Total Expenditure, Opex + Maintenance Capex
BP	Business Plan
CAA	Civil Aviation Authority, responsible inter alia for economic regulation of airports
CBA	Cost Benefit Analysis
CC	Competition Commission: predecessor body to CMA
CEPA	Cambridge Economic Policy Associates: economic consultancy engaged by Ofwat to produce totex models for PR14
CMA	Competition and Markets Authority: non-ministerial UK government body tasked with promoting competition and protecting consumers
DBP	Draft Business Plan
DEA	Data Envelopment Analysis: Less elegant technique than SFA but considerably easier to implement.
DPCR5	Electricity Distribution Price Control Review 5 (covering 2010-15)
dWRMP	Draft Water Resource Management Plan
FBP	Final Business Plan
GDPCR1	Gas Distribution Price Control Review 1 (covering 2008-13)
Multi collinearity	Perfect multi collinearity occurs if there is a linear relationship between the variables. More generally, if two variables are correlated a model is said to display multi collinearity. In this situation the coefficient estimates of the regression may change erratically in response to small changes in the model or the data.
NERA	Economic consultancy, subsidiary of Marsh & McLennan, used by AWS during PR14 to develop SFA model of UK water and wastewater industry
Ofcom	Office of Communications
Ofgem	Office of Gas and Electricity Markets
Ofwat	The Water Services Regulation Authority, the economic regulator of the water sector in England and Wales
OLS	Ordinary Least Squares: Entry level econometric approach
Openreach	Wholely owned wholesale subsidiary of BT plc.
Opex	Operating Expenditure
ORR	Office of Rail and Road
PR14	Price Review 2014, setting prices for AMP6
QoS	Quality of Service

RBR	Risk Based Review
RIIO - ED1	Revenue = Incentives + Innovation + Outputs – Electricity Distribution period 1
RIIO - GD1	Revenue = Incentives + Innovation + Outputs – Gas Distribution period 1
SFA	Stochastic Frontier Analysis: Theoretically elegant but computationally complex econometric technique
SIM	Service Incentive Mechanism – measures WaSC and WoC QoS
TFP	Total Factor Productivity
Totex	Total Expenditure, Botex + Enhancement Capex
Triangulation	Arithmetic averaging approach taken by Ofwat to combine results of individual econometric models
UKWIR	UK Water Industry Research: a research body jointly run by UK water industry
WaSC	Water and Sewerage Company
WoC	Water only Company
WRMP	Water Resource Management Plan