# SRN-DDR-013: Regional Wages

# Cost Adjustment Claim

28th August 2024


from Southern Water

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# Our response to Ofwat's rejection of our regional wages CAC

As part of our business plan, we submitted a cost adjustment claim in relation to regional wages (SRN 23: Regional Wages). We argue that wages are relatively high in our area, which has a material impact on the level of our efficient costs given that labour is by far the main input used by companies. We provided strong evidence from the ONS on the difference in wages across water companies and proposed an adjustment which was based on an "accounting" method (i.e., no econometrics).

We used Ofwat's assumption on the proportion of costs that are due to labour cost, forecasted PR24 allowances by company, and adjusted those according to the ONS' data on regional manufacturing wages (manufacturing was Ofwat's comparator industry at PR19).

Ofwat rejected our CAC arguing that:

1. We do not fully demonstrate unique circumstances – our regional wage is second in the sector.

***Our response:*** Where a cost adjustment claim is based on a modelling adjustment, SWS considers that the key relevant criteria are the following (i) are the circumstances relevant as a cost factor that explains efficient costs; (ii) are they material? (iii) are they already captured in the cost assessment framework?

If a relevant and material cost driver such as water economies of scale is not included in the econometric models and one or more companies are impacted by this factor, the modelled allowances are insufficient for an efficient company to operate. In these cases, a symmetrical adjustment needs to be provided to all companies impacted by the absence of this driver. Therefore, a cost adjustment claim based on a modelling adjustment may not be individually unique to one company.

There are large and consistent differences in wages across regions with companies operating in London and South East collectively having the unique circumstance of higher wages as compared to the rest of the country. This is evidence by a trusted and reliable data from the ONS. These regional wage differences are not currently captured by the Ofwat econometric models.

2. We did not consider the extent that the density variably captures the effect of regional wages and thereby provides an implicit allowance against our claim.

***Our response*:** The correlation with the density variable is low, as the table below shows. And indeed for Southern Water this correlation is even weaker as Southern does not sit close to the linear best fit line – its regional wages are higher than its density, compared to the sector. Furthermore, all variables in the Ofwat models have a small degree of correlation and yet they are included in the models because they account for a significant driver of costs not captured by other variables. The same argument applies to regional wages.

**Table 1. Correlation between wage variable and density variables**

| Density variables | Wages - water | Wages - wastewater |
|---|---|---|
| MSOAtoLAD_population – water | 0.4918 | |
| MSOAtoLAD_population2 – water | 0.5058 | |
| MSOA_population – water | 0.5642 | |
| MSOA_population2 – water | 0.5664 | |

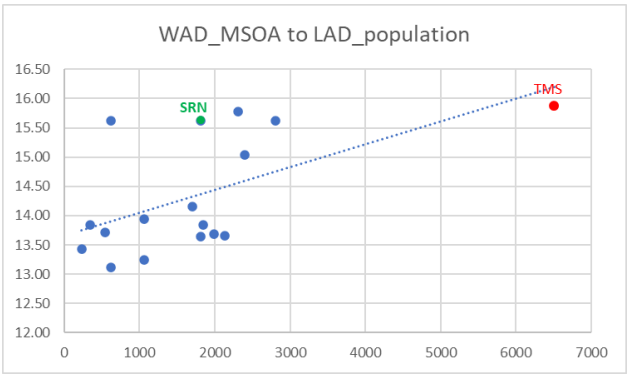
| | | |
|---|---|---|
| Density – wastewater | | 0.5818 |
| WAD_MSOAtoLAD_population – wastewater | | 0.5145 |

The correlations drop further if we exclude Thames Water, which is an outlier in the relationship between the density metrics and wages, with both very high density and very high wages. Southern has a similar wage to Thames but Thames' density is between 2 and 3.5 times higher. This is illustrated in the scatterplots below (see Figure 1).

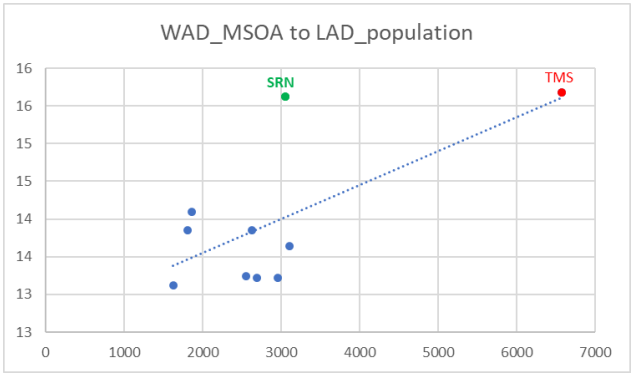
The scatterplots also show that Southern sits outside the best fit line having high wages with moderate density. We note that in water, the other companies with a correlation above the correlation line are the water only companies operating in the South East region, which also face high wages with moderate population density. This demonstrates quite clearly that population density is not a good proxy for higher wages in the South East. For illustration purposes, we present scatterplots for only one measure of density – WAD_MSOA to LAD_population, but the same pattern also exists for the other measures of density used in the base econometric models.

**Figure 1. Scatterplots density vs wages**

**Water**




**Wastewater**




If we excluded the outlier Thames Water, the correlation between the density variables and wages drops significantly and is almost non-existent in wastewater, as the table below shows.

**Table 2. Correlation between wage variable and density variables without Thames Water**

| Density variables | Wages - water | Wages - wastewater |
|---|---|---|
| MSOAtoLAD_population – water | 0.3850 | |
| MSOAtoLAD_population2 – water | 0.3954 | |
| MSOA_population – water | 0.4702 | |
| MSOA_population2 – water | 0.4746 | |
| Density – wastewater | | 0.2645 |
| WAD_MSOAtoLAD_population – wastewater | | 0.1177 |

3. Ofwat says it has done its own analysis to test whether regional wage works as a variable in the econometric models or as a pre-modelling adjustment. With the econometric approach, it found that "Including regional wage indices in the base cost models does not produce sensible results as the estimated coefficients are not statistically significant and often have a counterintuitive negative sign." With the pre-modelling adjustment approach, it found that the impact on Southern is immaterial and sometimes negative so does not support the need for a cost adjustment.

***Our response:*** We have done the same analysis and received different results. We have requested further information from Ofwat to try to replicate their results.

**Evidence from an econometric approach**

We developed econometric evidence using appropriate ONS data (i.e., using ASHE hourly wage, workplace-based, and using wage information from relevant sectors only by SIC Code[1]). We tested the variable in wholesale water and wastewater models.

The results were robust in water models, as can be seen in Table A.1 in Appendix A. We get a positive and significant coefficient on regional wage. While the value of the coefficient is higher than expected in some models, it is because of its interaction with the other cost drivers in the model, namely properties – a value of a coefficient cannot always be considered in isolation. Ignoring a variable because the coefficient appears 'too high'—therefore essentially assuming its value is zero—is wrong.

In wastewater, as shown in table A.2, Appendix A, the coefficient is significant, has a positive sign and of expected magnitude of approximately 1 in the sewage treatment price control, although it is not statistically significant in sewage collection and in the wastewater network plus models. The wage variable is statistically insignificant also in the bioresources models. This might be due to the smaller sample of companies in the wastewater models hence we considered an alternative approach as below.

**Evidence from a pre-modelling adjustment approach**

Ofgem makes an adjustment for regional wages differences through a pre-modelling adjustment in every price control. We have replicated Ofgem's approach to assess the impact of regional wages using a pre-modelling adjustment to the data. The adjustments remove the effects of high and low wages from the data. Like Ofgem, we then reverse the adjustments, subject to an efficiency challenge, after obtaining the econometric results.

We followed Ofgem's method and obtained results that support our claim. Estimating the models with the regional wage pre-modelling adjustments we obtain robust models in both water and wastewater. The

[1] The sectors we included in the analysis are and corresponding weights are: manufacturing (30%); water supply, sewage, waste management and remediation activities (25%); construction (15%), information and communication (10%); professional, scientific and technical activities (10%); and administrative and support service activities (10%).

approach results in an adjustment of about £55m across all price controls, which is lower than the £88m we included in the original CAC[2].

Results of our econometric and pre-modelling approaches are presented in Appendix A and B, respectively.

4. Last, Ofwat also suggests that ASHE evidence on regional wage "can vary significantly depending on the choice of wage measure, which questions the reliability of the regional wage differentials calculated using ONS ASHE data, and any subsequent cost adjustment claim value."

***Our response:*** We disagree. The ASHE is a large survey, and its results are consistent over time – wages in London and the South East are clearly higher than in the rest of the country. Compared to the reliability and quality of other sources of evidence that Ofwat uses, the evidence on wages from the ONS is very strong and reliable. It would be wrong to dismiss this evidence as inconclusive – it is not.

**The basic facts remain that:**

- Labour is our dominant input by far, and its impact on totex is very material.
- There are large and consistent differences in wages across regions. This is evidence by a trusted and reliable source.
- Ofgem recognises the importance of regional wage differences in efficiency assessment. It considers the ONS evidence as a stronger, more reliable evidence than its own econometric models, which may provide inconclusive results due to the small sample limitations.
- Ignoring the effect of regional wages leads to inaccurate comparative efficiency assessment.
- We note that while our CAC is focused on base costs, the same applies to enhancement where labour is the predominant input as well.

[2] The pre-modelling evidence corroborates the findings of the original claim and we have thus retained the original value of the claim. We note that the value for water is marginally below the materiality threshold. However, we believe it is still valid given (1) it rounds up to the 1% materiality; (2) it is still material against the total botex of the price control; (3) we are proposing a symmetrical claim and not all companies will be materially impacted using the Ofwat threshold; and (4) the value is above the materiality threshold using the pre-modelling approach.

# Appendix A – Our econometric results

## Table 3. Econometric modelling results with wage variable - Water

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 | Model 10 | Model 11 | Model 12 | Model 13 | Model 14 | Model 15 | Model 16 | Model 17 | Model 18 | Model 19 | Model 20 | Model 21 | Model 22 | Model 23 | Model 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lnproperties | 1.101*** | 1.100*** | 1.103*** | 1.100*** | 1.113*** | 1.110*** | | | | | | | 1.075*** | 1.064*** | 1.082*** | 1.070*** | 1.093*** | 1.080*** | 1.076*** | 1.069*** | 1.080*** | 1.071*** | 1.097*** | 1.088*** |
| | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | | | | | | | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} |
| pctwatertreated36 | 0.003** | | 0.002 | | 0.003 | | | | | | | | 0.003*** | | 0.002 | | 0.002 | | 0.003** | | 0.001 | | 0.001 | |
| | {0.044} | | {0.165} | | {0.131} | | | | | | | | {0.000} | | {0.127} | | {0.129} | | {0.046} | | {0.410} | | {0.360} | |
| lnWAD_MSOAtoLAD_population | -1.559** | -1.496** | | | | | -2.832*** | | | -3.043*** | | | -2.134*** | -1.943*** | | | | | -2.388*** | -2.273*** | | | | |
| | {0.013} | {0.039} | | | | | {0.000} | | | {0.000} | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} | | | | |
| lnWAD_MSOAtoLAD_population2 | 0.092** | 0.087* | | | | | 0.217*** | | | 0.227*** | | | 0.143*** | 0.130*** | | | | | 0.156*** | 0.148*** | | | | |
| | {0.030} | {0.071} | | | | | {0.000} | | | {0.000} | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} | | | | |
| **lnrealwage_median** | **1.238** | **1.202** | **1.366** | **1.305*** | **1.436*** | **1.366*** | **1.590***** | **1.527***** | **1.399***** | **1.461***** | **1.312***** | **1.275***** | **1.100**** | **0.963**** | **1.353**** | **1.205**** | **1.392***** | **1.237**** | **1.104**** | **1.027*** | **1.368**** | **1.271**** | **1.411***** | **1.305***** |
| | **{0.152}** | **{0.101}** | **{0.125}** | **{0.081}** | **{0.086}** | **{0.055}** | **{0.000}** | **{0.000}** | **{0.001}** | **{0.000}** | **{0.001}** | **{0.002}** | **{0.035}** | **{0.045}** | **{0.020}** | **{0.026}** | **{0.009}** | **{0.013}** | **{0.048}** | **{0.050}** | **{0.018}** | **{0.018}** | **{0.008}** | **{0.009}** |
| lnwac | | 0.254 | | 0.215 | | 0.241 | | | | | | | | 0.361*** | | 0.258 | | 0.266* | | 0.254 | | 0.163 | | 0.179 |
| | | {0.295} | | {0.395} | | {0.346} | | | | | | | | {0.008} | | {0.101} | | {0.090} | | {0.104} | | {0.308} | | {0.256} |
| lnWAD_MSOA_population | | | -6.033*** | -6.008** | | | | -6.648*** | | | -7.010*** | | | | -6.391*** | -5.949*** | | | | | -7.446*** | -7.248*** | | |
| | | | {0.009} | {0.016} | | | | {0.000} | | | {0.000} | | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} | | |
| lnWAD_MSOA_population2 | | | 0.357** | 0.355** | | | | 0.445*** | | | 0.465*** | | | | 0.390*** | 0.363*** | | | | | 0.451*** | 0.439*** | | |
| | | | {0.011} | {0.020} | | | | {0.000} | | | {0.000} | | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} | | |
| lnpropperlength | | | | | -9.391** | -9.400** | | | -14.706*** | | | -16.352*** | | | | | -11.758*** | -10.898*** | | | | | -13.309*** | -12.922*** |
| | | | | | {0.016} | {0.017} | | | {0.000} | | | {0.000} | | | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} |
| lnpropperlength2 | | | | | 1.010** | 1.011** | | | 1.829*** | | | 1.997*** | | | | | 1.334*** | 1.235*** | | | | | 1.495*** | 1.451*** |
| | | | | | {0.024} | {0.026} | | | {0.000} | | | {0.000} | | | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} |
| lnlengthsofmain | | | | | | | 1.096*** | 1.056*** | 1.092*** | 1.089*** | 1.050*** | 1.086*** | | | | | | | | | | | | |
| | | | | | | | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | | | | | | | | | | | | |
| lnboosterperlength | | | | | | | 0.326*** | 0.278*** | 0.359*** | | | | 0.302*** | 0.311*** | 0.310*** | 0.323*** | 0.281*** | 0.292*** | | | | | | |
| | | | | | | | {0.000} | {0.001} | {0.000} | | | | {0.001} | {0.001} | {0.001} | {0.001} | {0.005} | {0.005} | | | | | | |
| lnAPH_TWD | | | | | | | | | | 0.306*** | 0.346*** | 0.336*** | | | | | | | 0.280** | 0.274** | 0.282** | 0.277** | 0.305** | 0.297** |
| | | | | | | | | | | {0.000} | {0.000} | {0.000} | | | | | | | {0.025} | {0.029} | {0.039} | {0.039} | {0.017} | {0.016} |
| _cons | -8.456** | -8.673*** | 10.191 | 10.154 | 6.129 | 6.227 | -0.024 | 15.976*** | 20.970*** | -1.33 | 15.582*** | 22.349*** | -4.109*** | -4.509*** | 13.492*** | 12.054*** | 12.854*** | 11.362*** | -5.422** | -5.671** | 15.550*** | 14.968*** | 13.977*** | 13.399*** |
| | {0.012} | {0.009} | {0.257} | {0.306} | {0.442} | {0.454} | {0.988} | {0.007} | {0.000} | {0.535} | {0.002} | {0.000} | {0.005} | {0.002} | {0.002} | {0.007} | {0.003} | {0.008} | {0.032} | {0.020} | {0.003} | {0.005} | {0.001} | {0.001} |
| depvar | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbotex |
| | xwrp | xwrp | xwrp | xwrp | xwrp | xwrp | xplustwd | xplustwd | xplustwd | xplustwd | xplustwd | xplustwd | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | plusww |
| Estimation_method | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE |
| N | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 | 190 |
| vce | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster |
| R_squared | 0.889 | 0.882 | 0.879 | 0.876 | 0.896 | 0.893 | 0.944 | 0.937 | 0.946 | 0.949 | 0.95 | 0.954 | 0.963 | 0.964 | 0.958 | 0.961 | 0.957 | 0.961 | 0.959 | 0.959 | 0.953 | 0.955 | 0.959 | 0.96 |
| RESET_P_value | 0.069 | 0.027 | 0.11 | 0.072 | 0.132 | 0.082 | 0.268 | 0.163 | 0.378 | 0.853 | 0.961 | 0.798 | 0.188 | 0.068 | 0.256 | 0.091 | 0.179 | 0.034 | 0.947 | 0.897 | 0.9 | 0.939 | 0.978 | 0.995 |

RE – Random Effects.

Results with the wage variable is highlighted in blue.

Notes:

Modelling results using data from 2010-11 to 2021-23 published by Ofwat as part of the April 2023 base cost model consultation plus 2022-23 data from APRs.

We use the model specifications that Ofwat proposed in the April 2023 consultation with the addition of the wage variable highlighted in blue.

We derived the wage variable from ONS ASHE data for hourly wages, workplace-based and for the relevant sectors Water supply; sewerage, waste management and remediation, Construction, Information and communication, Professional, scientific and technical activities, and Administrative and support service activities.

## Table 4. Econometric modelling results with wage variable – Wastewater network plus

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| lnsewerlength | 0.830*** | 0.885*** | 0.861*** | | |
| | {0.000} | {0.000} | {0.000} | | |
| lnpumpingcapperlength | 0.369*** | 0.550*** | 0.528*** | | 0.218** |
| | {0.009} | {0.001} | {0.002} | | {0.013} |
| lndensity | 1.067*** | | | | |
| | {0.000} | | | | |
| lnurbanrainfallperlength | 0.105*** | 0.151*** | 0.145*** | | 0.094*** |
| | {0.000} | {0.000} | {0.000} | | {0.002} |
| lnrealASHE_SIC_medians | -0.005 | 0.173 | 0.034 | 0.939* | 0.381 |
| | {0.992} | {0.735} | {0.949} | {0.058} | {0.268} |
| lnWAD_MSOAtoLAD_population | | 0.242*** | | | |
| | | {0.001} | | | |
| lnWAD_MSOA_population | | | 0.414*** | | |
| | | | {0.001} | | |
| lnload | | | | 0.775*** | 0.716*** |
| | | | | {0.000} | {0.000} |
| lnWATS | | | | -0.232*** | -0.105*** |
| | | | | {0.000} | {0.003} |
| pctnh3below3mg | | | | 0.005*** | 0.005*** |
| | | | | {0.000} | {0.000} |
| _cons | -8.007*** | -6.780*** | -7.691*** | -5.372*** | -3.515*** |
| | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} |
| depvar | lnrealbotexplusswc | lnrealbotexplusswc | lnrealbotexplusswc | lnrealbotexplusswt | lnrealbotexpluswwnp |
| Estimation_method | Random Effects | Random Effects | Random Effects | Random Effects | Random Effects |
| N | 120 | 120 | 120 | 120 | 120 |
| vce | cluster | cluster | cluster | cluster | cluster |
| R_squared | 0.919 | 0.911 | 0.909 | 0.899 | 0.959 |
| RESET_P_value | 0.089 | 0.214 | 0.134 | 0.329 | 0.082 |

RE – Random Effects.

Results with the wage variable is highlighted in blue.

Notes:

Modelling results using data from 2010-11 to 2021-23 published by Ofwat as part of the April 2023 base cost model consultation plus 2022-23 data from APRs.

We use the model specifications that Ofwat proposed in the April 2023 consultation with the addition of the wage variable highlighted in blue.

We derived the wage variable from ONS ASHE data for hourly wages, workplace-based and for the relevant sectors Water supply; sewerage, waste management and remediation, Construction, Information and communication, Professional, scientific and technical activities, and Administrative and support service activities.

## Table 5. Econometric modelling results with wage variable – Bioresources

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 | Model 10 | Model 11 | Model 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lnsludgeprod | 1.055*** | 0.971*** | 1.058*** | 0.971*** | 0.970*** | 0.922*** | 0.943*** | 0.897*** | | | | |
| | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | | | | |
| pctbands13 | 0.033 | 0.025 | | 0.043 | | | | | 0.049*** | | | |
| | {0.337} | {0.546} | | {0.236} | | | | | {0.001} | | | |
| lnWAD_MSOAtoLAD_population | -0.203 | | | | -0.229 | | -0.253 | | | -0.260*** | | |
| | {0.178} | | | | {0.229} | | {0.248} | | | {0.008} | | |
| lnrealASHE_SIC_medians | 0.755 | 0.639 | 0.915 | 0.49 | 0.725 | 0.691 | 0.735 | 0.661 | 0.477 | 0.764 | 0.793 | 0.867 |
| | {0.199} | {0.394} | {0.132} | {0.429} | {0.231} | {0.309} | {0.277} | {0.408} | {0.401} | {0.198} | {0.232} | {0.166} |
| lnWAD_MSOA_population | | -0.142 | | | | -0.217 | | -0.201 | | | -0.339** | |
| | | {0.681} | | | | {0.522} | | {0.607} | | | {0.029} | |
| lnswtwperpro | | | 0.275 | | | | | | | | | 0.227*** |
| | | | {0.207} | | | | | | | | | {0.006} |
| lnWATS | | | | | | | 0.05 | 0.026 | | | | |
| | | | | | | | {0.640} | {0.794} | | | | |
| _cons | -1.74 | -1.345 | -1.262 | -2.139 | -0.945 | -0.554 | -1.151 | -0.74 | -2.267 | -0.958 | -0.232 | -1.245 |
| | {0.165} | {0.428} | {0.305} | {0.121} | {0.504} | {0.751} | {0.513} | {0.698} | {0.138} | {0.476} | {0.859} | {0.318} |
| depvar | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh_unit | lnrealbotexbrenh_unit | lnrealbotexbrenh_unit | lnrealbotexbrenh_unit |
| Econometric_model | | | | | | | | | | | | |
| N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| vce | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster |
| R_squared | 0.796 | 0.778 | 0.778 | 0.781 | 0.771 | 0.76 | 0.764 | 0.753 | 0.261 | 0.211 | 0.188 | 0.216 |
| RESET_P_value | 0.873 | 0.716 | 0.793 | 0.606 | 0.817 | 0.896 | 0.051 | 0.967 | 0.998 | 0.364 | 0.524 | 0.663 |

RE – Random Effects.

Results with the wage variable is highlighted in blue.

Notes:

Modelling results using data from 2010-11 to 2021-23 published by Ofwat as part of the April 2023 base cost model consultation plus 2022-23 data from APRs.

We use the model specifications that Ofwat proposed in the April 2023 consultation with the addition of the wage variable highlighted in blue.

We derived the wage variable from ONS ASHE data for hourly wages, workplace-based and for the relevant sectors Water supply; sewerage, waste management and remediation, Construction, Information and communication, Professional, scientific and technical activities, and Administrative and support service activities.

# Appendix B – Our pre-modelling adjustment results

## Table 6. Econometric modelling results with Ofgem wage pre-modelling adjustment - Water

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 | Model 10 | Model 11 | Model 12 | Model 13 | Model 14 | Model 15 | Model 16 | Model 17 | Model 18 | Model 19 | Model 20 | Model 21 | Model 22 | Model 23 | Model 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lnproperties | 1.084*** | 1.079*** | 1.060*** | 1.057*** | 1.030*** | 1.025*** | | | | | | | 1.071*** | 1.058*** | 1.049*** | 1.040*** | 1.041*** | 1.032*** | 1.070*** | 1.060*** | 1.043*** | 1.037*** | 1.026*** | 1.020*** |
| | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | | | | | | | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} |
| pctwatertreated36 | 0.005*** | | 0.005*** | | 0.005*** | | | | | | | | 0.004*** | | 0.003*** | | 0.004*** | | 0.003** | | 0.003* | | 0.003** | |
| | {0.001} | | {0.002} | | {0.000} | | | | | | | | {0.000} | | {0.004} | | {0.000} | | {0.020} | | {0.051} | | {0.010} | |
| lnWAD_MSOAtoLAD_population | -1.617*** | -1.505** | | | | | -2.852*** | | | -3.041*** | | | -1.919*** | -1.679*** | | | | | -2.242*** | -2.075*** | | | | |
| | {0.004} | {0.019} | | | | | {0.000} | | | {0.000} | | | {0.000} | {0.001} | | | | | {0.000} | {0.000} | | | | |
| lnWAD_MSOAtoLAD_population2 | 0.102*** | 0.094** | | | | | 0.226*** | | | 0.234*** | | | 0.135*** | 0.118*** | | | | | 0.153*** | 0.141*** | | | | |
| | {0.005} | {0.023} | | | | | {0.000} | | | {0.000} | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} | | | | |
| lnwac | | 0.437 | | 0.414 | | 0.459* | | | | | | | | 0.423** | | 0.397** | | 0.426*** | | 0.343* | | 0.316* | | 0.364** |
| | | {0.120} | | {0.146} | | {0.089} | | | | | | | | {0.013} | | {0.020} | | {0.006} | | {0.070} | | {0.091} | | {0.037} |
| lnWAD_MSOA_population | | | -5.205** | -5.113** | | | | -5.933*** | | | -6.653*** | | | | -4.959*** | -4.416*** | | | | | -6.307*** | -5.967*** | | |
| | | | {0.012} | {0.028} | | | | {0.000} | | | {0.000} | | | | {0.000} | {0.002} | | | | | {0.000} | {0.000} | | |
| lnWAD_MSOA_population2 | | | 0.318** | 0.311** | | | | 0.415*** | | | 0.453*** | | | | 0.316*** | 0.281*** | | | | | 0.395*** | 0.373*** | | |
| | | | {0.012} | {0.027} | | | | {0.000} | | | {0.000} | | | | {0.000} | {0.001} | | | | | {0.000} | {0.000} | | |
| lnpropperlength | | | | | -8.043** | -7.586** | | | -16.005*** | | | -17.014*** | | | | | -11.807*** | -10.640*** | | | | | -12.996*** | -12.189*** |
| | | | | | {0.012} | {0.021} | | | {0.000} | | | {0.000} | | | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} |
| lnpropperlength2 | | | | | 0.894** | 0.837** | | | 2.016*** | | | 2.103*** | | | | | 1.378*** | 1.237*** | | | | | 1.497*** | 1.399*** |
| | | | | | {0.018} | {0.027} | | | {0.000} | | | {0.000} | | | | | {0.000} | {0.000} | | | | | {0.000} | {0.000} |
| lnlengthsofmain | | | | | | | 1.070*** | 1.025*** | 1.068*** | 1.064*** | 1.017*** | 1.047*** | | | | | | | | | | | | |
| | | | | | | | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | | | | | | | | | | | | |
| lnboosterperlength | | | | | | | 0.320*** | 0.315*** | 0.364*** | | | | 0.335*** | 0.353*** | 0.375*** | 0.388*** | 0.293** | 0.296** | | | | | | |
| | | | | | | | {0.005} | {0.002} | {0.000} | | | | {0.007} | {0.003} | {0.003} | {0.002} | {0.011} | {0.012} | | | | | | |
| lnAPH_TWD | | | | | | | | | | 0.338*** | 0.394*** | 0.346*** | | | | | | | 0.332*** | 0.319*** | 0.343*** | 0.331*** | 0.275** | 0.259** |
| | | | | | | | | | | {0.000} | {0.000} | {0.000} | | | | | | | {0.002} | {0.002} | {0.003} | {0.004} | {0.022} | {0.033} |
| _cons | -5.208*** | -5.728*** | 10.124 | 9.628 | 7.268 | 6.167 | 4.101*** | 16.741*** | 27.061*** | 2.271 | 17.059*** | 26.956*** | -2.141 | -3.052* | 10.989** | 8.752 | 16.571*** | 13.961*** | -3.545** | -4.187** | 13.786*** | 12.380** | 17.292*** | 15.522*** |
| | {0.001} | {0.002} | {0.186} | {0.274} | {0.274} | {0.367} | {0.009} | {0.001} | {0.000} | {0.159} | {0.000} | {0.000} | {0.190} | {0.050} | {0.042} | {0.106} | {0.000} | {0.001} | {0.046} | {0.020} | {0.006} | {0.017} | {0.000} | {0.000} |
| depvar | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote | lnrealbote |
| | xwrp | xwrp | xwrp | xwrp | xwrp | xwrp | xplustwd | xplustwd | xplustwd | xplustwd | xplustwd | xplustwd | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww | xplusww |
| Estimation_method | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE |
| N | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 | 204 |
| vce | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster |
| R_squared | 0.906 | 0.901 | 0.897 | 0.894 | 0.906 | 0.902 | 0.955 | 0.953 | 0.959 | 0.96 | 0.964 | 0.966 | 0.965 | 0.967 | 0.963 | 0.965 | 0.965 | 0.967 | 0.963 | 0.964 | 0.96 | 0.961 | 0.964 | 0.966 |
| RESET_P_value | 0.504 | 0.411 | 0.786 | 0.653 | 0.436 | 0.282 | 0.072 | 0.123 | 0.592 | 0.365 | 0.635 | 0.777 | 0.144 | 0.065 | 0.175 | 0.071 | 0.252 | 0.101 | 0.697 | 0.76 | 0.711 | 0.825 | 0.819 | 0.711 |

RE – Random Effects.

Notes:

Modelling results using data from 2010-11 to 2021-23 published by Ofwat as part of the April 2023 base cost model consultation plus 2022-23 data from APRs.

We use the model specifications that Ofwat proposed in the April 2023 consultation with the addition of the wage variable highlighted in blue.

We derived the wage variable from ONS ASHE data for hourly wages, workplace-based and for the relevant sectors Water supply; sewerage, waste management and remediation, Construction, Information and communication, Professional, scientific and technical activities, and Administrative and support service activities.

## Table 7. Econometric modelling results with Ofgem wage pre-modelling adjustment – Wastewater Network Plus

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 | Model 10 | Model 11 | Model 12 | Model 13 | Model 14 | Model 15 | Model 16 | Model 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lnsewerlength | 0.781*** | 0.878*** | 0.850*** | 0.814*** | 0.885*** | 0.862*** | | | | | | | | | | | |
| | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | | | | | | | | | | | |
| lnpumpingcapperlength | 0.311** | 0.562*** | 0.519*** | 0.320** | 0.535*** | 0.494*** | | | | 0.338*** | 0.351*** | 0.327*** | 0.267** | 0.328*** | 0.342*** | 0.316*** | 0.245*** |
| | {0.013} | {0.000} | {0.001} | {0.019} | {0.000} | {0.001} | | | | {0.003} | {0.004} | {0.008} | {0.018} | {0.003} | {0.002} | {0.004} | {0.002} |
| lndensity | 1.075*** | | | 1.029*** | | | | | | | | | | | | | |
| | {0.000} | | | {0.000} | | | | | | | | | | | | | |
| lnWAD_MSOAtoLAD_population | | 0.205** | | | 0.231*** | | | | | | | | | | | | |
| | | {0.020} | | | {0.000} | | | | | | | | | | | | |
| lnWAD_MSOA_population | | | 0.348*** | | | 0.376*** | | | | | | | | | | | |
| | | | {0.004} | | | {0.000} | | | | | | | | | | | |
| lnurbanrainfallperlength | | | | 0.109*** | 0.151*** | 0.148*** | | | | | | | | 0.075** | 0.077** | 0.082** | 0.091** |
| | | | | {0.000} | {0.000} | {0.000} | | | | | | | | {0.022} | {0.013} | {0.015} | {0.012} |
| lnload | | | | | | | 0.647*** | 0.753*** | 0.774*** | 0.633*** | 0.713*** | 0.694*** | 0.703*** | 0.637*** | 0.717*** | 0.710*** | 0.709*** |
| | | | | | | | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} |
| pctbands13 | | | | | | | 0.028 | | | | 0.023* | | | | 0.023** | | |
| | | | | | | | {0.217} | | | | {0.082} | | | | {0.038} | | |
| pctnh3below3mg | | | | | | | 0.006*** | 0.006*** | 0.006*** | 0.005*** | 0.005*** | 0.005*** | 0.005*** | 0.005*** | 0.005*** | 0.005*** | 0.006*** |
| | | | | | | | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} |
| pctSTWslarger100k | | | | | | | | -0.010*** | | | | -0.003 | | | | -0.004* | |
| | | | | | | | | {0.002} | | | | {0.143} | | | | {0.094} | |
| lnWATS | | | | | | | | | -0.240*** | | | | -0.097** | | | | -0.102*** |
| | | | | | | | | | {0.000} | | | | {0.021} | | | | {0.002} |
| pct_coastal | | | | | | | | | | | | | | | | | |
| _cons | -7.814*** | -6.443*** | -7.385*** | -7.678*** | -6.247*** | -7.287*** | -3.645*** | -4.357*** | -2.846*** | -2.805*** | -3.902*** | -3.403*** | -2.727*** | -2.634*** | -3.727*** | -3.333*** | -2.486*** |
| | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.007} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.001} | {0.000} | {0.000} | {0.000} |
| depvar | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl | lnrealbotexpl |
| | usswc | usswc | usswc | usswc | usswc | usswc | usswt | usswt | usswt | uswwnp | uswwnp | uswwnp | uswwnp | uswwnp | uswwnp | uswwnp | uswwnp |
| Estimation_method | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE | RE |
| N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| vce | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster |
| R_squared | 0.916 | 0.887 | 0.886 | 0.919 | 0.906 | 0.904 | 0.843 | 0.858 | 0.901 | 0.937 | 0.943 | 0.939 | 0.948 | 0.943 | 0.95 | 0.948 | 0.956 |
| RESET_P_value | 0.246 | 0.095 | 0.071 | 0.127 | 0.147 | 0.134 | 0.021 | 0.314 | 0.78 | 0.313 | 0.283 | 0.489 | 0.708 | 0.052 | 0.063 | 0.001 | 0.139 |

RE – Random Effects.

Notes:

Modelling results using data from 2010-11 to 2021-23 published by Ofwat as part of the April 2023 base cost model consultation plus 2022-23 data from APRs.

We use the model specifications that Ofwat proposed in the April 2023 consultation with the addition of the wage variable highlighted in blue.

We derived the wage variable from ONS ASHE data for hourly wages, workplace-based and for the relevant sectors Water supply; sewerage, waste management and remediation, Construction, Information and communication, Professional, scientific and technical activities, and Administrative and support service activities.

## Table 8. Econometric modelling results with Ofgem wage pre-modelling adjustment - Bioresources

| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 | Model 7 | Model 8 | Model 9 | Model 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| lnsludgeprod | 1.178*** | 1.133*** | 1.144*** | 1.108*** | 1.039*** | 1.028*** | | | | |
| | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | {0.000} | | | | |
| pctbands13 | 0.063*** | 0.061** | | 0.073*** | | | 0.053*** | | | |
| | {0.007} | {0.018} | | {0.003} | | | {0.000} | | | |
| lnWAD_MSOAtoLAD_population | -0.161 | | | | -0.25 | | | -0.219** | | |
| | {0.135} | | | | {0.132} | | | {0.037} | | |
| lnWAD_MSOA_population | | -0.144 | | | | -0.344 | | | -0.310** | |
| | | {0.456} | | | | {0.186} | | | {0.045} | |
| lnswtwperpro | | | 0.301 | | | | | | | 0.190** |
| | | | {0.117} | | | | | | | {0.028} |
| _cons | -0.737 | -0.537 | 0.97 | -1.604** | 0.809 | 1.773 | -1.009*** | 0.768 | 1.641 | 0.75 |
| | {0.378} | {0.680} | {0.204} | {0.011} | {0.242} | {0.197} | {0.000} | {0.299} | {0.174} | {0.279} |
| depvar | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh | lnrealbotexbrenh_unit | lnrealbotexbrenh_unit | lnrealbotexbrenh_unit | lnrealbotexbrenh_unit |
| Econometric_model | | | | | | | | | | |
| N | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| vce | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster | cluster |
| R_squared | 0.82 | 0.813 | 0.786 | 0.813 | 0.778 | 0.775 | 0.254 | 0.149 | 0.135 | 0.162 |
| RESET_P_value | 0.001 | 0.002 | 0.001 | 0.01 | 0 | 0.001 | 0.542 | 0 | 0.016 | 0.062 |

RE – Random Effects.

Notes:

Modelling results using data from 2010-11 to 2021-23 published by Ofwat as part of the April 2023 base cost model consultation plus 2022-23 data from APRs.

We use the model specifications that Ofwat proposed in the April 2023 consultation with the addition of the wage variable highlighted in blue.

We derived the wage variable from ONS ASHE data for hourly wages, workplace-based and for the relevant sectors Water supply; sewerage, waste management and remediation, Construction, Information and communication, Professional, scientific and technical activities, and Administrative and support service activities.

### Table 9. Adjustment Ofgem wage pre-modelling adjustment

| Company | Water | Wastewater | Total |
|---|---|---|---|
| ANH | 23.81 | 26.60 | 50.41 |
| HDD | -0.05 | -0.29 | -0.33 |
| NES | -3.15 | -26.98 | -30.13 |
| NWT | 14.67 | 14.80 | 29.47 |
| SRN | 26.03 | 28.70 | 54.73 |
| SVE | -16.71 | -27.97 | -44.69 |
| SWB | 5.64 | -2.16 | 3.48 |
| TMS | 16.91 | 64.58 | 81.48 |
| WSH | -1.10 | -14.76 | -15.86 |
| WSX | 2.84 | -3.08 | -0.24 |
| YKY | -23.68 | -24.80 | -48.48 |
| AFW | 12.15 | 34.64 | 46.79 |
| BRL | -6.51 | | -6.51 |
| PRT | 0.44 | | 0.44 |
| SES | 4.67 | | 4.67 |
| SEW | 36.13 | | 36.13 |
| SSC | -3.34 | | -3.34 |

Notes:
Results for Southern Water are highlighted in blue.
Modelling results using data from 2010-11 to 2021-23 published by Ofwat as part of the April 2023 base cost model consultation plus 2022-23 data from APRs.
We use the model specifications that Ofwat proposed in the April 2023 consultation with the addition of the wage variable highlighted in blue.
We derived the wage variable from ONS ASHE data for hourly wages, workplace-based and for the relevant sectors Water supply; sewerage, waste management and remediation, Construction, Information and communication, Professional, scientific and technical activities, and Administrative and support service activities.