Severn Trent

Rationale, evidence base and impact of potential Severn Trent and Hafren Dyfrdwy cost modelling claims for PR19

Report

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ARUP

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1 Introduction

Arup was commissioned by Severn Trent to undertake analysis on potential cost modelling claims for PR19 that would inform Severn Trent and Hafren Dyfrdwy's special cost factor submissions to Ofwat in May 2018.

This report sets out the analysis and rationale for the claims, drawing on the models published by Ofwat as part of the 'Cost Assessment for PR19' consultation and the models developed by Severn Trent. It focuses on Severn Trent and Hafren Dyfrdwy's specific circumstances within the industry. At this stage, it is unclear what final models Ofwat would use to determine efficient wholesale costs at PR19. Therefore, the impact assessment analysis uses as a baseline the model assumptions made by Severn Trent in their response to Ofwat's `Cost assessment for PR19 - a consultation on econometric cost modelling'.

2 Severn Trent

We have identified three potential cost modelling claims for Severn Trent in light of the recent modelling consultation published by Ofwat and Severn Trent's unique characteristics. These claims are:

1. Economies of scale at water treatment works (WTWs);
2. Economies of scale at sewage treatment works (STWs); and
3. Wastewater treatment complexity.

Depending on Ofwat's final selection of models for PR19, there could be additional cost modelling claims identified. Substantive comments on model coverage are currently being addressed in Severn Trent's consultation response to Ofwat's draft models.

This report only focuses on the three claims set out above.

2.1 Economies of scale at water treatment works (WTWs)

Rationale

Economies of scale can be driven by the relative dispersion of population, geographical constraints and WTW asset history. They have a strong and complicated interaction with totex required, and differ at network and treatment level. We consider that it is most appropriate to use population density metrics to represent the clearly verifiable network economies of scale cost drivers. The more complicated effect of economies of scale on treatment costs should be considered more directly through an asset size metric (with appropriate care taken to account for the systemic differences between surface water (SW) and groundwater (GW) treatment assets). This would also serve to disentangle the effect from network density.

As the number of water treatment works increases for a given company size (processing a certain fixed amount of distribution input), costs can be expected to rise due to diseconomies of scale. However, as the size of WTWs increases, companies can benefit from economies of scale as a result of reduced maintenance and opex unit costs. These opportunities for economies of scale will increase in part with increasing population density as large demand centres form. However, they are also strongly influenced by geography and history:

- **Geography**: Groundwater source location and size is constrained by the location and potential yield of suitable aquifers. Surface water source abstraction locations and size are driven by fundamental availability of rivers and reservoir sites (in addition to their proximity to demand centres).
- **History**: Economies of scale of strategic long life assets are largely fixed once constructed. Therefore, they inevitably become disconnected from current population density- (and to a lesser extent geography) driven economies of scale. For example, the capacity of WTWs cannot easily be re-sized to

respond to growing urbanisation. Equally, boreholes cannot be moved in response to growing environmental pollution.

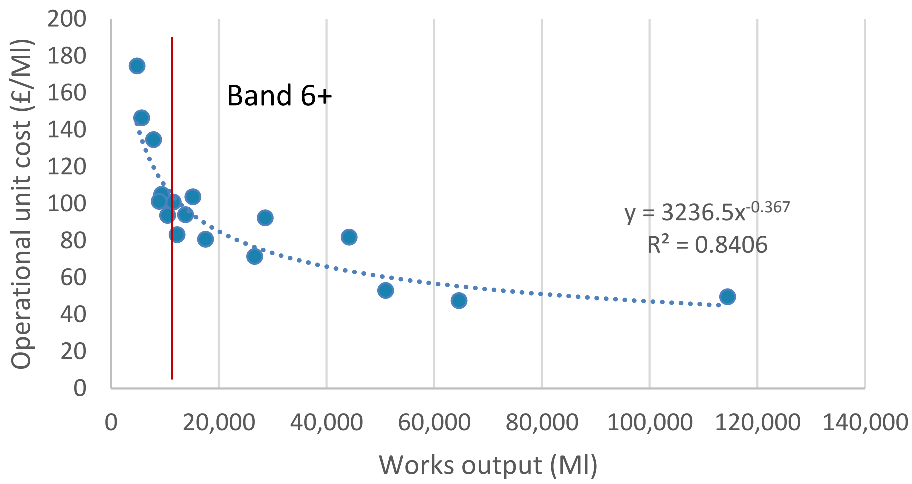
Population density fails to capture these aspects that are outside management control and would drive the ability to scale WTWs. Severn Trent's consultation response discusses the appropriate asset size driver in detail.

Evidence base and justification for modelling claim

In this section, we consider the empirical and statistical evidence of economies of scale at WTWs. The hypothesis is that companies with many small works can be expected to face higher costs than companies with a few large works when controlling for distribution input (DI). For example, WTWs in size bands 7 and 8, which consist of largest treatment works, would benefit from significant economies of scale in each of the above aspects, whilst smaller works do not experience economies of scale.

Figure 1 and Figure 2 below show the downward trend in unit costs as size of works increases for Severn Trent's surface water and ground water works. The operational costs presented consist of manpower, chemicals, (pumping and other) power, and other, encompassing both fixed and variable opex.

Figure 1: Total operational unit cost for surface WTWs

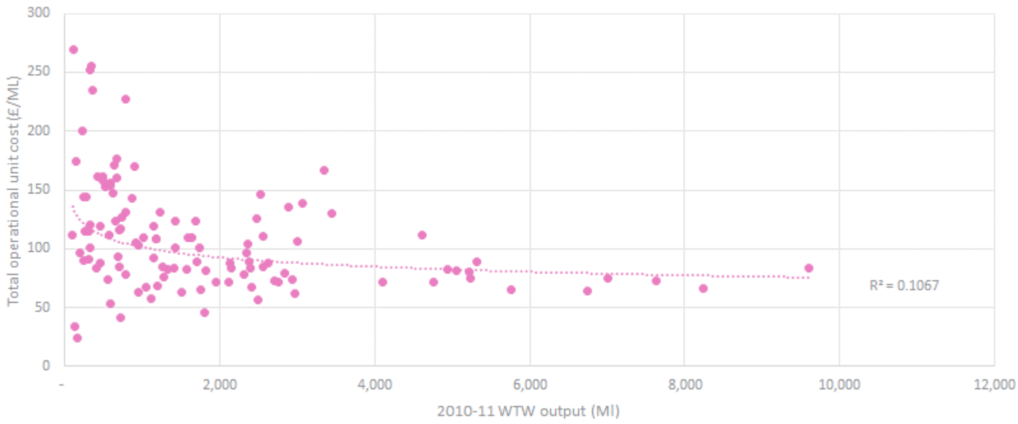


Source: Severn Trent

As can be seen above, there are significant economies of scale with unit costs reducing by 78% from the smallest to the largest surface WTWs with an R-squared of 0.84. We note that the trend continues even within Bands 6-8 (above 11,000 Ml), showing that economies of scale exist not only for small works.

Groundwater works are generally smaller than surface water works but we see economies of scale there as well, as shown in the figure below.

Figure 2: Total operational unit cost by borehole size



Source: Severn Trent

The distribution of unit costs is much wider for smaller works than for larger ones, suggesting that at larger scale, cost efficiencies are more achievable. For very small works, unit costs can be up to three times those of mid-size works, circa 10,000 Ml.

As evidenced by the data above, we expect that as the size of WTWs increases (or the number of works decreases), costs will decrease, holding distribution input constant. This can be viewed as treatment density, which is distinct from network or customer density and is often legacy-driven as discussed above. Consequently, a generic population density metric will not adequately account for this primary cost driver. However, the average size of works can be proxied by:

- The average capacity of groundwater works and surface works (separately, to account for materially different cost profiles); or
- The number of WTWs and their split into GW and SW (via a GW:SW ratio)

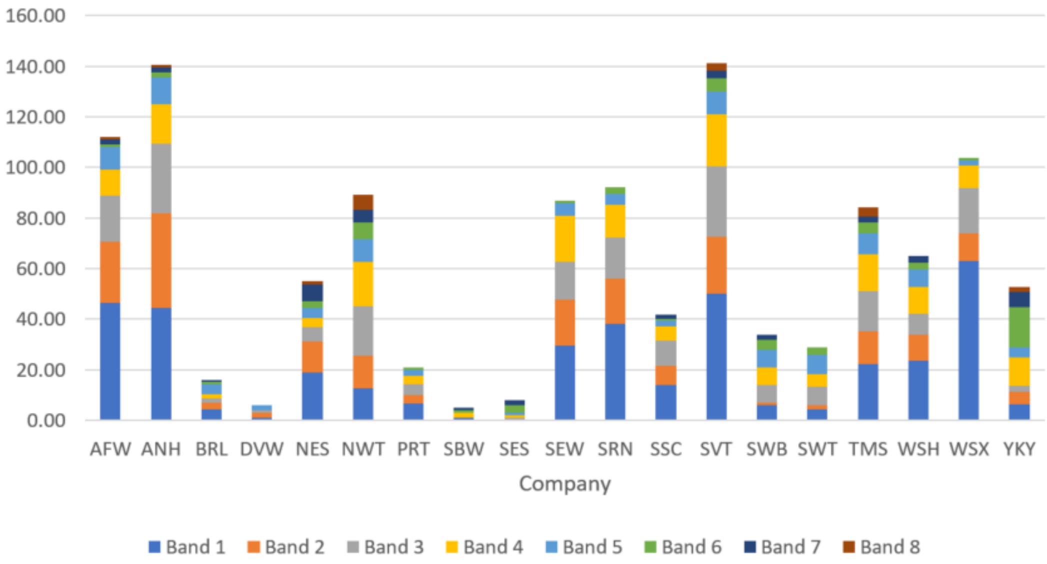
Including number of works, a normalised proxy, and the differentiation between size of GW and SW WTWs in models helps isolate the economies of scale at WTWs, allowing the population density variable to capture network or demand density. A priori, we expect the coefficient on economies of scale at treatment works to be positive if the model is correctly specified.

Outlier analysis

The figures above already show the varying economies of scale across SVT's surface water and groundwater works. Assuming that these cost relationships hold across the industry, it is worth considering how exposed SVT is to these legacy arrangements compared to other water companies.

As shown in Figure 1Figure 3 below, Severn Trent (SVT) rank 2nd in terms of number of WTWs in bands 1-6 across all 18 companies with 135 WTWs, mainly driven by its borehole works. Only 6 of SVT's works are in Bands 7 and 8.

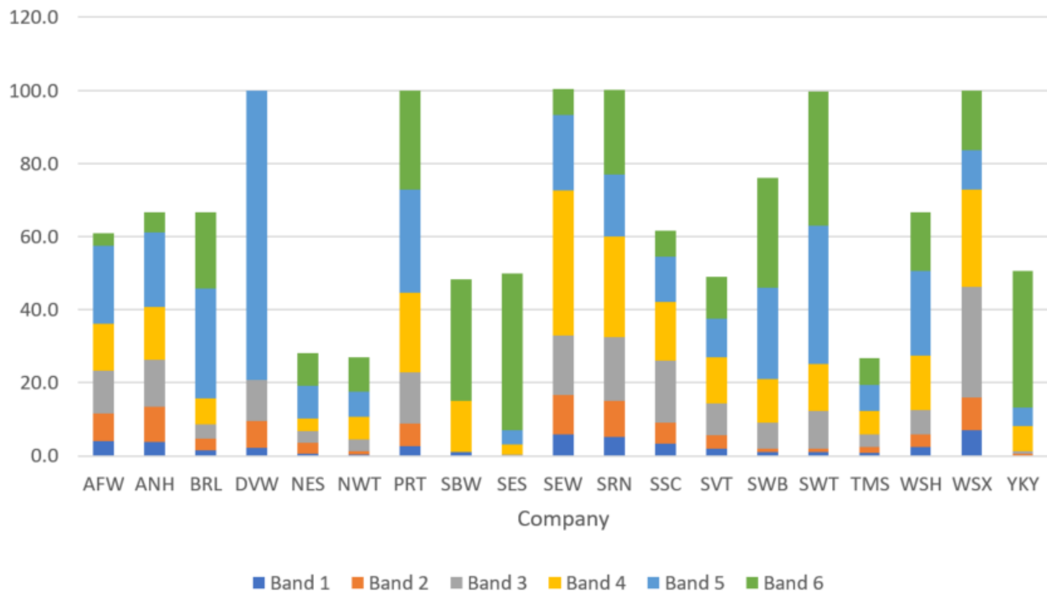
Figure 3: Number of WTWs by size band



Source: Ofwat Stata Master Wholesale Water, Cost Assessment for PR19, 2018

Similar to Wessex and Anglian, Severn Trent still has a significant proportion of its DI treated in Bands 1-6, circa 50%. Unlike other large WaSCs, it cannot take advantage of the economies of scale of larger works for 50% of the volumes it distributes. The remaining 50% is still not guaranteed to be able to take advantage of the economies of scale that WaSCs with the largest WTWs can achieve as SVT's largest WTW has output of under 120,000 Ml.

Figure 4: Percentage of DI by size band (%)



Source: Ofwat Stata Master Wholesale Water, Cost Assessment for PR19, 2018

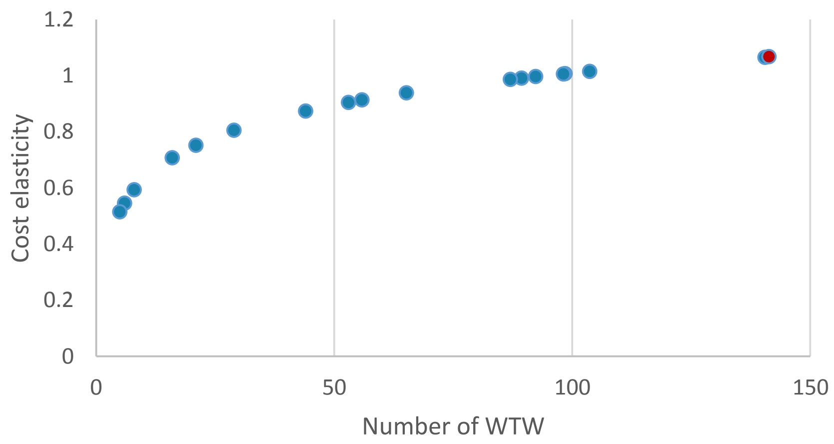
Allowed costs under Ofwat's model are likely to be lower if the variables discussed above are excluded, and since SVT is an outlier in terms of number of small works and has less scope for treatment economies of scale, it is likely to be more acutely impacted than the rest of the industry. This would also affect the overall efficiency estimate as the variation across the industry is significant (as demonstrated in Severn Trent's consultation response).

Model inclusion

Although the Ofwat 'network plus' models include scale variables such as the number of connected properties or length of mains and a population density (in only four of their models), there is no variable capturing economies of scale at treatment level. At the same time, treatment costs form 31% of 'network plus' botex for the industry. In this sense, Ofwat's models omit a significant cost driver for Severn Trent, which is likely to result in the pollution of the variables that are included in the models.

As an alternative, all SVT network plus models capture the elasticity of cost with respect to number of WTWs and the groundwater/surface water works ratio. As expected, the results indicate economies of scale since the coefficients are positive and less than 1. Additionally, in the 2 models where quadratic terms are included (SVTNP3 and SVTNP5), this elasticity is allowed to vary with the number of works, allowing for diseconomies of scale to be taken into account. It is expected that the quadratic variable has a positive coefficient to reflect diseconomies of scale via an increasing cost elasticity. This is seen to be the case in model 3 where the coefficient on the squared term is significant. As shown in the below graph, which charts cost elasticity with respect number of WTWs for each company, SVT is one of 5 companies to experience diseconomies of scale at the water treatment level – elasticity of 1.07 (in red). The ratio of GW:SW works is controlled for in all Severn Trent models.

Figure 5: Cost elasticity with respect to number of WTWs



Source: Severn Trent

Impact analysis and size of adjustment

Ofwat 'network plus' and wholesale models are highly unstable due to omissions of some primary cost drivers. We therefore focus our impact analysis on the treatment models and on Severn Trent's consultation models, which we consider to be less prone to coefficient switches because they are more appropriately specified for treatment-focused analysis.

We have tested the impact of omitting economies of scale at WTWs in the following ways:

1. Including the average capacity of GW and average capacity of SW in the Ofwat 'treatment' models (OWT1-6) as these models have only treatment drivers;
2. Including number of WTWs/property and GW/SW ratio in the Ofwat 'treatment' models (OWT1-6); and
3. Removing both number of WTWs and the ratio of GW/SW from all SVT 'network plus' models (SVTNPW1-7).

Our hypothesis across all is that the models that take into account economies of scale at treatment works would result in higher allowed costs. The average results across models are set out in the table below. They assume UQ efficiency challenge, applied after triangulation.

Table 1: Impact analysis

Approach	Driver	Impact (£m, 2016/17 prices)
Impact on Ofwat treatment models	Average capacity of SW and average capacity of GW WTWs	£51m
Impact on Ofwat treatment models	Number of WTWs/property and ratio of GW/SW	£32m
Impact on SVT models	Number of WTWs and ratio of GW/SW	£81m[1]

Source: Arup and Severn Trent analysis

We therefore consider that the potential size of the adjustment required would be in the range of **£32-81m**. The exact position in the range would depend on the final specification of the Ofwat models used for PR19.

[1] This is £74m in 2012/13 prices.

2.2 Economies of scale at sewage treatment works (STWs)

Rationale

The rationale for economies of scale at STWs is similar to that in water. Population density metrics are typically used as proxies for opportunities for economies of scale. Similar to water, economies of scale exist not only at network level but also at treatment level. Unit costs of wastewater treatment are expected to decrease as sewage treatment works increase in size since maintenance and opex costs can be spread over greater load. However, population density does not fully capture the opportunity for treatment economies of scale. They will also be strongly influenced by geography and history:

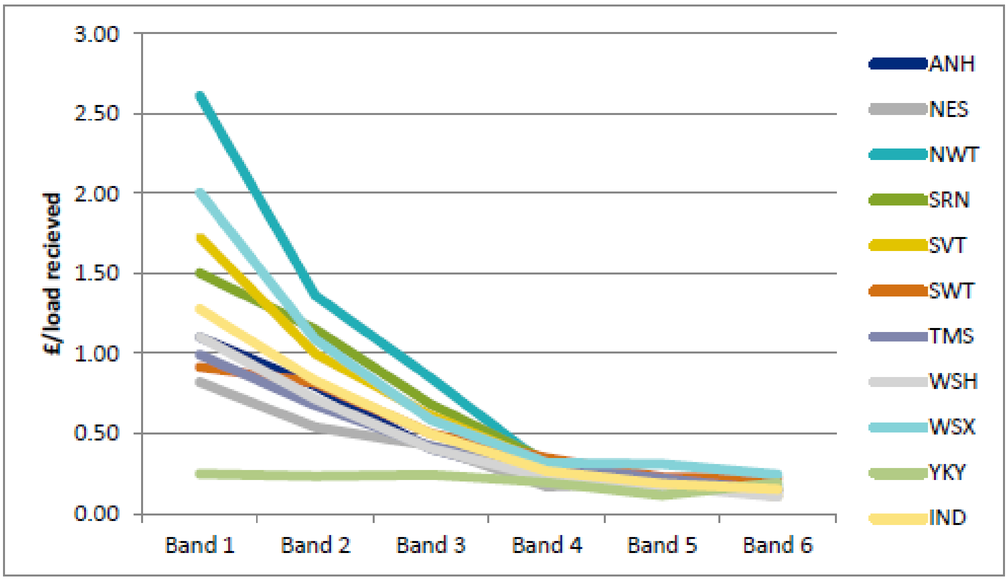
- **Geography**: The availability of an appropriately sized receiving water with capacity to take nutrient load. Whilst theoretically a constraint, this is typically overcome by installing higher levels of treatment.
- **History**: Economies of scale of strategic long-life assets are largely fixed once constructed. Therefore, they inevitably become disconnected from current population density (and to a lesser extent geography) driven economies of scale. For example, whilst some processes may be expanded in a modular fashion, the size of STWs is likely to be constrained, e.g. by the diameter of the strategic trunk sewers that feed them.

Ceteris paribus, failing to account for treatment economies of scale would particularly disadvantage companies that have a disproportionate number of small works (including Severn Trent) since they would be less likely to benefit from unit cost reductions.

Evidence base and justification for modelling claim

The figure below illustrates how treatment unit costs reduce as size of works increases. A consistent trend across the industry is visible.

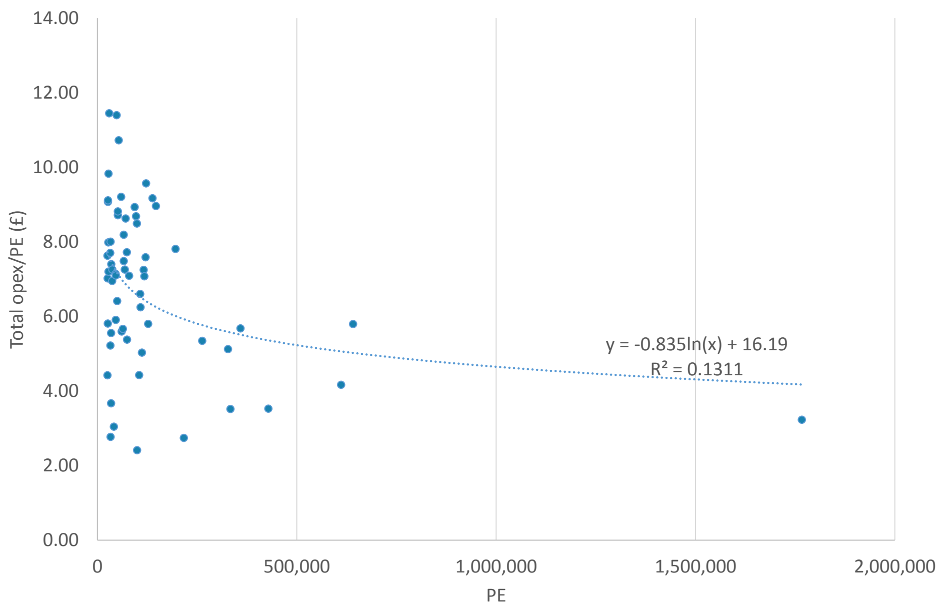
Figure 6: Direct unit costs by band (2015-16)



Source: Jacobs, Wastewater Treatment Cost drivers, 2017.

The figure below zooms in on the individual Band 6 works data for Severn Trent, demonstrating that there is significant economies of scale even with the highest band (the scatter is likely to be related to varying levels of treatment that should be captured by an appropriate complexity driver). Therefore, assuming a consistent unit cost (per population equivalent, PE) is delivered at all Band 6 works would be unrealistic.

Figure 7: Total operating unit cost by works size (Band 6 only)



Source: Severn Trent

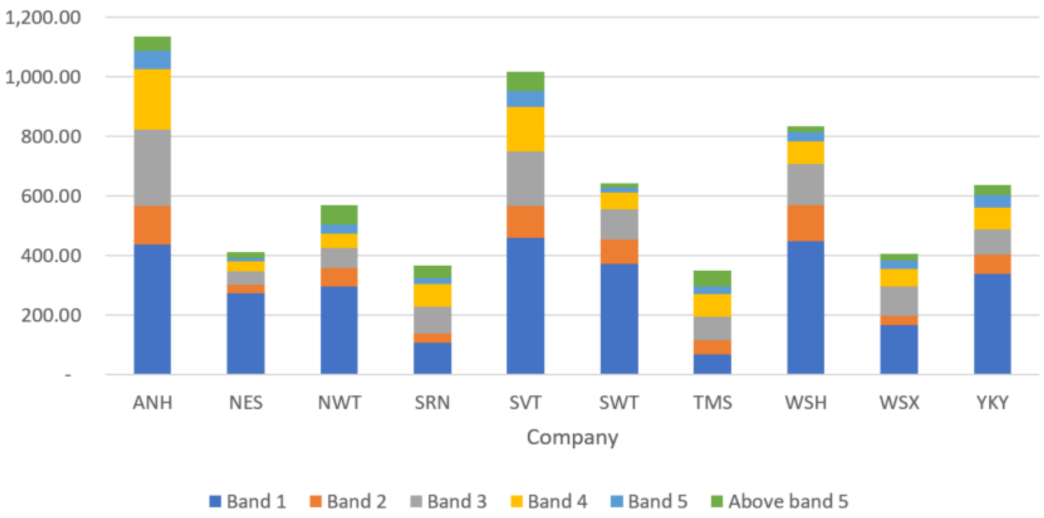
We consider that total number of STWs is also a good indicator of treatment economies scale. Companies with a significant number of works are likely to have more works in the lower bands. Including a driver like total number of STWs or number of STW/property would also serve to isolate the treatment density effect (a proxy for geographical constraints and historical assets), allowing the population density variable in the models to purely capture network density.

A proxy for economies of scale at treatment level should be included in the models. We expect that the coefficient on this variable would be positive and less than 1 to reflect economies of scale.

Outlier analysis

SVT has 899 STWs in bands 1-4, placing it in the top 2 WaSCs in terms of number of small STWs, after Anglian. While these works only treat 20% of load, they have much higher unit costs than large works as set out in the previous section.

Figure 8: Number of Sewage Treatment works by size band

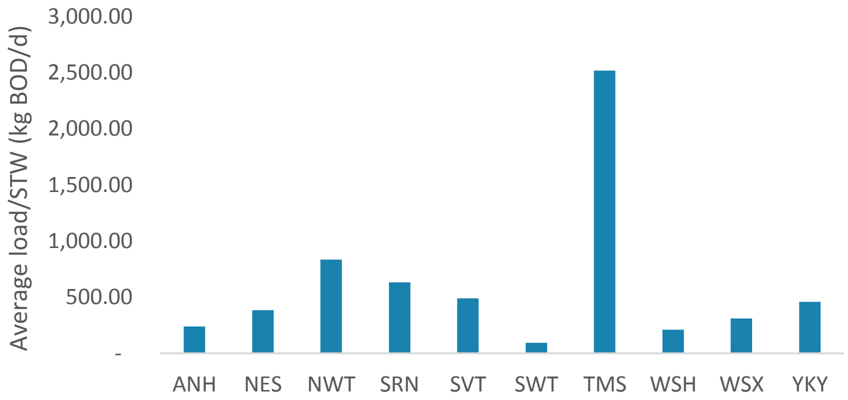


Source: Ofwat Stata Master Wholesale Wastewater, Cost Assessment for PR19, 2018

As a result, SVT is likely to be disproportionately impacted by the exclusion of economies of scale at the treatment level. We can particularly see that SVT has the highest number of Band 1 works in the industry – five times higher than Thames, for instance.

In addition, SVT has relatively small works above Band 5. As demonstrated in the figure below, the average size of STW in the largest band for SVT is below 500kg BOD/d. This is more than five times lower than the average size of Thames' large STW and still lower than United Utilities' and Southern's.

Figure 9: Average size of STW above Band 5



Source: Ofwat Stata Master Wholesale Wastewater, Cost Assessment for PR19, 2018

Overall, we expect that SVT would be disproportionately disadvantaged if economies of scale at STWs is not appropriately taken into account in the PR19 models.

Model inclusion

The need for an adjustment would come from the exclusion of the driver from likely Ofwat models. We note that at this stage, there is no confirmation which models Ofwat would use at PR19 and we therefore explore a range of scenarios based on the latest consultation.

Economies of scale at treatment level is not necessarily a new consideration. At PR14, Ofwat partially controlled for it via the inclusion of a variable capturing proportion of load treated in STW size bands 1-3.

The size band 1-3 metric is used again in the Ofwat wholesale and disaggregated treatment consultation models. It captures the proportion of load that is most effected by diseconomies of scale, such that companies with a higher proportion incur higher costs. However, this essentially infers that no further economies of scale exist over and above the very smallest STWs. As seen in Figure 7 above, this is not theoretically justifiable or supportable based on observed data.

In the Ofwat network plus consultation models, neither size nor number of works are controlled for. As a result, we expect that treatment economies of scale to be either not accounted for (network plus) or only partly accounted for (disaggregated treatment and wholesale models). The population density effect is still not fully disentangled.

At the same time, SVT include economies of scale in sewage treatment in all five models published in the consultation. The coefficient is positive, less than 1 and significant in each SVT model.

Impact analysis and size of adjustment

We have tested the impact of omitting key variables related to economies of scale at treatment level, which are key to SVT's operations and costs. We have approached this in two ways:

1. Including a proxy in the Ofwat 'network plus' models (ONPWW1-3 as we focus on models with network density taken into account)[2]; and
2. Including Bands 1 to 3 driver in the treatment models (which partially allows for EOS) instead of the number of STWs (which fully allows for EOS) in the SVT models (SVTNPWW1, SVTNPWW4, SVTNPWW5)[3].

Our hypothesis across all is that the models that take into account economies of scale at treatment works would result in higher allowed costs. The table below shows the results. All figures assume UQ efficiency challenge, applied after triangulation.

Table 2: Impact analysis

Approach	Driver	Impact (£m, 2016/17 prices)
Include driver in Ofwat 'network plus'	Number of STWs	£44m
Impact on SVT models	Number of STWs instead of proportion of load in Bands 1-3	£119m

Source: Arup and Severn Trent analysis

There is no perfect way of estimating the impact and therefore the size of the adjustment. However, we consider that there is merit in each of the approaches above and considering that at this stage it is unclear what the final Ofwat models would be, the potential claim can range from **£44-119m**. The true position within that range would depend on the final model specifications.

[2] We note that as a basis for the testing undertaken on model ONPWW2, the load variable is defined as suggested by Severn Trent in the consultation response, not as originally calculated in the Ofwat dataset.
[3] Again, we note that all these models have been run with a recalculated load variable as set out in Severn Trent's consultation response.

2.3 Wastewater Treatment Complexity

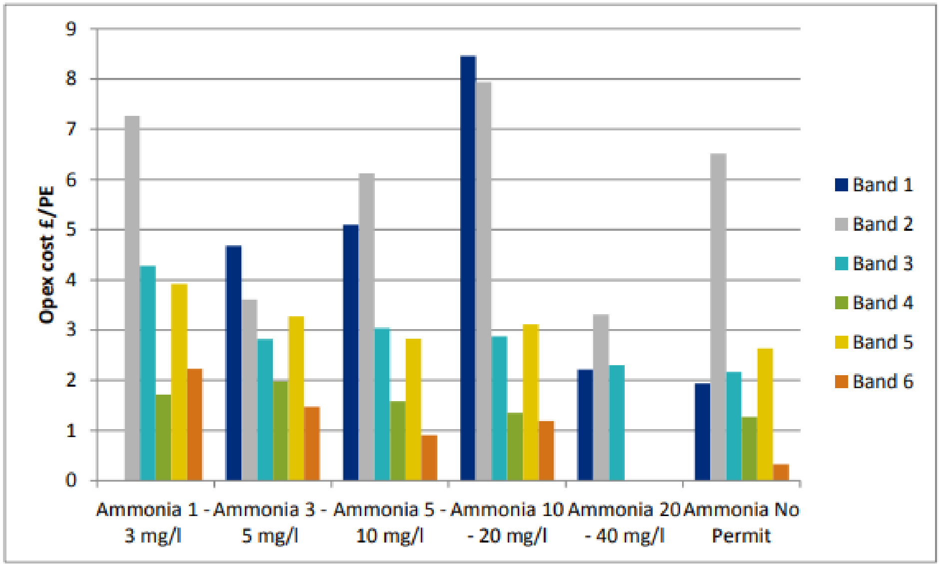
Rationale

Treatment costs are driven by the load to be treated and the standard to which it must be treated. The more stringent the quality requirements, the more complex the treatment process (and more energy-intensive), the higher the wastewater treatment cost. Hence, we expect a positive relationship between cost and any complexity variables included. The choice of the complexity variable is also key as set out in Severn Trent's consultation response.

Evidence base and justification for modelling claim

One of the drivers of complexity considered by both Ofwat and Severn Trent is the tightness of ammonia consent. The graph below, which shows opex per population equivalent (PE) for ammonia consents of varying tightness, demonstrates that load subject to consents in the range of 1-3mg/l is more expensive on a unit cost basis than looser consents across the majority of size bands.

Figure 10: Unit cost by tightness of ammonia consents



Source: Jacobs, Wastewater Treatment Cost drivers, 2017

The analysis by Jacobs in Table 2 shows the proportion of load within certain ammonia consent ranges. The majority of companies do not have ammonia consents below 1mg/l, except Northumbrian and Thames and that still makes a small part of the load that needs to meet those standards. Instead, a significant proportion of load needs to be treated to between 1-3mg/l and 3-10mg/l. SVT, in particular, has 87% percent of its load in these categories.

Table 2: Proportion of load treated by ammonia consent range

	Ammonia <= 1mg/l	Ammonia >1 to <=3mg./l	Ammonia >3-<=10mg/ l	Ammonia >10mg/l	Ammonia no permit
ANH	0.0%	13.4%	47.2%	16.4%	22.9%
NWT	0.0%	2.5%	13.2%	23.5%	60.8%
NES	14.7%	29.2%	27.7%	6.7%	21.8%
SRN	0.0%	12.4%	15.4%	10.9%	61.3%
SVT	0.0%	**46.3%**	**42.8%**	7.2%	**3.7%**
SWT	0.1%	0.9%	29.9%	13.8%	55.3%
TMS	5.3%	80.2%	13.0%	1.1%	0.4%
WSH	0.0%	1.9%	21.6%	43.6%	32.9%
WSX	0.0%	4.1%	42.4%	13.3%	40.2%
YKY	0.0%	40.7%	34.3%	9.1%	15.9%

Source: Jacobs, Wastewater Treatment Cost drivers, 2017

It is true that STWs with consents of 1 Mg/l will require complex and costly treatment processes. However, delivering against a 3Mg/l consent will require a commensurate technological process.

In addition to the proportion of load subject to tight ammonia consents (defined as <3 mg/l or 1 mg/l), other treatment complexity proxies would be:

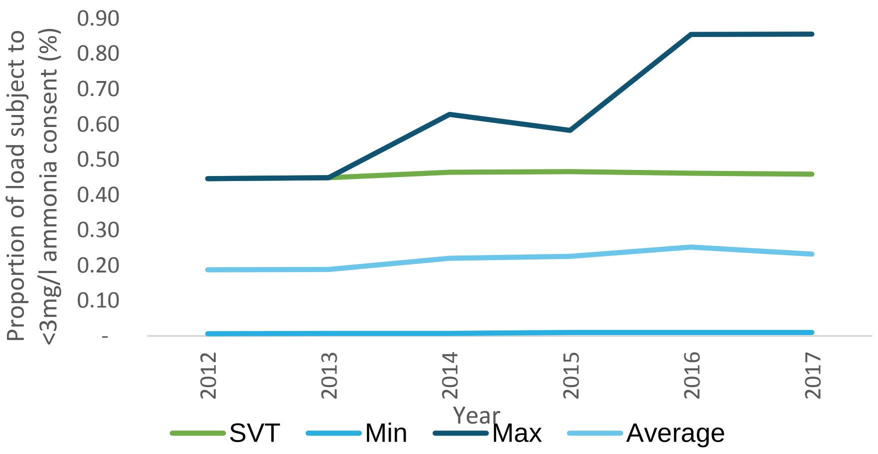
- Tight BOD permits;
- The number of band 6 works that have a tertiary treatment stage; and
- Proportion of load subject to tight BOD consents.

We consider that the 'network plus' or the wholesale model needs to take into account treatment complexity to correctly capture treatment costs and if it does not, SVT allowed costs would require an adjustment.

Outlier analysis

SVT is in the top 2 for both the proportion of its load received that is subject to ammonia consents of <3mg/l and the number of tight BOD and ammonia permits. As can be seen in the below graph, SVT have more than double the average proportion of load that is subject to ammonia consents of <3mg/l.

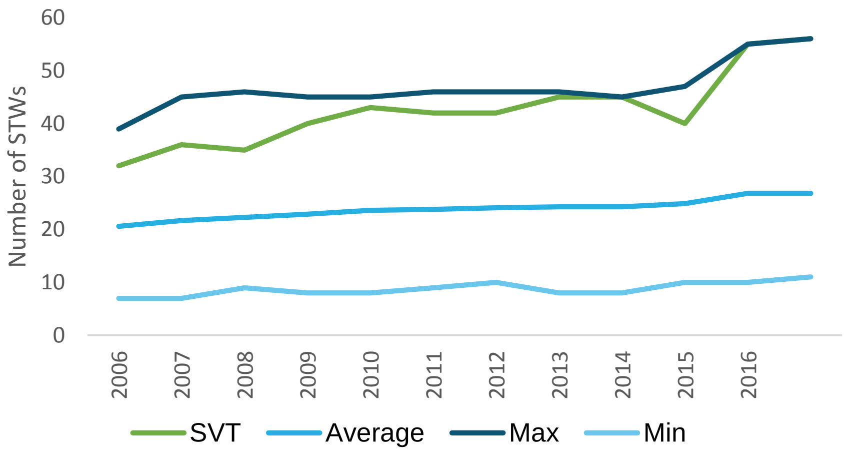
Figure 11: Proportion of load received subject to tight (<3mg/l) ammonia consents



Source: Severn Trent

Similarly, SVT rank in the top 3 in terms of average number of large works with a tertiary treatment stage, having more than double the average as can be seen from the graph below. Therefore, we expect that if treatment complexity is not taken into account appropriately, SVT would be disproportionately affected compared to other WaSCs.

Figure 12: Number of large (band 6) STWs with tertiary treatment stage



Source: Severn Trent

Model inclusion

Ofwat models treatment complexity using percentage of load subject to ammonia consent of <1mg/l, which it includes in only two of its 10 'network plus' models. This variable is also included in four of the six disaggregated Ofwat treatment models. The rest of the models take no account of treatment complexity.

This variable is very narrowly specified as shown in the section above and only accounts for a minimal proportion of consent-related treatment (as it only impacts

15% of Northumbrian load and 5% of Thames load). This essentially means that 98% of load is removed under 1mg/l, while a similarly high proportion of load is removed for 3mg/l (94%). The relative cost increase when consents decrease to <3mg/l (compared to a 10mg/l consent) have a more substantial marginal impact than the move to <1mg/l. This is further reinforced via a model run of Ofwat model ONPWW10 altered to use ammonia consents of <3mg/l rather than <1mg/l. The coefficient on the complexity variable increases from 0.018 by over a factor of 10 to 0.25, capturing a much greater differential in elasticity from that step change.

Table 3: Model runs with different ammonia consent definitions

Driver	Ofwat ONPWW10	Sensitivity ONPWW10
ln (load)	0.69	0.66
% of load, ammonia consent < 1mg/l	0.018	
% of load, ammonia consent < 3mg/l		0.25
% lengths of sewer laid post 2001	-0.016	-0.02
Constant	10.6	10.96

Source: Arup and Severn Trent analysis

We therefore consider it important to expand the treatment complexity variable definition that Ofwat uses in its consultation and to include it explicitly in all models to capture Severn Trent's costs correctly. We consider that the sparse specification of the published Ofwat models would allow that. There are multiple ways to do so. For example, SVT capture treatment complexity in each of the four models published as part of the consultation; the models use a combination of tight BOD and ammonia permits in two models, proportion of load subject to tight ammonia consents (defined as <3mg/l) in one model, and the number of band 6 works that have a tertiary treatment stage in one model.

Impact analysis and size of adjustment

Considering that SVT appears to be an outlier, we hypothesise that it would be particularly negatively impacted were Ofwat to only include a narrowly defined complexity driver in its models. We have tested the impact of changing how complexity is defined by performing the following sensitivities:

1. Comparing Ofwat treatment models (OSWT3-6)[4] with complexity defined as per Ofwat standards (<1mg/l) versus SVT ammonia consents (<3mg/l) to look at the impact of consent stringency; and

[4] We note that the load variable used here has been recalculated by Severn Trent.

2. Comparing Ofwat 'network plus' models (ONPW9-10)[5] with complexity defined as per Ofwat standards (<1mg/l) versus SVT ammonia consents (<3mg/l) to look at the impact of consent stringency; and
3. Changing the driver in the SVT models (SVTNPWW4-5) to 1mg/l.

We expect that predicted costs would be higher when complexity is included and when consents are tighter. The table below summarises the testing results.

Table 4: Impact analysis

Approach	Driver	Impact (£m, 2016/17 prices)
Ofwat consent vs SVT consent stringency in Ofwat treatment models	% of load with ammonia consent <1mg/l vs 3mg/l	£84m
Ofwat consent vs SVT consent stringency in Ofwat 'network plus' models	% of load with ammonia consent <1mg/l vs 3mg/l	£130m
Impact on SVT models of using less stringent consents	% of load with ammonia consent <1mg/l	£66m

Source: Arup and Severn Trent analysis

We note that the potential size of the adjustment required would depend on the final specification of the PR19 models but we consider it could possibly be in the range of **£66-130m**. This assumes that Ofwat would include a treatment complexity variable in all models.

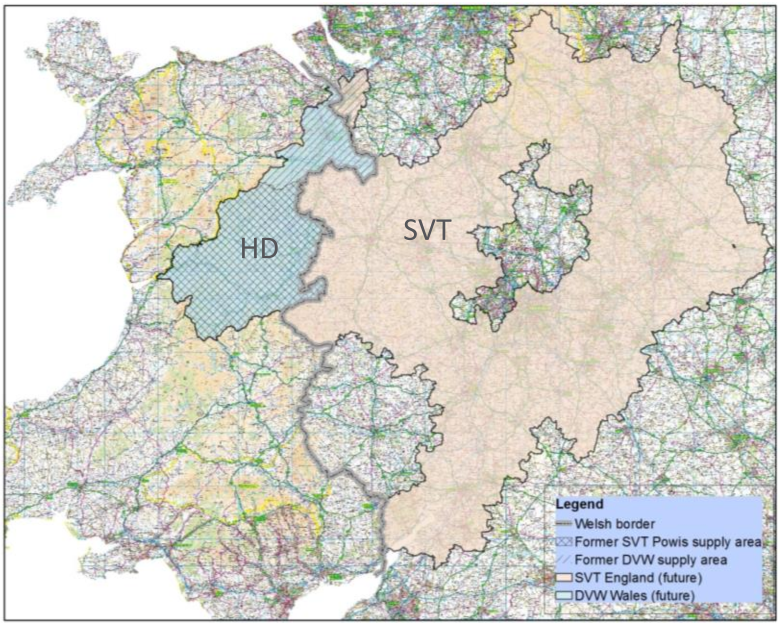
[5] We note that the load variable used here has been recalculated by Severn Trent.

3 Hafren Dyfrdwy (HD)

3.1 Water - size and rurality

HD Water is the newly formed business, comprising the DVW catchments in Wales (removing DVW catchments in England) plus the old Severn Trent catchments in Wales.

Figure 13: HD and SVT area of operation



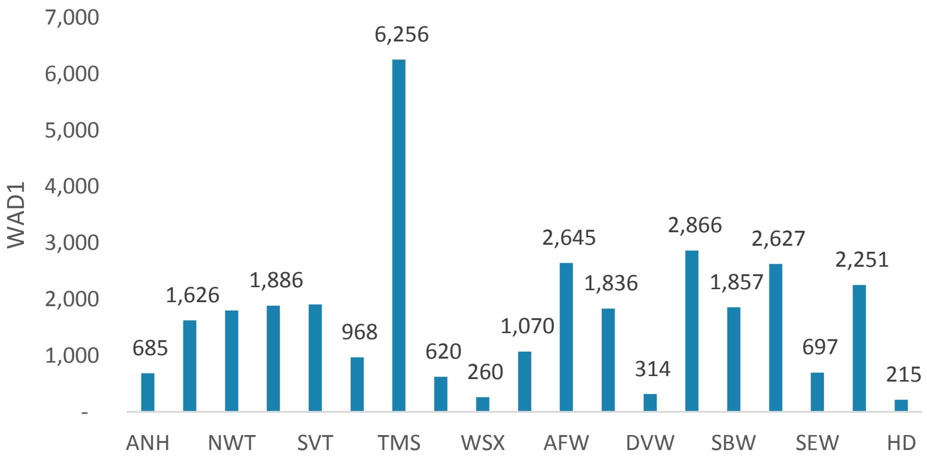
Source: Severn Trent

Outlier analysis

HD Water and its predecessor DVW are industry outliers both in terms of rurality and size.

HD Water is the sparsest company in the industry with Wessex being a close second. HD Water is less dense than the old DVW because Chester (ex-SVT) has a higher population density than Powys (ex-DVW). The new company covers a supply area three times the size of the DVW supply area (2,856 km^2), which has significantly reduced the density. As seen in the figure below, this has reduced the weighted average density from 314 to 215. However, even without considering the company's updated borders, DVW was the second least dense company after Wessex and far below the industry lower quartile.

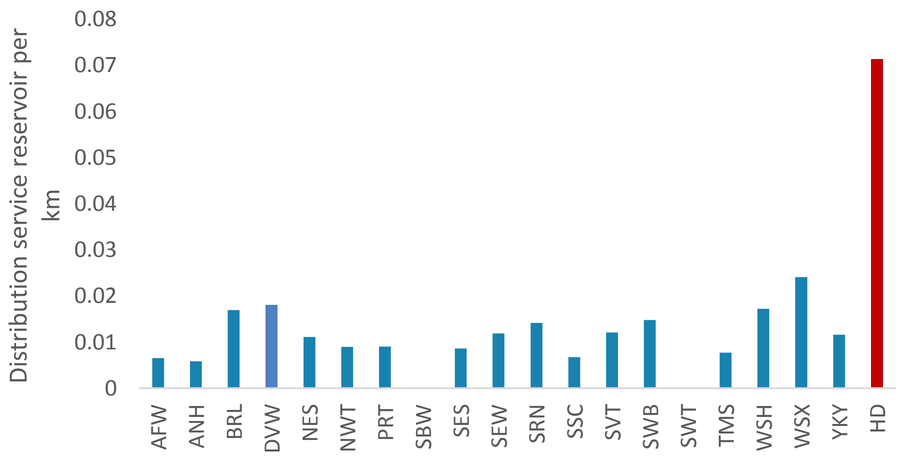
Figure 14: Weighted Average Density (2015-16)



Source: Ofwat density estimation

Because it is rural, HD also has a high number of service reservoirs, which require maintenance and operation. The industry comparison is shown below with HD being five times higher than the industry average.

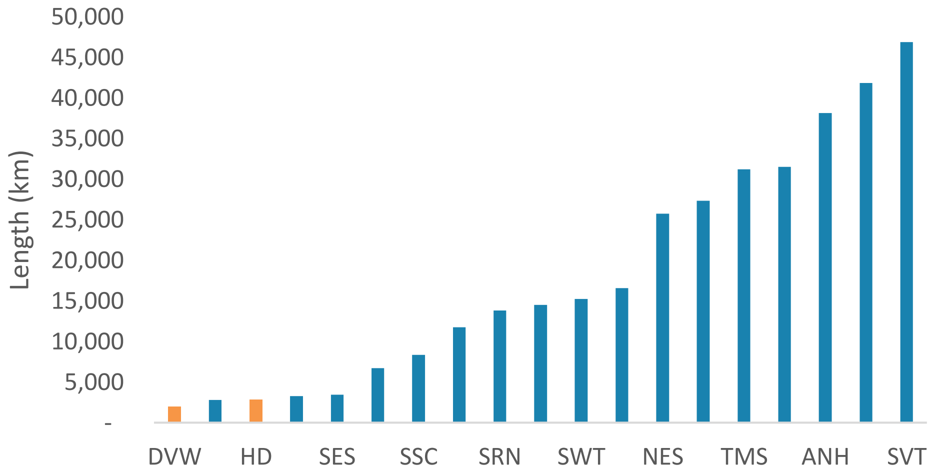
Figure 15: Density of service reservoirs (2016/17)



Source: Ofwat Stata Master Wholesale Water, Cost Assessment for PR19, 2018 and Severn Trent

HD is also the smallest company by totex and the second smallest by length of mains in the industry, although slightly larger than DVW, as can be seen in the figure below.

Figure 16: Network length



Source: Ofwat Stata Master Wholesale Water, Cost Assessment for PR19, 2018 and Severn Trent

Rationale

Operating a highly rural network with numerous service reservoirs incurs higher maintenance and operational unit costs than operating an averagely dense network. At the same time, small companies face lumpy maintenance expenditure that would lead to a different relationship between size and cost from the one modelled for average or large companies. We therefore consider that to properly capture both the lack of economies of scale at the company level and density / network complexity for a small company, like HD, a model should take into account varying returns to scale or an adjustment needs to be made for HD Water.

Model inclusion

None of the models proposed by Ofwat in the consultation include varying returns to scale. Furthermore, only half of the Ofwat ‘network plus’ models include a density variable. However, we note that the models include various combinations of booster stations or service reservoirs/water towers per length, which proxies HD’s increased asset distribution assets. If this variable is included, we consider that it is unlikely for a cost claim to arise.

Impact analysis and size of adjustment

To estimate the size of a potential adjustment required, we have focused on comparing the Severn Trent models without and without varying economies of scale and density and on the impact of the booster and service reservoir variables:

1. Impact of squared terms: Subtract botex estimate of SVTNPW1 from SVTNPW2 and SVTNPW3 respectively[6];
2. Impact of booster stations/service reservoir density: remove these drivers from Ofwat models OWW5 and OWW6 (essentially comparing to OWW4; and
3. Impact of booster stations/service reservoir density: remove these drivers from Ofwat models ONPW3, ONPW4, ONPW6.

The table below summarises the results. They assume UQ efficiency targets.

Table 5: Impact results

Approach	Driver	Impact (£m, 2016/17 prices)
Impact of squared terms on SVT models	Ln(length)^2 Ln(density)^2	£28-44m
Impact of booster stations or service reservoir density in Ofwat wholesale models	Booster stations/km Service reservoirs/km	£33-42m
Impact of booster stations or service reservoir density in Ofwat 'network plus' models	Booster stations/km Service reservoirs/km	£14-26m

Source: Arup and Severn Trent analysis

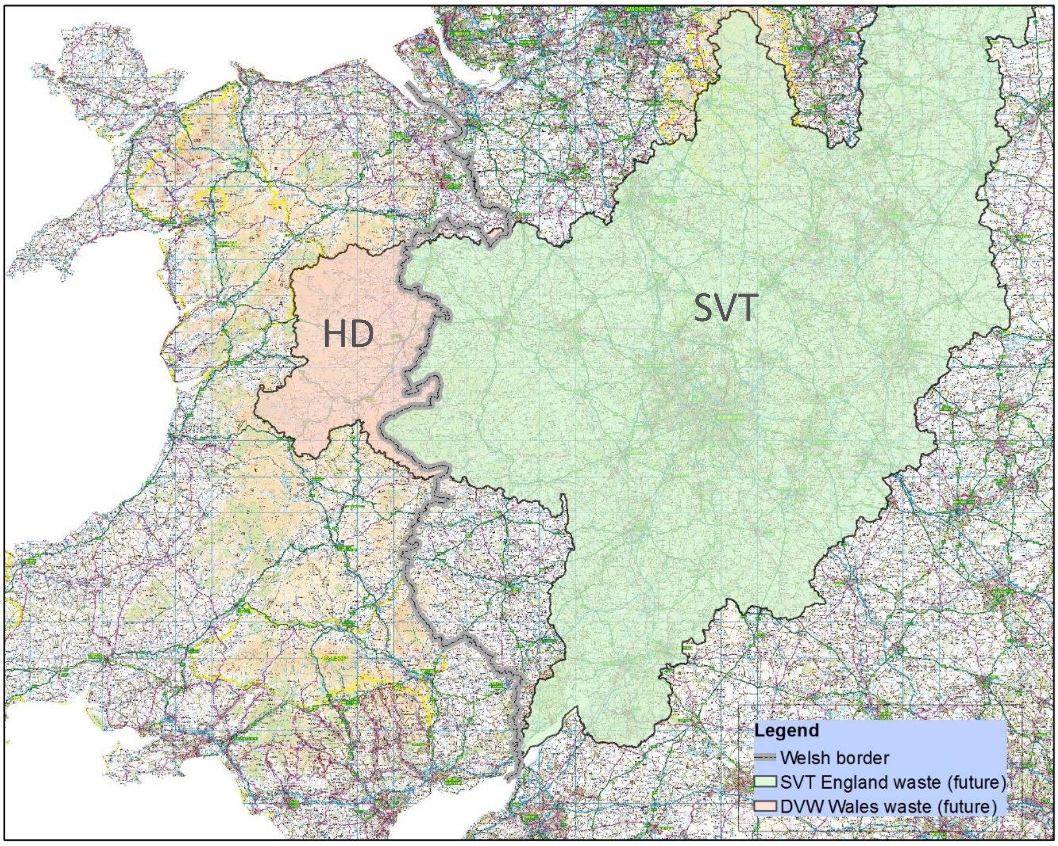
We therefore expect the adjustment to be in the range of **£14m-£44m.** The exact adjustment required would depend on the final specification of the PR19 models.

[6] Focusing on model that include a density variable as set out in Severn Trent's consultation response.

3.2 Wastewater – size and rurality

HD also has a wastewater business formed out of the merger of Severn Trent and Dee Valley. The boundaries of HD wastewater are shown in the map below.

Figure 17: HD wastewater boundaries



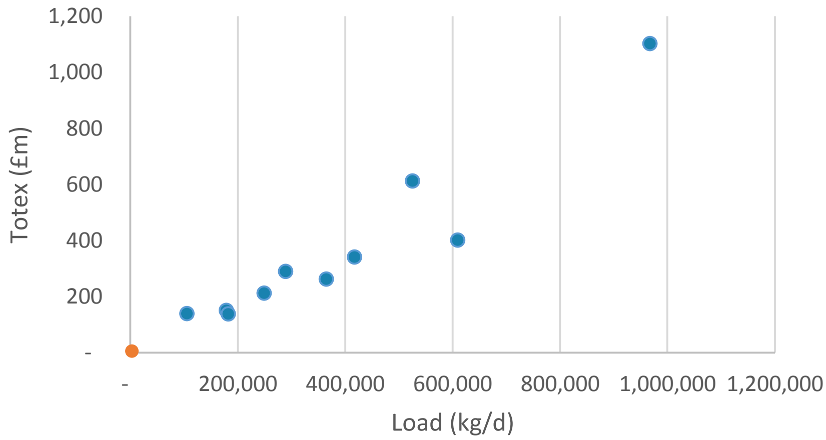
Source: Severn Trent

HD is a new WaSC and would require a separate price control determination from Severn Trent. As such, Severn Trent expects that HD's revenue will be set on a building blocks basis and would therefore require a cost allowance. Because of its highly unusual characteristics compared to other WaSCs, we consider that cost adjustments would be required to correctly capture HD's efficient totex.

Outlier analysis

HD Wastewater is a complete outlier compared to the other 10 WaSCs in terms of size, economies of scale and rurality/density. The diagram below shows its relative size to the rest of the industry in terms of load treated (orange dot at origin). HD Wastewater is around 30 times smaller than the next smallest WaSC (WSX) in terms of both network+ totex and load.

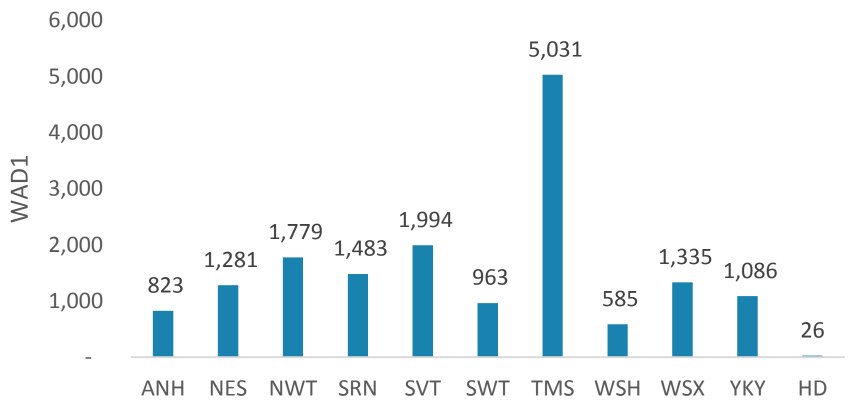
Figure 18: Wastewater industry 'network plus' distribution (2015/16)



Source: Ofwat Stata Master Wholesale Wastewater, Cost Assessment for PR19, 2018 and Severn Trent

This stark difference holds for other drivers as well, e.g. density. HD Wastewater operates in a very rural area, all driven by one local authority district (Powys), it is much more sparse than the rest of the industry with weighted average density of 26 vs industry average of 1,636.

Figure 19: Wastewater – weighted average density (2016-17)



Source: Ofwat density estimation

The network is small – 285km of Gravity sewer and served by 55 small STWs and no sludge treatment facilities or sludge RCV. Overall, HD Wastewater is a clear outlier in the industry and we consider that the coefficients in the wastewater Ofwat models would not be representative of the cost and driver relationships that HD faces in the absence of economies of scale at any level of its operations. We therefore consider it would be prudent to take an alternative approach to setting efficient costs for HD Wastewater.

Rationale

Severn Trent's initial attempt to run models for HD does not give coherent results. This suggests that modelling at this scale is likely to be problematic. We would therefore recommend making an adjustment to the HD Wastewater allowance and specifically basing it on pro-rata analysis of Severn Trent Wastewater, where the catchment used to sit previously.

Model inclusion

A review of the current Ofwat models suggests that they would be very punitive to HD since the density driver has a positive coefficient and economies of scale driver and rurality are not sufficiently taken into account.

Impact analysis and size of adjustment

As mentioned above, we consider that running the Ofwat models for HD is not likely to result in an efficient cost estimate for a WaSC of this size. We therefore estimate the impact and the required adjustment pro-rating SVT adjustments for scale. We note that the adjustment estimated in that way is likely to be lower than the true adjustment required for HD as it would assume that HD has similar asset sizing and density characteristics as the rest of SVT, whereas it is distinctly different (even if only looked on a density basis).

We consider that the Severn Trent models give better coverage for density, EOS and rurality than Ofwat's draft models. The difference between the Severn Trent and Ofwat models (scaled to HD) then would be at the bottom-range of the claim.

We estimate the impact in the following ways:

1. Pro-rata analysis using draft PR19 models (as described above); and
2. Calculating the gap between the rolled forward HD AMP6 'network plus' botex and the pro-rata estimate for HD, using Ofwat draft models for SVT (ONPWW9-10).

Based on a range of scale metrics (properties served, load, length of sewers, AMP6 totex), the HD wastewater business is on average 0.7% of the SVT wastewater business. We use this scaling factor for conversions from SVT to HD wastewater. The average allowance for HD (pro-rata of SVT allowance) across the proposed Ofwat network plus models is £10.5m.

However, the 'network plus' botex assumed in HD's current plan (which is based on rolling forward AMP6, is approximately £20m for AMP7. This would suggest that the size of the adjustment would be circa £10m.The table below summarises the results. They assume UQ efficiencies.

Table 6: Impact analysis

Approach	Driver	Impact (£m, 2016/17 prices)
Pro-rata analysis using PR19 models	Various	£1-2m
Gap between AMP7 efficient plan and potential Ofwat estimate for AMP7	N/A – current HD plan	£10m

Source: Arup and Severn Trent analysis

We therefore expect that the potential size of the adjustment could be from **£2-10m**. The pin-point in the range would depend on the approach Ofwat takes to estimating the efficient costs for HD wastewater.