PR24 cost assessment working group

Average pumping head, connected properties and ensuring quality data

Draft for discussion

7th September 2021

Ofwat

Agenda

(1) Welcome and housekeeping (13:00 to 13:05) 2

(2) Average pumping head
- Introduction (13:05 to 13:15)
- Daniel Haire, SES Water (13:15 to 13:30)
- Richard Goodwin, Anglian Water (13:30 to 13:40)
- Break out session (13:40 to 14:00)
- Feedback (14:00 to 14:10)

(3) Number of connected properties
- Introduction (14:10 to 14:20)
- Break out session (14:20 to 14:35)
- Feedback (14:35 to 14:45)

(4) Ensuring quality data (14:45 to 14:55)

(5) Closing remarks (14:55 to 15:00)

1. Welcome and housekeeping

2. Average Pumping Head, APH

Recap on APH

1. It gives an indication of **economic and operational challenges** companies face to pump water into, within, across and throughout the distribution system through **each element of the supply chain**.

2. It accounts for **each company's** bespoke water system infrastructure, topography and customer demand centres.

3. **It's complex** requiring comprehensive instrumentation, producing quality data, effective assurance to produce impactful management decision making information.

4. **It's been around a while** (June Return Chapter 12, Line 5: Average Pumping Head Total)

5. **Definition of APH** is included in RAG-2.08.pdf (ofwat.gov.uk) Appendix A1 with examples and further points to note and A2: Allocation of operating costs and capital costs for borehole pumping

6. APH is dynamic and requires continuous telemetry monitoring of levels, flows, pressures. Static 'top down' estimates should be minimised over time.

7. APH was **used at PR14** for cost modelling, **but not at PR19** due to robustness of results across the industry which led to the Number of Booster Pumping Stations being used instead.

8. **Changes to the guidance**. High lift pumping now reported under Treated Water Distribution and removal of DI as the standard denominator in favour of water entering each price control element (includes waste).

9. APH **reporting can be improved** and there are **opportunities to optimise APH.**

Average Pumping Head Overview (RAG 2.08 Appendix 1 & 2)

- Raw Water Abstraction
- Raw Water Transport
- Water Treatment
- Treated Water Distribution

Average Pumping Head is defined using the following formula:

$$APHt = \frac{\Sigma(hi \times WPi)}{VP + Vg}$$

Where, for each price control area:

- $APHt$ is Average pumping head reported for the Period, t, (in m.hd)
- hi is the annual mean head, h, (in m.hd). The annual mean head is defined as the average delivery pressure minus the average suction pressure when the pump is operating
- WPi is the total measured volume of water pumped, (in Ml), entering each price control and any repumping within
- Vp is the volume of water pumped, (in Ml), entering each price control
- Vg is the volume of water gravitated, (in Ml), entering each price control

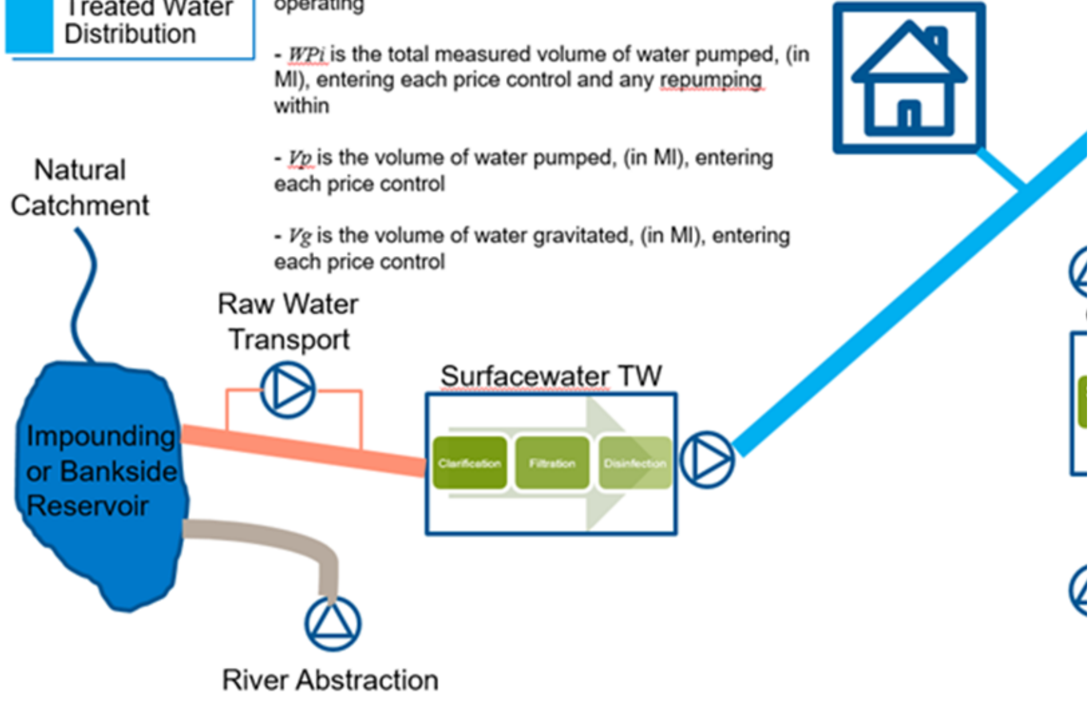


Photo © credit

Example 4: Treated Water Distribution

A company has the following processes:

- 95Ml of Water treatment enters the Treated water distribution from site A, as 5Ml is treatment works losses, and is pumped 150m.
- 73Ml of Water treatment enters the Treated water distribution from site B, as 2Ml is treatment works losses, and pumped 30m.
- 20Ml of Water treatment enters the Treated water distribution from site C, zero treatment works losses, and is pumped 90m.
- 9Ml of Water treatment enters the Treated water distribution from site D, as 1Ml is treatment works losses, and is pumped 80m.
- 15Ml of treated water gets repumped 10m at site E

The average pumping head for this price control – Treated water distribution would be calculated as follows:

$$APH = \frac{(95 * 150) + (73 * 30) + (20 * 90) + (9 * 80) + (15 * 10)}{(95 + 73 + 20 + 9)}$$

water treatment, **APH = 97.0 m.hd**

Proportional allocation from Site D

15Ml repumped 10m at site E

Total amount of water entering the Treated water distribution, Ml price control unit

What are we doing?

1. **Reconsidering** the use of APH in the wholesale water base cost models at PR24.

2. We are **scrutinising the 2020/21 APR returns** in Tables 5A, 6A and 6B. What have we found so far?
   - Calculation errors
   - Methodological improvements
   - Company merger issues
   - Use of DI rather than water entering each price control
   - Weather and Covid effects
   - Forecasting challenges
   - Increased assurance
   - Regional reporting systems
   - APR and BP variations

3. **Considering** the impact APH has on power costs and net zero challenges, and whether it has appropriate incentive

4. **Testing revised data** for initial PR24 cost modelling analysis

Company	Confidence grades (mode for historical period)		
	Number of booster pumping stations	Capacity of booster pumping stations	Average pumping head (distribution)
Anglian Water	B2	B3	C3
Dŵr Cymru	B3	C4	B3
Northumbrian Water	B2	B3	A2
Severn Trent Water	A2	B4	C3
South West Water	B2	B3	B3
Southern Water	B2	C4	B4
Thames Water	A4	C5	B2
United Utilities	B2	B2	B2
Wessex Water	A1	A3	C2
Yorkshire Water	A1	A2	B3
Affinity Water	A2	B2	B2
Bournemouth Water	A2	A2	B3
Bristol Water	B4	B4	C3
Dee Valley Water	A1	A1	B3
Portsmouth Water	A1	B2	A2
South East Water	A2	B3	B2
South Staffs Water	A1	B2	A2
SES Water	A1	A1	B2

Notes: The confidence grade is an alphanumeric code that companies assign to data in their annual performance review submissions. The letter refers to reliability and the number to accuracy.

APR 2019-20 to 2020-21 Analysis

Sub Price Control	Range	APH	Observations
Raw Water Abstraction	Lowest	5.01	• % variation range between APRs: +20% to -33% • Reclassifications between RWA and RWT, system operation, high rainfall impacts
	Median	26.47	
	Highest	50.63	
Raw Water Transport	Lowest	0.00	• % variation range between APRs: +36% to -41% • Reclassifications between RWT and RWA, system operation, high rainfall impacts
	Median	19.40	
	Highest	58.52	
Water Treatment	Lowest	1.87	• % variation range between APRs: +35% to -22% • Both WSH (41.58) and SRN (32.65) are very high compared to remaining average of 8.28
	Median	9.02	
	Highest	41.58	
Treated Water Distribution	Lowest	36.15	• % variation range between APRs: +26% to -8% • Only a few queries between APRs.
	Median	92.62	
	Highest	126.73	
Total	Lowest	64.80	• % variation range between APRs: +10% to -13% • **Aggregate maximum variations are mostly less than sub price control variations**
	Median	144.42	
	Highest	190.75	

To sum up…

- At the PR19 redeterminations, the CMA agreed that APH makes sense from an engineering and economic perspective. But the CMA also raised substantial concerns regarding:
  - Data quality
  - Statistical significance
- Overall, the CMA concluded that APH should not be included as an explanatory variable in the econometric models as a "superior alternative was available" (i.e., boosters per km of mains)

- APH data quality remains a significant concern, with several data issues and large year-on-year variations in data found in 2020-21 APR data.

- Companies have encouraged the early release of base cost models at PR24. Therefore, if APH is to be seriously considered as an explanatory variable in the wholesale base cost models at PR24, all data quality issues will need to be resolved before 2021/22 APR submissions.

- South Staffs Water and Anglian Water will now present on how APH data quality could be improved along with other related issues.

South Staffs Water

Cambridge Water

Average pumping head as a cost driver

Presentation for cost assessment working group

7th September 2021

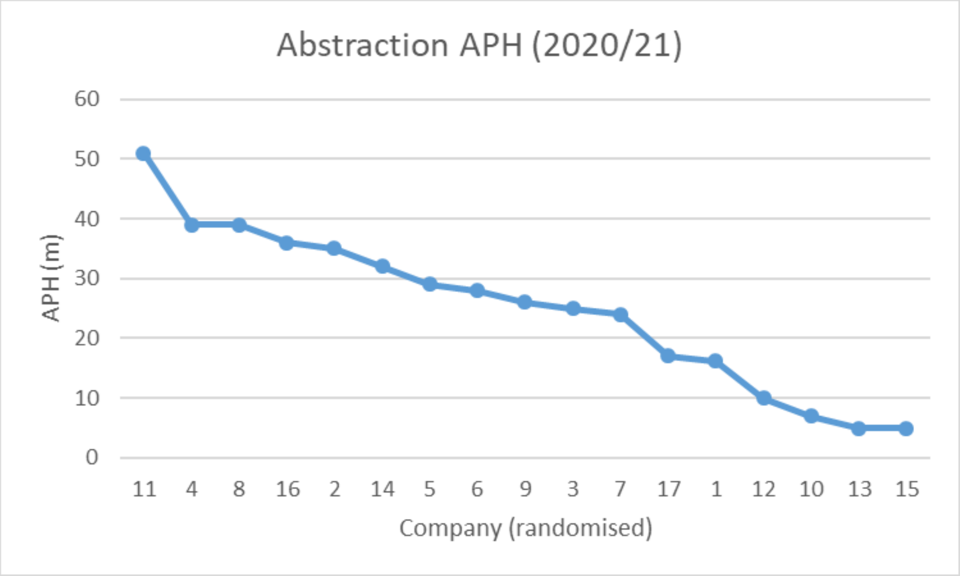
What is APH?

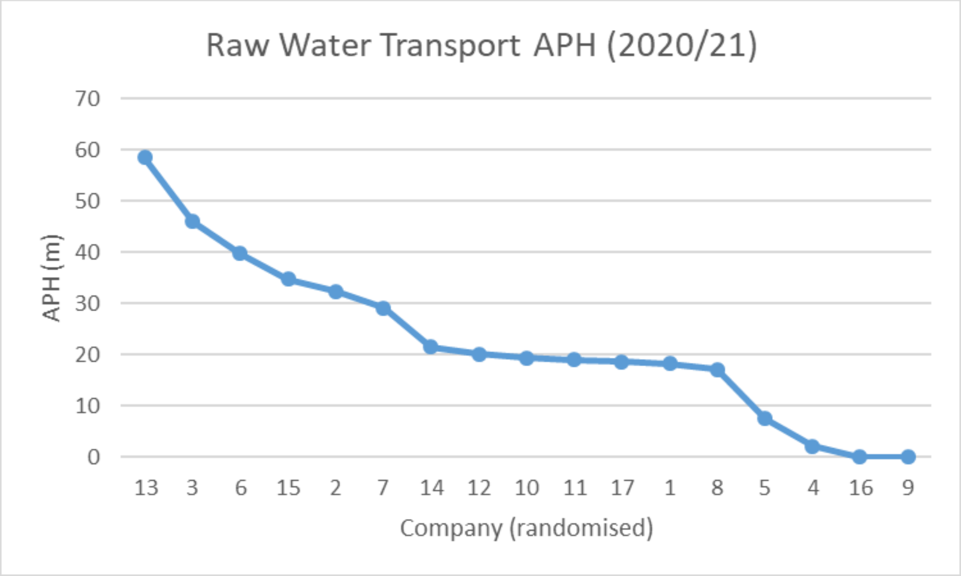
- A measure of the average pumping pressure needed to overcome gravity and frictional losses in company supply networks.
- APH may be influenced by several factors:
  - The proportion of gravity and pumped abstractions;
  - The depth below ground of borehole water levels;
  - The extent of use of raw water transport from one location to another;
  - The extent of use of treatment processes that restrict flow, eg pressure filters;
  - The topography in play for initial distribution of treated water from treatment works into service reservoirs;
  - The extent of, and topography, for re-pumping (strategic transfers or direct to customers) within the network;
- APH is a very asset based, engineering focused measure. Its values are rooted in the hydraulic configuration of company supply networks with respect to their operating geography.
- From a first principles perspective it should have a direct link to power use/energy costs.

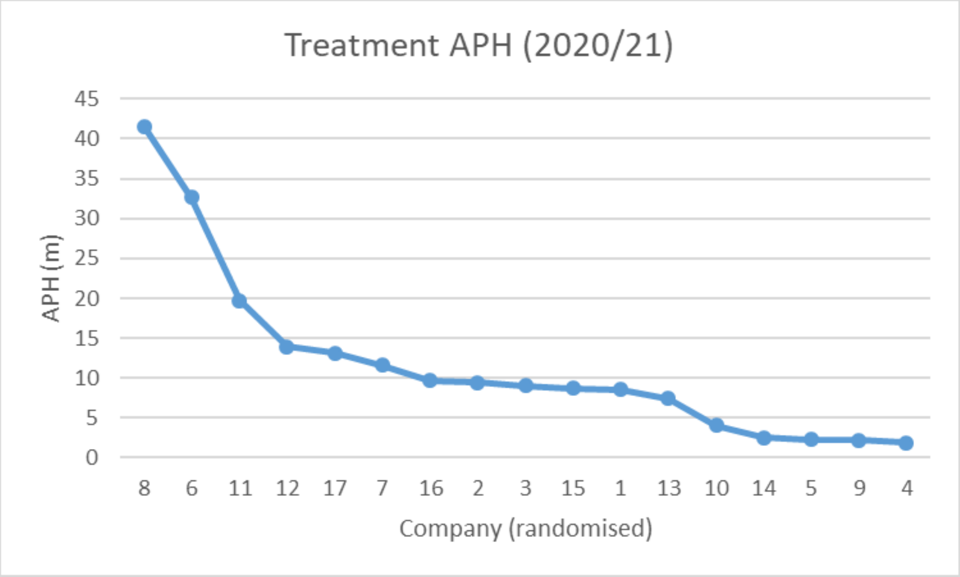
Is APH a good proxy for topography/pumping costs?

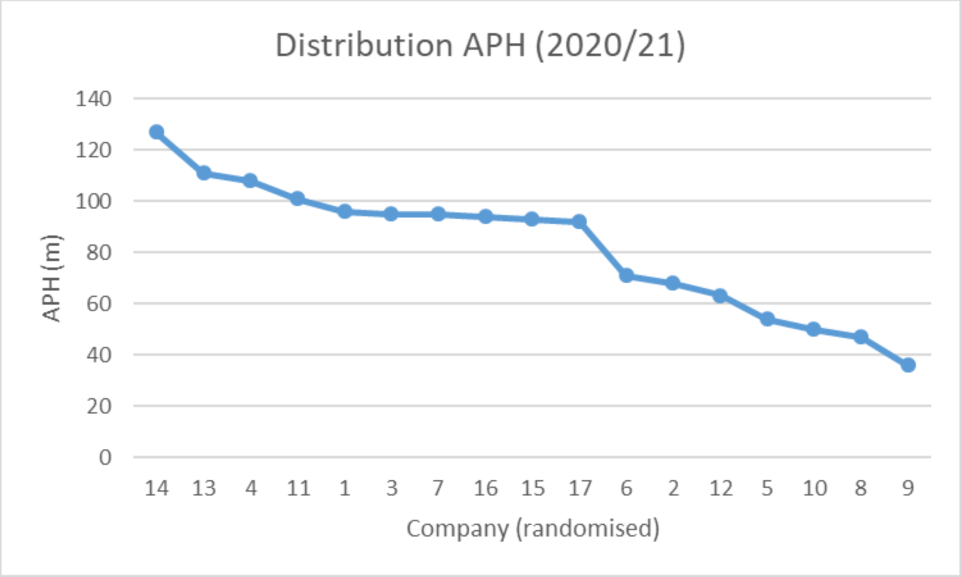
Factor	Response
Proportion of gravity and pumped abstractions	**Does include** – the APH calculation takes account of pumped or gravity feeds at abstractions.
Borehole water levels	**Does include** – the APH calculation takes account of the abstraction pressure to get water to ground level.
Treatment processes that restrict flow	**Does include** – the APH calculation takes account of the pressure needed to push water through treatment processes.
Supply topography and re-pumping	**Does include** – the APH calculation takes account of the pressure at every pumping installation and its share of the volume, including re-pumping.

Data - APH variation across companies



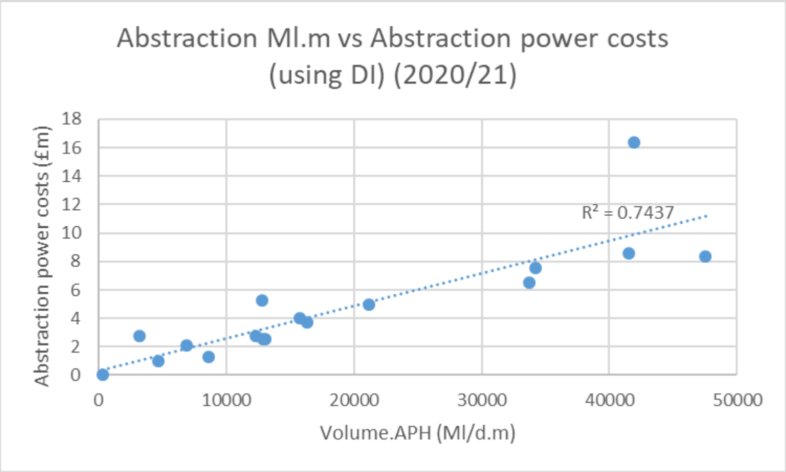


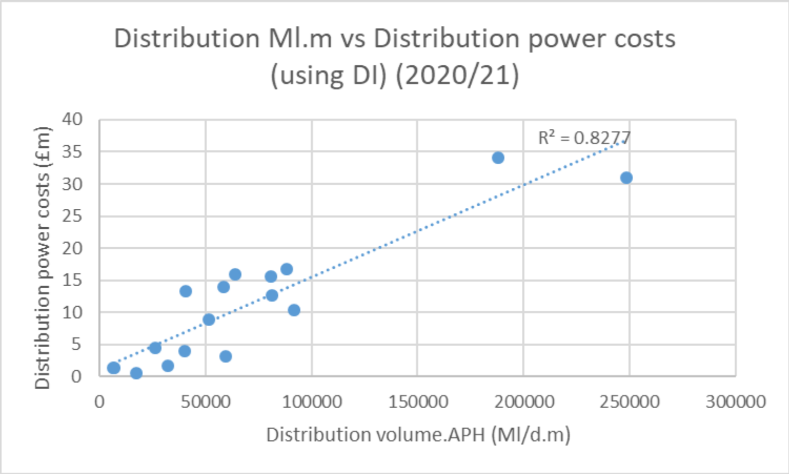




Data – is APH correlated to costs?

- Hydraulic power method used:





- For distribution, we don’t capture total volume pumped, only DI (input volume). Therefore we don’t know the extent of re-pumping within the network – it is a missing explanatory factor.
- For example for SSC, our DI (2020/21) = 406 Ml/d; our re-pumped volume = 118 Ml/d. Nearly 30% of water being re-pumped.

APH data quality

- APH:
  - Is a complex calculation
    - Each site has a flow and pressure which needs to be accounted for
    - Re-pumping
    - Sampled vs continuous telemetry calculation
    - Estimation of non-measured components (eg treatment works pressure overheads)

    SSC’s APH data sources:

    - Predominantly use live, granular, flow and pressure data directly from telemetry;
    - Do use some engineering assumptions mixed with live data, for example on borehole levels;
    - Are mostly assumption based for treatment process overheads.

- Costs:
  - Power cost allocation where there is dual purpose pumps or no sub-metering.

Benefits of improving data quality

- Cost allowance modelling
  - Reduce omitted variable problems and improve efficiency assessment.

- APH useful measure to inform:
  - Network/pumping/asset optimisation
  - Power cost reduction goals
  - Carbon emission reduction goals

Future improvements

- We should try and capture re-pumped volume for each company because its currently a missing explanatory factor in distribution power costs.

- Could we deep dive/evaluate APH calculation methods across companies to try and determine whether there are any material deviations in method and whether these influence the final results? Eg some kind of compliance checklist like was used in leakage/outage/interruptions.

- Could we capture explanatory factors to try and explain variation in APH? For example:
  - using map elevation data to explain regional topography;
  - using borehole water level data to bolster abstraction APH data;
  - companies explaining which of their treatment processes have a high pressure overhead?

APH: A long-term strategy for data quality improvement

7 September 2021 CAWG meeting

Issues in calculating APH: an Anglian perspective

Flow data

- Well defined but some investment required to ensure all trunk mains are fully metered
- Accurately measured
- Data used widely throughout the business

Lift data

- More problematic - likely needs investment
- Where available, based on telemetry pressure / level sensors
- Otherwise, based on operational site data

Disaggregation

- The level of definition needs to improve
- Need to get disaggregated data quality to the same level as aggregate data

- This is our perspective
- How does everyone else see the issue?
- If modelling is at the TWD/Water Resource Plus level, then this should be less of a problem

How to improve data quality

Approach to target setting

Follow approach taken with new AMP7 Performance Commitments in table 3S

Under the auspices of Water UK:

- Define key components for calculation
- Develop consistent definitions
- Develop consistent way for reporting how much data is based on actual vs estimated readings

This would:

- Ensure consistent reporting
- Categorise compliance – red/amber/green

4 Stage process

1. Review how each company computes APH
2. Define components of the process
3. Companies shadow APH and compliance with standard
4. Backcast historical data where appropriate/needed

Breakout room questions

APH Data Quality

1. What are the main factors causing APH reporting inconsistencies between companies and over time?

2. Which components of APH are more likely to be causing reporting inconsistencies / issues?
   - Annual mean head, *APHt* (m.hd)
   - Total measured volume of water pumped, *WPi* (Ml) entering each price control and any repumping within
   - Volume of water pumped, *Vp* (Ml) entering into each price control
   - Volume of water gravitated, *Vg* (Ml) entering into each price control

3. How can we eliminate/reduce APH reporting inconsistencies/issues?
   - ➢ Deep dive / audit?

Including APH in econometric cost models

1. Does APH need to be weighted by ‘total measured volume of water pumped’ to be included in the econometric models?

2. How can we ensure that the inclusion of APH in the econometric models does not lead to perverse incentives given there are opportunities to optimise APH (i.e., endogenous)?

Annex: RAG 2.08, A1 Definition of average pumping head

A1 Definition of average pumping head

A1.1 Average Pumping Head ("APH") is a key variable for cost modelling. Average Pumping Head is to be allocated to each of the following price control units:

- Raw water abstraction
- Raw water transport
- Water treatment
- Treated water distribution

A1.2 Average Pumping Head is defined using the following formula:

$$APH_t = \frac{\Sigma(h_i \times WP_i)}{V_P + V_g}$$

Where, for each price control area:

Term	Definition
APH_t	Average pumping head reported for the Period, t, (in m.hd)
Hi	Annual mean head, h, (in m.hd). The annual mean head is defined as the average delivery pressure minus the average suction pressure when the pump is operating
WP_i	Total measured volume of water pumped, (in Ml), entering each price control and any repumping within
V_p	Volume of water pumped, (in Ml), entering each price control
V_g	Volume of water gravitated, (in Ml), entering each price control

RAG 2.08, A1 Definition of average pumping head

Further Points to note:

- Annual mean head (hi) = Static Head + Dynamic Head (all infrastructure losses)
- Companies are expected to use measured **flow and pressure data**.
- Companies should state in their commentary the **proportion (in %)** of their Average Pumping Head that has been **calculated using measured data** in accordance with the above methodology.
- Where companies do not have measured data available they should estimate their Average Pumping Head using **credible methods based on robust engineering assessments**.
- Companies should describe in their commentary **each method used and the proportion (in %)** of their Average Pumping Head calculated using that method.
- Pumping of water as part of an **environmental improvement scheme** (for example stream support) **should be included**, in the appropriate price control unit, **unless funded by a third party**.
- Pumping of water that is **exported to another company (raw and treated bulk supply exports) should not be included**. Companies should describe in their commentary these exclusions.
- All other ancillary pumping (for example as part of the treatment process) **should be included**, based on robust engineering assessments, in the price control units.
- Any averaging across separate operating regions should be individually weighted within price control areas

3. Number of connected properties

Total connected properties at year end – issues and proposal (1)

- Total connected properties at year end (water) was used as a cost driver in the PR19 base models and is used in the reporting of the supply interruptions common performance commitment
- As part of consolidation of data for RAG 4.09 we drew together customer, property and population data together into Table 4R.
- This also allowed the opportunity to collect additional information on metering technology installed.

Total connected properties at year end (water only), lines 4R.17 to 4R.25

Line description	Units	Dps	Water								
			Unmeasured				Measured				Total
			No meter	Basic meter	Smart meter	Total	No meter	Basic meter	Smart meter	Total	
Property and meter numbers - at end of year											
Total new residential properties connected in year	000s	3				0.000				0.000	0.000
Total new business properties connected in year	000s	3				0.000				0.000	0.000
Residential properties billed at year end	000s	3				0.000				0.000	0.000
Residential void properties at year end	000s	3									0.000
Total connected residential properties at year end	000s	3				0.000				0.000	0.000
Business properties billed at year end	000s	3				0.000				0.000	0.000
Business void properties at year end	000s	3									0.000
Total connected business properties at year end	000s	3				0.000				0.000	0.000
Total connected properties at year end	000s	3				0.000				0.000	0.000

- In lines 4R.26 and 4R.27 we also collect resident population (water/wastewater) and non-resident population (wastewater only)

Total connected properties at year end – issues and proposal (2)

- The reporting for APR21 in this revised format has highlighted some variations in company reporting of total connected properties at year end for water.
- We consider that the table and related line definitions will require revisions for future reporting to ensure consistency.
- We want to take this opportunity to discuss some proposed amendments to reporting and the classification of properties within certain scenarios
- We propose that there are three types of total connected property we will need to collect information on:
  - **Billed properties;**
  - **Void properties;** and
  - **Unbilled properties (not classed as voids**)
- Our expectation is that these categories would be used for both household and non-household total connected property at year end reporting.

Total connected properties at year end – issues and proposal (3)

- Where companies report unbilled properties we would expect the narrative to describe what these properties represent and if necessary sub-divide the total by different unbilled types.
- We do not propose to change the definition of a **void property:**

  "void properties are properties, within the company's supply area, which are connected to the company's assets for either a water only service, a wastewater only service or both services but do not receive a charge, as there are no occupants. Additionally, a property connected for both services that is not occupied, only counts as one void property. Exclude properties that are not billed as it is uneconomical to do so."

- As per the consultation on APR reporting for 2021-22 we propose to split the smart meter reporting for each category further into AMR and AMI meters.
- Total connected properties at year end for water is also used in the reporting of **supply interruptions** in line 3F.7 with the 'standardising data value', ''Number of properties' stated as being 'copied from 4R.25 total column'. However, we have recorded a number of discrepancies between lines 4R.25 and 3F.7 and we want to ensure we can clearly define and derive the 'standardising data numerical value' for 3F.7 in table 4R.

Average customer and properties data – no change proposed

- Table 4R includes average customer data (4R.1 to 4R.9) and average property data (4R.10 to 4R.16)
- We **do not propose to change** the average customers and properties reporting (4R.1 to 4R.16) which should continue exclude the unbilled properties.

Average customer numbers (4R.1 to 4R.9)

Line description	Units	DPs	Unmeasured	Measured	Total	Voids	RAG 4 reference
Customer numbers - average during the year							
Residential water only customers	000s	3			0.000		4R.1
Residential wastewater only customers	000s	3			0.000		4R.2
Residential water and wastewater customers	000s	3			0.000		4R.3
Total residential customers	000s	3	0.000	0.000	0.000	0.000	4R.4
Business water only customers	000s	3			0.000		4R.5
Business wastewater only customers	000s	3			0.000		4R.6
Business water & wastewater customers	000s	3			0.000		4R.7
Total business customers	000s	3	0.000	0.000	0.000	0.000	4R.8
Total customers	000s	3	0.000	0.000	0.000	0.000	4R.9

Average property numbers (4R.10 to 4R.16)

Line description	Units	Dps	Water			Wastewater			
			Unmeasured	Measured	Total	Unmeasured	Measured	Total	
Property numbers - average during the year									
Residential properties billed	000s	3			0.000			0.000	4R.10
Residential void properties	000s	3							4R.11
Total connected residential properties	000s	3			0.000			0.000	4R.12
Business properties billed	000s	3			0.000			0.000	4R.13
Business void properties	000s	3							4R.14
Total connected business properties	000s	3			0.000			0.000	4R.15
Total connected properties	000s	3			0.000			0.000	4R.16

Breakout room questions

1. Do you agree with the three categories for reporting total connected household properties at year end for water:
   - Billed
   - Void
   - Unbilled

2. Are there any additional considerations that should be made for non-household property reporting?

3. How should properties be reported in the following scenarios?
   - Uneconomic to bill properties;
   - Properties billed by a third party fed from a bulk supply point – for example NAVs; and
   - Household properties owned by developers prior to sale to first homeowner

4. Do you consider there are any issues with excluding unbilled properties (i.e., only including billed and void properties) from average property totals in the reporting year?

5. How can the 'Number of properties' used in the calculation of the supply interruptions performance commitment be captured in Table 4R?

6. Is there value in capturing non-resident population for water separately to resident population?

7. Would there be benefit in capturing total population for water split between measured and unmeasured in Table 4R as this is a component of the measured/unmeasured PCC calculation?

4. Ensuring quality data

Ensuring quality data

High quality information is vital for trust and confidence in the water sector, and underpins PR24.

It is essential that company data submissions are accurate, assured and consistent with our information requirements.

Through our review of 2020/21 APR data, we have identified a number of data reporting issues that have needed to be resolved.

There have also been other instances where reporting improvements have led to step changes in the data. The absence of confidence grade information makes it challenging to understand when data quality improvements have been made, and the quality of data more generally.

We are therefore seeking ways to improve the quality of company data submissions moving forward, and to improve our understanding of the quality of the data/information provided.

Question: What additional measures do you think we should implement to improve data quality, if any?

5. Closing remarks

Closing remarks

- We will circulate meeting notes following the meeting for comment, before uploading onto our website.
  - https://www.ofwat.gov.uk/regulated-companies/price-review/2024-price-review/pr24-working-groups-and-workshops/
- Next Cost Assessment Working Group meetings:
  - **Cost Service Link (YKY and SES) - 14th September**
  - **Forward looking capital maintenance (SWB and tbc) – 28th September**
  - **Growth cost assessment (ANH and tbc) – 12th October**
- Please let us know if you are currently working on any relevant papers for the Future Ideas Lab and would like to present an overview of the paper at a forthcoming workshop.

Average Pumping Head

July 2021

Introduction

- The aim of this presentation is to provide *insights* and *ideas* on how we could improve our current cost assessment framework for PR24 in a constructive way.

- In particular, we have focused on Ofwat's requests presented during the last CAWG (see "PR24 cost assessment working group, Draft for discussion, May 2021").

- This presentation covers the following areas:

1) Average Pumping Head

Average Pumping Head (APH)

- It is recognised across the industry the importance of average pumping head as an important cost driver in water production and its strong theoretical arguments to support the consideration of this driver in the cost models.
- APH not only captures the amount of energy used, but also captures the topographical/natural conditions that are fixed for each company.
- We believe that the current definition of APH defined in the RAG. 2.08 is a measure that contains all the engineering elements to capture a robust measure from the engineering point of view.
- However, the potential problem with companies reporting APH resides on the different interpretations that companies might have used bringing some potential inconsistencies.

A brief summary of APH during PR14/19

- There is a large discussion since PR14/19 between appealing companies, Ofwat and the CMA on how to measure and include APH in the models. The following is just a brief summary:

1. At PR14 in the totex model developed by CEPA, APH was a *weighted* measure: Ln(APH*DI)

2. The CMA during the appealing process at PR14 incorporated an *unweighted* measure in the Ln's aggregate costs models: Ln(APH). The reason was to avoid potential multicollinearity issue. However, there was not evidence of this in their pooled OLS models (e.g., VIF).

3. At PR19, Ofwat tried an *unweighted* version as suggested by CMA Ln(APH) in different specifications without robust results across water wholesale. Ofwat also argued that the confidence grades of number of pumping stations was grater than APH.

4. In PR19, the CMA supported Ofwat's choice of booster pmp_stn. They argued that the quality of APH is weaker compared to booster pmp_stn, in terms of: measurement, statistical level of significance and cost modelling approach (e.g., botex v power).

What is the evidence suggesting on APH and Booster_Pmp_Stn?

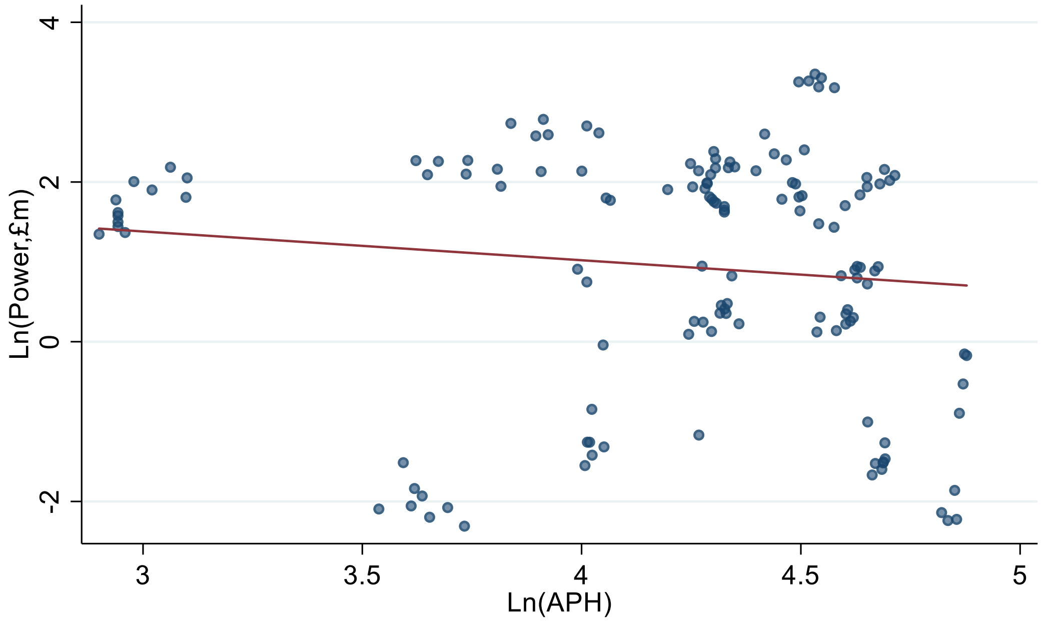
- When looking at the correlation between power costs and APH (unweighted) in water distribution we find a negative correlation of -0.11 (see left right) which is not aligned with the expectations.

- Hence, during PR19 Ofwat chose a proxy for APH: “*number of booster pumping stations per length of mains*” (Booster_Pmp_Stn). We correlated this proxy using just the number of booster pumping stations (unweighted or not divided by length of mains) with power costs and found a positive correlation of 0.72 (see right chart).

- At this stage both measures are unweighted and seems that Booster_Pmp_Stn is a good predictor of power costs.

Power Costs v APH (unweighted)

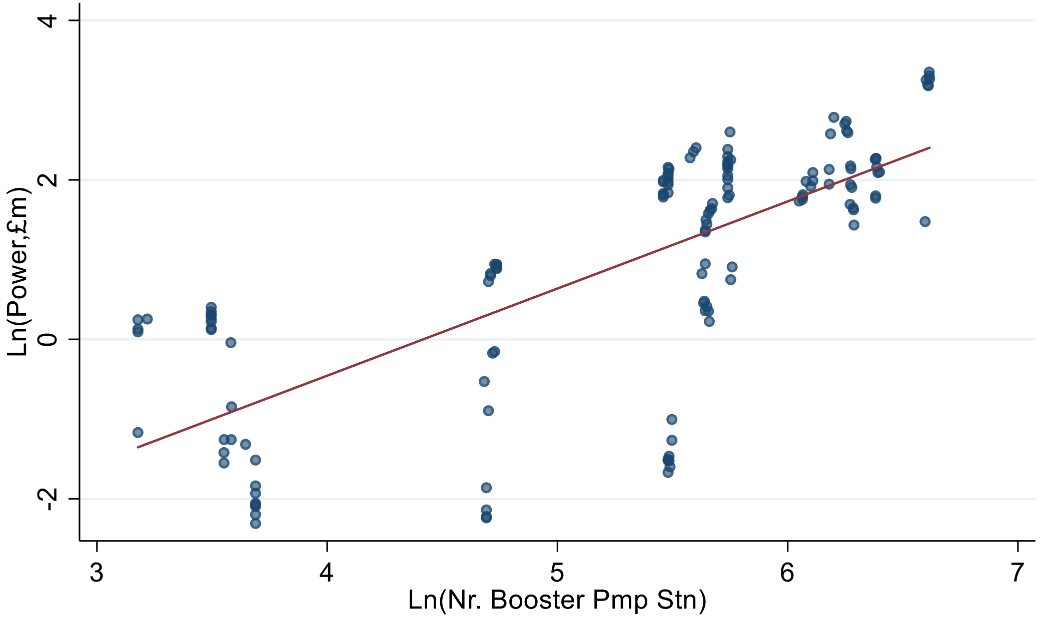
Water Distribution (From 2012 to 2019)



Source: Economic Regulation, Thames Water. Note R2=.014 and Correaltion=-.1176

Power Costs v Booster Pmp Stn (unweighted)

Water Distribution (From 2012 to 2019)



Source: Economic Regulation, Thames Water. Note R2=.522 and Correaltion=.7224

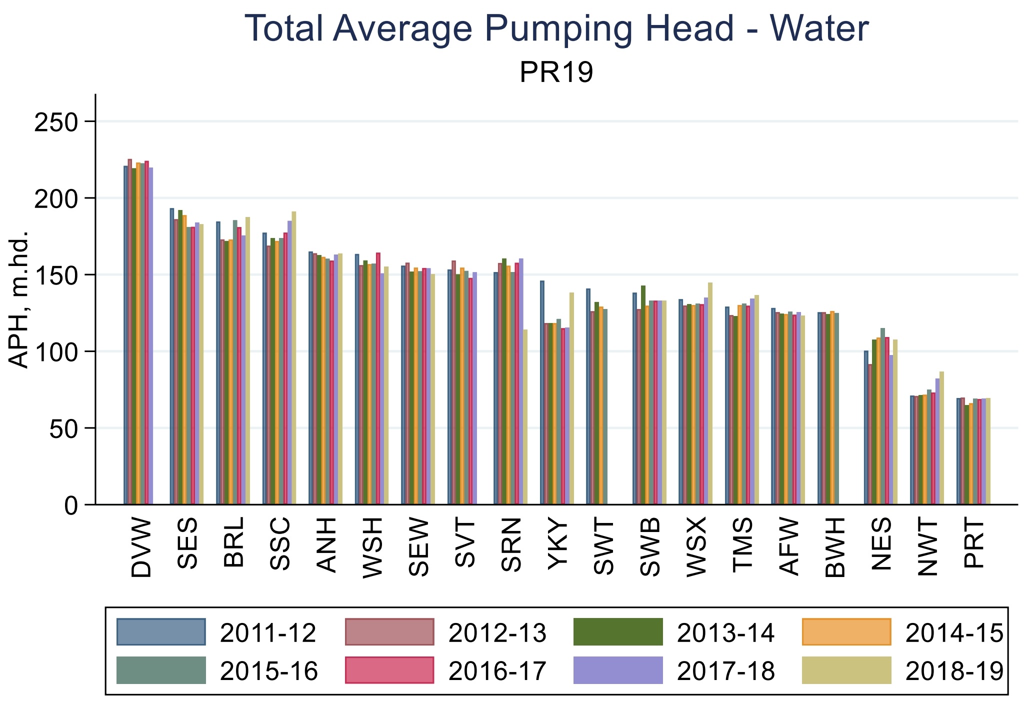
Do we need to weight in order to consider APH in the models?

- We might need to consider APH in the following form:

  - Average pumping head is a measure of the average vertical distance each unit of water supplied is 'lifted' from source (e.g., river or borehole) to tap (e.g., customer). This means it represents the average water system topography. There is little that can be done to change the APH, except if customers were to move their water demand from high head systems to lower head ones (or vice versa).

  - It is therefore perfectly possible for a very small water company to have the same average pumped head as a very large one. *Consequently*, APH could be the same whilst the cost of supplying water could be very different. In order to *benchmark* effectively we could either divide the cost by MLd and compare to APH, or multiply the APH by MLd and compare to cost. Either would allow for effective comparison of efficiency. For example, using Distribution Input or Water Delivered, or Water Treated.

  - In reality larger water companies are more likely to have multiple systems with higher and lower pumped head, whereas small water companies will have fewer systems and therefore the average pumped head of their smaller data set of systems is more likely to be influenced by a few either high or low head systems. As a result the smaller water companies with lower costs are likely to sit as relative outliers in the range of APHs (e.g., DVW and PRT).



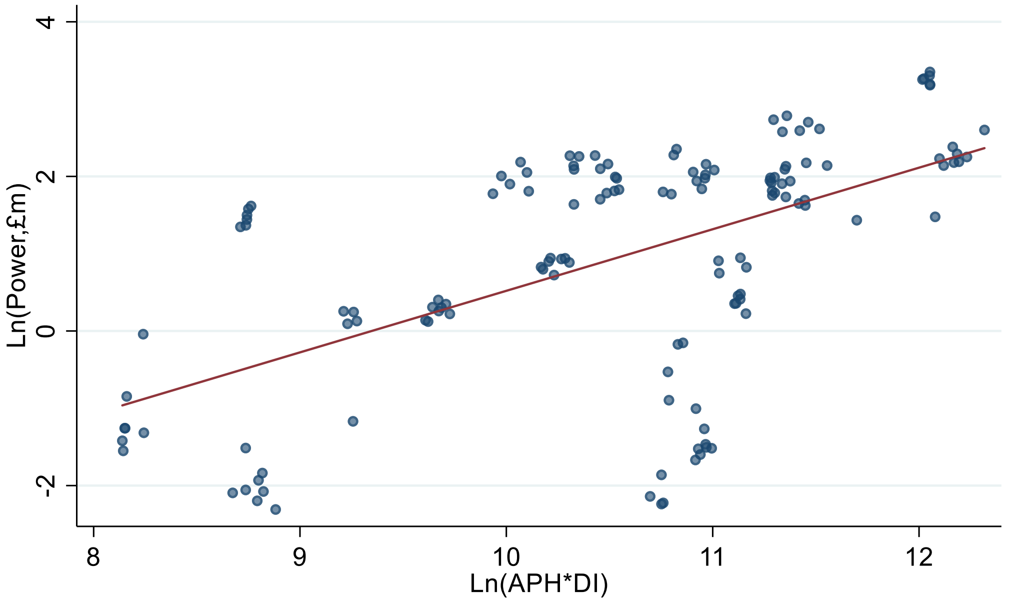
Source: Economic Regulation, Thames Water.

What the evidence suggests on APH and Booster_Pmp_Stn when weighted?

- When we weighted both variables, APH by Distribution Input (DI) and Number of Booster Pmp_Stns by Length of mains, both variables suggest a positive correlation with power costs as expected.
- This evidence also suggests that the use of APH (weighted) is stronger (0.56) than the Booster Pmp_Stns (0.10) (weighted).
- We use this approach as the appropriate way to proceed when APH is used in the models.
- We use Water Distribution as an example, as it represents on average the highest proportion of power costs over opex across the value chain in the water industry (6.5%). Total power costs represent around 15.5% of opex costs across wholesale water.

Power Costs v APH (weighted)

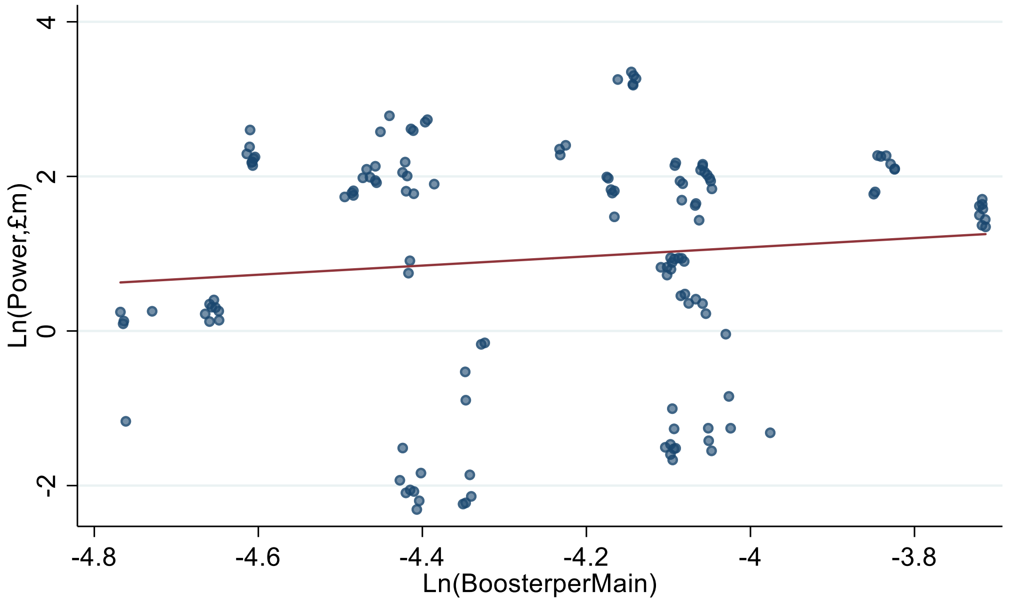
Water Distribution (From 2012 to 2019)



Source: Economic Regulation, Thames Water. Note R2=.318 and Correaltion=.5636

Power Costs v Booster PMP_Stn per Main (weighted)

Water Distribution (From 2012 to 2019)



Source: Economic Regulation, Thames Water. Note R2=.011 and Correaltion=.104

So, how could we improve our understanding of APH?

- After internal discussion with engineers in the business we concluded that:

  1. The current definition of APH is adequate to capture the energy used to pump water and the topography conditions that are particular to each company as explained before.

  2. Companies could provide all the components of APH calculation in order to understand potential anomalies in the reporting across companies and price controls (e.g., h_i, WP_i, V_p, V_g).

  3. A potential external audit could help to mitigate the risks on the reporting process in order to improve consistency across companies and price controls.

$$APH_t = \frac{\Sigma(h_i \times WP_i)}{V_P + V_g}$$

Where, for each price control area:

Term	Definition
APH_t	Average pumping head reported for the Period, t, (in m.hd)
Hi	Annual mean head, h, (in m.hd). The annual mean head is defined as the average delivery pressure minus the average suction pressure when the pump is operating
WP_i	Total measured volume of water pumped, (in Ml), entering each price control and any repumping within
V_p	Volume of water pumped, (in Ml), entering each price control
V_g	Volume of water gravitated, (in Ml), entering each price control