Drought resilience metric - Risk of severe restrictions in a drought

1. Overview

The overall metric will be, on a company basis, the percentage of the customer population at risk of experiencing severe restrictions (for example, standpipes or rota cuts as part of Emergency Drought Orders - EDO) in a 1-in-200 year drought, on average, over 25 years.

The population is considered to be 'at risk' if the supply-demand balance calculation in each water resource zone (as used for water resource planning) for the 1-in-200 year drought event results in a shortfall (deficit). This will occur when the theoretical deployable output minus outage allowance (available supply) is less than the dry year demand plus base year target headroom (demand plus uncertainty).

$$At\ risk\ if, DO - OA\ < DD + TH$$

Where:

- Deployable output (supply) = DO
- Outage allowance (unavailable supply) = OA
- Dry year demand = DD
- Target headroom (uncertainty) = TH

The data and assumptions used for this metric should be consistent with those forecast and reported for the water resources management plans (WRMPs) which have their own technical guidance issued by the Environment Agency and Natural Resources Wales in collaboration with Defra, the Welsh Government and Ofwat. We expect the company to provide its own data assurance on the components that contribute to this metric on the basis that it is the company's responsibility to own and assure its data.

2. Metric calculation and assumptions

Supply demand balance

The supply-demand balance (SDB) as used for WRMPs should be applied for this metric. This should include consistent approaches taken to the calculation and application of the following (where applicable):

- Deployable output (DO) forecast (supply) including deployable output reductions due to:
    - Sustainability reductions (licence changes)
    - Climate change
- Outage allowance (OA)

- Dry year demand forecast (DD)
- Target headroom (TH)

Using 1-in-200 year drought inputs the basic SDB calculation for this metric should be:

$$SDB = DO - OA - DD - TH$$

For target headroom companies should use the 95th percentile certainty (or equivalent for complex methods) for the first five years of the planning period forecasts and for performance reporting. Beyond the 5 years the percentile should follow the same trend as the company's WRMP19.

The SDB should be undertaken for the 25-year forecast (2020-21 to 2044-45), consistent with the minimum planning period required for WRMPs, so that the company can report its year-on-year risks.

1-in-200 year drought estimation

There is no standard approach to estimating drought return periods used for water resources planning. It is understood that there will be a range of 1-in-200 year type drought events (including variations in duration, severity and geographical coverage). There will also be differences in the methodologies used to estimate the 1-in-200 year data used and the robustness of these estimates. This uncertainty and variability in forecasting is captured as part of the Certainty Grading related to this metric's reporting (see Certainty Grading section below).

The 1-in-200 year drought used in this metric should be the same design event as used to provide cost information for the reference level of service (0.5% or 1-in-200 year) as required by the water resources planning guidelines (section 3.6 - Reference level of service). The testing of this reference level of service for WRMP19 only applies to companies wholly or mainly in England. Companies wholly or mainly in Wales do not have a requirement to test a 1-in-200 year drought in their WRMP19. However, it is still expected that companies wholly or mainly in Wales will estimate a 1-in-200 year drought event for this metric.

The event (or events) used to determine the model inputs should be reflective of the range of 1-in-200 year type drought events that are likely so that there is relative confidence that in an actual 1-in-200 year event the modelled outputs (and hence the reported risks) are close to reality.

Impacts of restrictions

Companies' forecasts should include the impacts of less severe restrictions, e.g. temporary use bans (TUBs) or non-essential use bans (NEUBs), on the SDB input components (i.e. supply or demand) at a frequency as stated in their WRMPs, when

calculating this measure. This may include drought orders and permits where these are likely to be permitted (consistent with a company's WRMP) and where the benefits reflect those that would be considered reasonable in a 1-in-200 year drought.

Population forecasts

The water resource zone (WRZ) population and total company population (sum of the WRZ populations) should be consistent with those forecast in the company's WRMP19. This is one of the fixed in-period inputs for the drought risk metric with updates allowable only at the end of the control period (where necessary).

Measuring performance (including delivery)

Companies should measure performance as follows (including example below):

- **Baseline performance (start of period)**: This will be used as the initial performance level for PR19. This will be a single number representing the 25-year average of the long term supply-demand balance (the current level of risk forecast over 25 years, assuming no additional investment to improve the SDB). The baseline performance (single risk number) submitted as part of PR19 will exclude assumed delivery of future schemes and programmes identified as part of WRMP19 and PR19. In many cases, we would expect the SDB in a 1-in-200 year drought to be deteriorating over time as a result, for example, of climate change. The baseline performance figure should reflect this deterioration over the 25-year period.
- **Setting performance commitment levels**: To set performance commitment levels for the 2020 – 2025 period, you should include expected AMP7 schemes. The benefit of the schemes is only assumed to contribute to the average from the year of completion, and not before. When setting the longer term projections of the performance commitment levels (at least a further 10 years) as required in the PR19 methodology, planned schemes should similarly be included but only reported in the years after their expected delivery. To be clear, this means that the benefit of the investment/scheme contributes to the supply demand balance only for the performance commitment level after the year it is planned to be delivered. Once a scheme is assumed to have started, the supply-demand balance and hence risk level should include the benefits from then on.
- **Reported performance (in-period)**: For the purposes of annual reporting, in-period, a company would look at the same 25-year period as the baseline (2020-21 to 2044-45), and calculate the single number representing the 25 year average of the long term supply-demand balance including all the schemes that have actually been delivered (up to that point) or any changes

to the baseline starting point. This will be compared to the original baseline and the performance commitment levels pledged. If a company considers there is no change in-period then it can report this without updating the analysis or modelling, but it would need to confirm this is the case in its commentary on the metric. If a change in delivery or a key variable assumption is identified this does not require a company to carry out a full update of its modelling. It may depend on the scale of the change and how close the zone is to crossing the threshold of customers moving into or out of risk of severe restrictions. A company will need to provide commentary where the assumption of no change is made without this testing.

- **Reported performance (end of period)**: At the end of the period, a company should look at the same 25-year period as the baseline, and calculate the single number representing the 25-year average of the long term supply-demand balance including all the schemes that have actually been delivered (and their forecast benefits into the future). As discussed above, the benefit of the investment/schemes contributes to the supply-demand balance reported average only for the year after it is actually delivered. This will be compared to the original performance baseline and the company's pledged 2025 performance commitment level. The supply-demand balance may still decline over time depending on the AMP7 implemented schemes. The end of period reporting may include a full refresh of models and data including methodology updates where this is consistent with WRMP24. However, if changes are made to the model or methodology that would impact the original forecast and performance commitment level calculations, the company will need to repeat these using the updated methods in order to be able to assess the end of period risk position on the same basis as the baseline and the original commitment made.

A simplified example of the calculation and reporting approach is provided in the tables below. In the first example, table 1, the 73.3% risk reported represents the current risk (with the assumption that no new future measures are implemented that benefit the drought risk in a 1-in-200 year event). In this instance this would be the baseline performance (start of period). Fifteen years are shown rather than 25 for simplicity. We calculate the 73.3% risk as follows: 4 years of 0% of customers being at risk and 11 years of 100% of customers being at risk, averaged over 15 years.

$$[(4 \times 0) + (11 \times 100)]/_{15} = 73.3$$

Table 1: simplified calculation of baseline performance

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034

Supply		30	29	28	23	22	21	20	19	18	17	16	15	14	13	12
Demand		20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
SDB		10	8	6	0	-2	-4	-6	-8	-10	-12	-14	-16	-18	-20	-22
Risk		No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%		0	0	0	0	100	100	100	100	100	100	100	100	100	100	100
Average %	73.3															

In table 2 the 6.7% risk reported represents the final expected average risk once all planned options are delivered (for the 15 years used in the simplified example) and reported for 2034. In this instance this represents the final position of the performance commitment projection reported for 2034.

$$[(14 \times 0) + (1 \times 100)]/_{15} = 6.7$$

Table 2: simplified calculation of final year target performance

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Supply	30	29	28	23	22	21	30	29	28	27	26	25	24	23	22
Demand	20	20	20	20	20	20	20	20	20	20	20.5	21	21.5	22	22.5
SDB	10	9	8	3	2	1	10	9	8	7	5.5	4	2.5	1	-0.5
Risk	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes
%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
Average %															6.7

Table 3 shows that at the end of the first period, in 2024-25, the average risk (over the same 25 year period 2020-21 to 2044-45) reported for the performance commitment is 60.0%. This is based on the options that are planned to be delivered by this point (and their benefits continuing though the planning period).

$$[(6 \times 0) + (9 \times 100)]/_{15} = 60.0$$

Table 3: simplified calculation of end of 2020-25 period year target performance

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Supply	30	29	28	23	22	21	20	19	18	17	16	15	14	13	12

Demand	20	20	20	20	20	21	22	23	24	25	26	27	28	29	30
SDB	10	9	8	3	2	0	-2	-4	-6	-8	-10	-12	-14	-16	-18
Risk	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%	0	0	0	0	0	0	100	100	100	100	100	100	100	100	100
Average %					60.0										

Table 4 shows the performance commitment projection (for the 15-year simplified example). This shows the projected 25-year average risk over the period. The average 25-year risk for each year should be reported (the 5 year intervals are shown for simplicity).

Table 4: simplified performance commitment projection trend

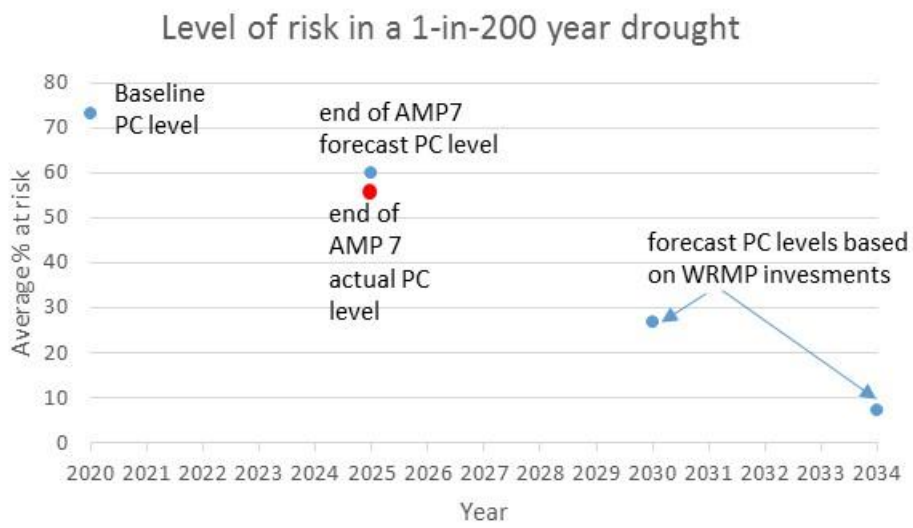
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Performance commitment (average risk %)	73.3					60.0					28.2					6.7

Figure 1 shows in graphical form the performance commitment projection trend, in terms of the average 25-year risk reducing over time from the baseline performance level of 73.3% to the 6.7% target by 2034.

This figure also shows how the company can outperform the average risk beyond that proposed in the performance commitment trend. This could be as a result of planned schemes delivering more than expected (or delivered in a way that results in higher supply or lower demand, over a longer time period). For example, in the figure the red dot shows the case where rather than maintaining demand at 20 Ml/d, the demand management options delivered over 2020-25 reduce this by a further 2 Ml/d, resulting in the deficit occurring one year later (2027 in this example). This would result in the average risk in 2024 being 53.3% (The red dot in 2025) rather than 60.0% (the blue dot in 2025).

$$[(7 \times 0) + (8 \times 100)]/_{15} = 53.3$$

Figure 1: simplified example performance commitment trend (average risk over time)



A company is able to improve its performance on this metric through a range of measures compared with its forecast performance. These can range from plans to reduce outage, reduce demand (for example, leakage or water efficiency), improve WRZ connectivity, or increase its available supplies in a drought (deployable output) that will be of benefit in the 1-in-200 year drought event. The early or improved delivery of these planned improvements can result in outperforming the company's performance commitment level. However, late delivery or underperformance of planned schemes would result in underperformance compared to the company's performance commitment level.

Companies' planned schemes may already be identified as part of WRMP19 or PR19, or companies may identify ways to amend their planned schemes to improve their drought resilience, or can just identify new ways, in-period, to decrease the risk for their customers.

Besides outperformance or underperformance of planned and then delivered schemes, other components that could impact in-period reported performance include:

- Demand forecasts (where new information can be incorporated into the estimation of dry year demand forecasting); and
- Outage allowance (where changes in planned and unplanned outage can be incorporated into the outage allowance forecast).

Components that influence the SDB that are not allowed to change as part of in-period reporting include:

- Baseline deployable output forecasts;
- Climate change assumptions;
- Population assumptions; and
- Target headroom assumptions.

Methodology updates

Various models and datasets are used in water resources planning to derive many of the inputs to the companies' SDB. In some cases these are complex. These models, methodologies and data can be updated frequently or, more commonly, at the start of a new round of WRMPs.

For in-period performance reporting the majority of the data inputs (see above), assumptions and tools to calculate the SDB forecasts should remain consistent with the forecasts submitted at PR19. Only changes to the underlying data as a result of delivery should be incorporated into the in-period performance reporting.

For generating the end-of-period performance reporting, it may be necessary to update data, assumptions and models to be consistent with those to be used for WRMP24. If large changes are made to the models and methods for WRMP24 then the company should also update the starting position (as of 2020-21), the forecast performance and the performance commitment levels (backcast). The updated end-of-period risk should then be calculated using the same methods. The company will need to provide an explanation of the changes such as a reconciliation or balance sheet highlighting which of the supply-demand balance components have changed.

Percentage risk calculation

Based on the outputs of the WRZ SDB assessment, the total customers at risk (number) and the proportion of customers at risk can be calculated.

All the company's zones should be summed together to give a total number of customers at risk in any given interval. The annual percentage of customers at risk is calculated by dividing this by the total number of customers served by the company. The overall metric will use the annual average, over the 25-year forecast, percentage of customers at risk.

- **Annually:** Total number of customers at risk in the reporting year divided by total number of customers served by the company (to be multiplied by 100 to give a percentage)

$$\left(\frac{\sum customers\ at\ risk\ across\ all\ WRZ}{all\ company\ customers}\right) \times 100$$

- **25-year average**: Average number of customers at risk over the 25 years (2020-21 to 2044-45) divided by total number of customers served by the company (to be multiplied by 100 to give a percentage)

$$Average\ number\ of\ customers\ at\ risk = \left(\frac{\sum^{customers\ at\ risk\ across\ all\ WRZ\ from\ 2020\ to\ 2045}}{25} \right) \times 100$$

3. Metric certainty grading

We expect a certainty grading to be reported with the metric, which should indicate the accuracy of the data that has been submitted.

The Water UK Long Term Planning Framework study has developed a Certainty Grade method (link to Water UK webpage) for the drought resilience metric and we consider this could be used for this purpose. The study has attempted to follow the two dimension method used for current Ofwat confidence grades. The study proposes these two dimensions:

- Methodology Grade: the rigour or sophistication of the drought definition process; and
- Risk Score: how close each company may come to implementing restrictions.

Methodology grade

The first dimension would reflect the sophistication of the method used to derive a 1-in-200 year drought event. For example, more certainty would be placed in a sophisticated stochastic modelling approach incorporating the latest findings from research on climate change effects on rainfall and hydrological processes, using many years of simulations, than in a method that relies upon extrapolation from historic, short, time-series data, which may not include severe drought episodes.

Risk score

The second dimension would cover how close a company would come to implementing Emergency Drought Order (Level 4) restrictions (rota cuts and standpipes) on its customers during a 1-in-200 year drought event.

The risk score can be interpreted as follows:

- For a WRZ with a surplus supply/demand balance at the 1-in-200 year level, the score represents the amount and reliability of this surplus water; and
- For a WRZ with a negative supply/demand balance (i.e. it is not resilient to the 1-in-200 year event) then the score represents a view of the level of deficit.

4. Metric reporting

This section summarises how companies can report the metric.

At PR19

- The 25-year average number of customers at risk and percentage of customers at risk in a 1-in-200 year drought (for baseline performance starting point and target performance commitment projection). This is shown in table 5.
- Additional contextual data:
    - Year-on-year breakdown of the 25-year period of customers at risk and percentage of customers at risk to a 1-in-200 year drought (for forecast and target). This would be the actual risk in each individual year rather than the 25-year average risk as reported for the main measure.
    - Forecast performance and performance commitment commentary.
    - Individual WRZ certainty grading and company level certainty commentary.

Table 5: company level risk reporting for measure at PR19 (all values in this table are 25 year average risks over the 2020-21 to 2044-45 period)

	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	…	2044-45
Baseline performance (start of period) - Total company population at risk (number)									
Baseline performance (start of period - Percentage of company customers at risk (%)									
PR19 commitment – Total company population at risk (number)									

PR19 commitment - Percentage of company customers at risk (%)									

Annual reporting (2020 to 2025, in-period)

- Based on any changes to the annual risk compared to performance commitment projection (under- or over-performance) an update of the 25-year (2020-21 to 2044-45) average risk should be undertaken and reported. The change in 25 year average risk applies only to the year in question (not any update to previous years or years after the year in question).
- Additional contextual data:
    - Annual reporting of the number of customers and percentage of customers at risk in a 1-in-200 year drought. See above for updates that can be included in this annual reporting (e.g. delivery and some data updates) which has resulted in any changes to the 25-year average risk reported as part of the measure.
    - As noted above, include commentary if the reported risk is unchanged from the previous year and no further modelling/updates have been undertaken.
    - A balance sheet of any supply-demand balance changes where there is complexity about the reasons for changes in performance (e.g. multiple under- or over-performance elements interacting).

End-of-period reporting

- The updated 25-year average customers at risk and percentage of customers at risk in a 1-in-200 year drought, which should:
    - Cover the same 25-year period (2020-45);
    - Be consistent with any delivery and other updates reported during in-period reporting; and
    - Where updated models, methods and data will be used for WRMP24, these can be applied to recalculate (backcast) the original baseline performance (start of period) and performance commitment projection. The end of period average 25-year risk can then be compared against these reset baselines on a consistent basis. A balance sheet of the supply-demand balance changes will need to be reported in this instance.
- Additional contextual data:
    - Commentary on performance; and
    - Individual WRZ certainty grading and company level certainty commentary.

5. Examples

Overview

A company has four water resource zones. Each zone has 250,000 customers. Each zone has a different SDB starting point with one at risk and three not at risk, based on the forecast.

Baseline performance forecast calculation – water resource zone

In water resource zone A, for each year interval in the 25-year planning period the supply-demand balance for the 1-in-200 year drought is as follows:

$$Deployable\ output - Outage\ allowance - Demand - Target\ headroom$$

For the 2020-21 reporting year this zone has a SDB as follows:

$$100 - 10 - 85 - 10 = -5$$

Therefore, a 5Ml/d deficit in the supply-demand balance calculation. This would result in all customers in this zone (250,000) being reported at risk for this year. Table 6 shows this example over time.

Table 6: calculation of baseline risk based on SDB for water resource zone A

	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	…	2044-45
Supply-demand balance (Ml/d)	-5	-6	-7	-8	-9	-10	-10	-10
Risk	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Population at risk (number)	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000

This SDB forecast excludes the planned delivery of schemes as presented in the WRMP19 and PR19 business plans. Any planned interventions as part of WRMP19 or PR19 and their likely benefits in the 1-in-200 year drought event should be incorporated into the company's performance commitment level projection (and the benefits only included from the date of planned delivery) not the baseline forecast.

Baseline forecast calculation – company

The other three WRZs (all with a population of 250,000 each) have different starting positions in terms of SDB. They all start not at risk.

This results in the risks for each zone as per table 7.

Table 7: calculation of baseline risk based on SDB for all water resource zones

	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	…	2044-45
Zone A Risk	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Zone A Population at risk (number)	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
Zone B Risk	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Zone B Population at risk (number)	0	0	250,000	250,000	250,000	250,000	250,000	250,000
Zone C Risk	No	No	No	No	Yes	Yes	Yes	Yes
Zone C Population at risk (number)	0	0	0	0	250,000	250,000	250,000	250,000
Zone D Risk	No	No	No	No	No	No	No	No
Zone D Population at risk (number)	0	0	0	0	0	0	0	0

Baseline performance calculation – company

The company level 25-year average risk calculation is shown in table 8.

Table 8: calculation of baseline performance at company level

	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	…	2044-45
Baseline annual performance - Total company population at risk (number)		250,000	250,000	500,000	500,000	750,000	750,000	750,000	750,000
Baseline annual performance - Percentage of company customers at risk (%)		25	25	50	50	75	75	75	75
Baseline performance									

– average customers	690,000
Baseline performance – average risk %	69.0

$$[(2 \times 25) + (2 \times 50) + (21 \times 75)]/_{25} = 69.0$$

PR19 reporting – Baseline (start of period) performance

The company reports the baseline (start of period) performance as a number and percentage of customers at risk on average over the 25 years – in this example, 690,000 and 69.0% (see table 9). The year-on-year reported risks should be provided for context and transparency in relation to the 25-year average.

Table 9: reporting of baseline performance at company level

	2019-20 (25-year average)
Baseline performance - average customers	690,000
Baseline performance - average risk %	69.0

PR19 (start-of-period) reporting – performance commitment

The company sets performance commitment levels for this metric to achieve an average risk over the 25 years of 250,000 customers, or 25%, by the end of the period (so three of the four zones and their populations are not at risk to a 1-in-200 year drought). The company can achieve this through the delivery of schemes highlighted in their WRMP19 and PR19 that have a benefit to the 1-in-200 year SDB. The individual calculation of year-by-year risks will be similar to that in the examples earlier in this document. This only shows the reported average 25-year risk (for the 2020-21 to 2044-45 period) at each stage on the performance commitment trend.

This shows how the 25% average 25 year risk is achieved from a 69% baseline performance risk. The targeted improvement over the 2020-25 period is from a 25 year average risk of 69% to 40% as shown in table 10.

Table 10: reporting of performance commitment at company level

	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	…	2044-45
PR19 commitment – Total company population at risk (number)	690,000	690,000	500,000	450,000	400,000	350,000	250,000	250,000
PR19 commitment - Percentage of company customers at risk (%)	69	69	50	45	40	35	25	25

During PR19 (in-period)

a) Delivery in line with performance commitment

In this example the schemes as planned for 2020-21, 2021-22, 2022-23 go ahead as planned. This can include demand management, leakage and supply solutions. This includes a large supply option that prevents zone B moving into risk as per the baseline forecast performance in 2022-23. These all have an impact on the 1-in-200 year drought SDB, but not enough to move any zone from risk to not at risk, beyond that assumed in the performance commitment (no under- or over-performance up to this point). These were incorporated in the company performance commitment level so there are no changes to be reported relative to the performance commitment level. Delivered performance is reported as being the same committed performance.

b) Under-performance relative to the performance commitment

Table 11 shows a case of under-performance relative to the performance commitment. In this example a scheme in Zone C to deliver more supply (DO), as identified in the preferred plan for WRMP19 and included in the performance commitment projection (assumed to move the zone out of risk), does not get completed in 2024-25 as planned. Therefore, the population in Zone C is still at risk from each year from 2024-25 onwards (a period of 21 years) which must then be incorporated into the updated 25-year average risk reported in-period for 2024-25. As shown in table 11 this increase the 25-year average risk from 40%, which was the performance commitment level, to 45% of the population being at risk. In this case the company is reporting that is has missed its performance commitment level in 2024-25 because of the delay to the scheme in Zone C.

Table 11: reporting of in-period performance at company level

	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	…	2044-45
Baseline performance- Total company population at risk (number)	690,000								
Baseline performance - Percentage of company customers at risk (%)	69.0								
Performance commitment – Total company population at risk (number)		690,000	690,000	500,000	450,000	400,000	350,000	250,000	250,000
Performance commitment - Percentage of company customers at risk (%)		69	69	50	45	40	35	25	25
In-period reporting - Total company population at risk (number)		690,000	690,000	500,000	450,000	**450,000**			
In-period reporting - Percentage of company customers at risk (%)		69	69	50	45	**45**			