OFWAT and Water UK

Targeted review of common performance commitments

KPMG LLP and Jacobs

Contents

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Glossary

BABE	Burst And Background Estimation
DI	Distribution Input
DMA	District Meter Area
FD	Final Determinations
FEH	Flood Estimation Handbook
FOC	Flooding Other Causes
GSS	Guaranteed Standards Scheme
HDF	Hour to Day Factor
HHNU	Household Night Use
IHM	Individual Household Monitor
MLE	Maximum Likelihood Estimation
MSPC	Maximum Sustainable Production Capacity
Ml/d	Mega-litres per day
NHHNU	Non-household Night Use
ODI	Outcome Delivery Incentive
OPA	Overall Performance Assessment
PC	Performance Commitment
PCC	Per Capita Consumption
PHC	Per Household Consumption
PR	Price Review
RAG	Regulatory Accounting Guideline
RCV	Regulatory Capital Value
RoRE	Return on Regulated Equity
SAM	Small Area Monitor
SIM	Service Incentive Mechanism
SPL	Supply Pipe Leakage
WRMP	Water Resources Management Plan

1 Executive summary

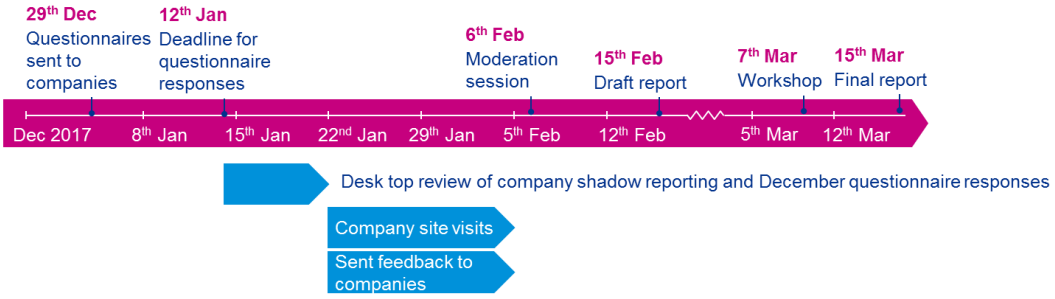
1.1 Introduction and approach

Ofwat and Water UK appointed KPMG and Jacobs to carry out targeted reviews of seven common Performance Commitment metrics (PCs) in order to understand how the companies currently approach and calculate the metrics these relate to. This will provide an understanding of companies' readiness for the implementation of those common PCs during AMP 7, the diversity that exists between companies' current reporting, and to allow for the development of more consistent definitions which are practical for all companies to implement.

In undertaking this targeted review we have relied upon desk research including questionnaires provided by companies, previous work on industry convergence and shadow reporting for three of the measures. We have also undertaken structured visits with each of the companies, reviewed certain evidence provided by them to confirm the approaches stated and also held a workshop with stakeholders where a draft of the guidance was discussed.

The project has been undertaken against a challenging timetable that is set out below. Maintaining this timeline has necessarily impacted on the level of detail that we have been able to go into in this exercise.

Figure 1: Review timescales



1.2 Key findings

Two key objectives of this work were to understand companies' current approaches to reporting and highlight any areas of inconsistency. Through this work we have found that:

- Across four of the PCs we reviewed (supply interruptions, sewer flooding, sewer collapses and mains repairs) there is a reasonable level of consistency in the approaches companies are adopting to allow them to capture and report their performance. This can be further improved through the additional changes to

the guidance that we have recommended allowing reasonable comparison in PR19.

- For two of the PCs (leakage and PCC) the changes we have recommended should drive a material improvement in comparability but companies will have a lot to do ahead of AMP 7 to comply with the new guidance. There also remain some significant opportunities for further work that will now need to be undertaken during AMP 7 ahead of the next price review.
- In the case of unplanned outages, through our review we have made material changes to the guidance and approach. These changes build on existing elements of the WRMP process to maximise consistency but the measure is still at a very early stage of development and our view is that meaningful comparative assessment is not currently possible. We recommend that a period of shadow reporting is undertaken to bed in the new guidance and that there is a further review of the PC guidance and definition during AMP 7.

Figure 2: Overall status of common PC reporting for AMP 7

PC	Status	Summary
Supply interruptions		■ The existing changes as part of the UKWIR work and proposed further changes to the guidelines should significantly improve consistency. ■ Companies are generally expecting to be fully compliant with the current guidance by the start of AMP7.
Sewer flooding		■ Some changes are required to the definition of the metric, as well as further guidance on the process that companies should use in recording and investigating flooding events. ■ Companies are generally expecting to be fully compliant with the current guidance by the start of AMP7.
Mains repairs		■ While there are refinements that can be made to the definition, there is currently a reasonable level of consistency in how companies are approaching this metric following historic reporting. ■ Companies are reporting that they expect to be compliant with the current guidance in time for AMP7.

Sewer collapses		■ Changes are required to the metric, in particular the removal and replacement of the 50% cross sectional area assessment, as well as increased levels of consistency across companies. ■ Some companies are reporting they have issues which may result in them not being compliant with the current guidance in time for AMP7.
Leakage		■ The existing guidelines should significantly improve consistency but it will not result in full convergence. ■ There are some specific areas within the guidance that can be improved easily. Other areas require further independent research to develop revised or new approaches that will now need to be undertaken in AMP 7. ■ Companies are reporting areas that may result in them not being fully compliant with the methodology as currently defined.
PCC		■ There are inconsistencies in how PCC is calculated across companies. ■ Companies are reporting that there are potential issues that may result in them not being fully compliant with the current methodology. ■ Some companies suggested a review of methodology is required for circumstances where meter penetration is high.
Unplanned outages		■ Companies are at an early stage of development of this new metric. Material uncertainty currently exists around core definitions such as MSPC and we have proposed a new and different approach building on existing WRMP definitions. ■ This metric will not be at a suitable stage of development to be consistent for the start of AMP7 and we recommend further development of the metric and shadow reporting.

The report makes a number of recommendations for each PC (see section 4) which are divided into three categories:

- Changes that we have made to the current guidance directly (these are also presented in Appendix A which includes revised guidance);

- Changes that we are recommending to the assurance of the measures for Ofwat to consider in the future; and
- Further work that we consider is needed to drive more consistency and comparability in these measures going forward.

In reaching our recommendations we have had to use a degree of judgement, for example where proposed improvements from different companies were in conflict. We have also focussed in the first instance on proposals that would improve comparability for AMP 7, sometimes at the expense of the accuracy of reporting.

PC	Immediate changes to guidance	Immediate changes to assurance	Recommendations for further work to drive consistency
Supply interruptions	3	0	0
Sewer flooding	4	0	4
Leakage	17	1	11
PCC	6	1	3
Outages	6	1	1
Mains repairs	4	0	1
Sewer collapses	2	0	0

We consider that the proposed changes to guidance outlined should be sufficient to allow the proposed PCs to be used during AMP 7. However comparative assessment and benchmarking of unplanned outages will not be possible across companies.

In reaching this judgement we have been mindful of how Ofwat has stated that it intends to use each of the proposed PCs (for example where there is a suggestion that comparative assessment consistency is more important than where targets are proposed on an individual company basis e.g. leakage). We have also considered where comparative assessment of similar PCs has been made in previous price reviews (e.g. supply interruptions at PR14 and the assessments of sewer flooding as part of the OPA) as well as the responses of the CMA in relevant appeals.

Similarly, in reaching this judgement we have considered the availability of data within companies for back-casting under the proposed (new) definitions as we understand it. We have proposed changes that we believe should generally improve and not exacerbate problems for companies in back-casting data for PR19 business planning, but we note the time periods for this work and that if these changes do create back-casting issues then it will impact on companies' ability to

prepare PC metrics for those business plans sensibly. The quality of data is something that Ofwat will need to consider in its assessment of business plans at PR19.

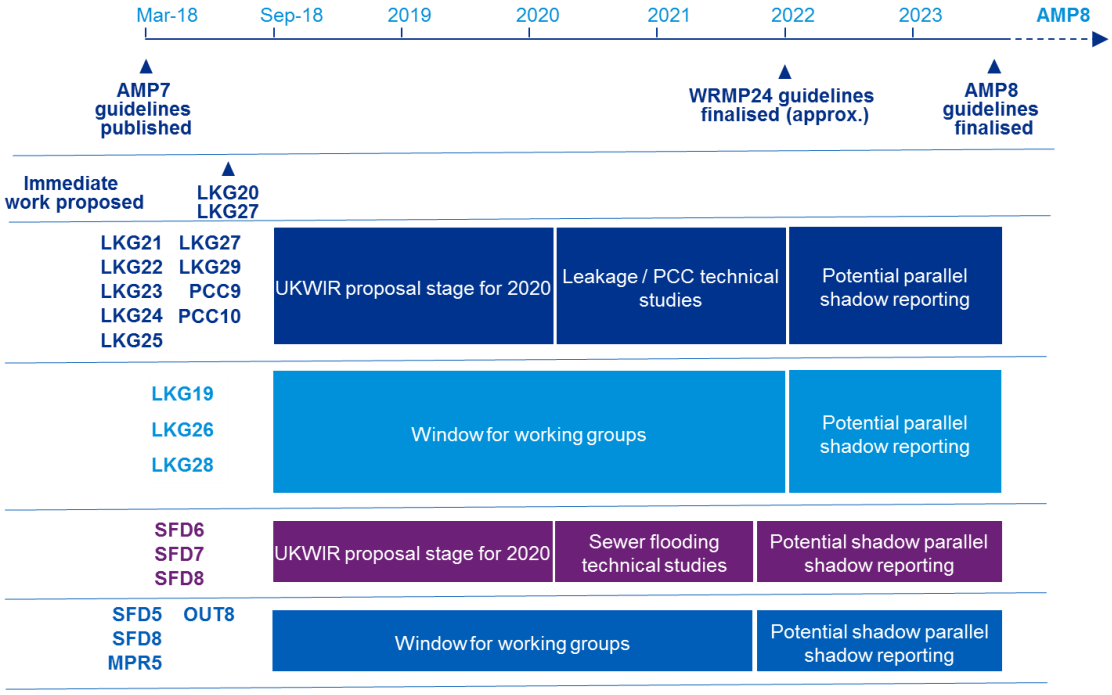
1.3 Next steps

Ofwat and the industry will need to consider the proposed changes to the guidance we have set out as part of this targeted review as well as our proposals for assurance and further work.

Whilst we consider that the direct guidance changes proposed, once implemented, will improve comparability of the metrics considered during AMP 7 we note that there is a great deal more that could be done over time to improve both the quality of the metrics and their comparability. An ongoing programme of work to further develop and review these metrics should be established. Ideally this would be an integrated programme recognising the various parties involved in this exercise and feeding into future updates to relevant sources such as the Discover Water website, future price reviews and other processes. We also recommend some changes to the RAG reporting that has been used under the shadow reporting for three of the PCs (leakage, supply interruptions and sewer flooding) and the expansion of this to all the PCs through the APR assurance process to provide a measure of the quality of the data to inform judgements made based on comparative assessment.

Beyond the immediate revised guidance, this report makes a number of other recommendations for future work which would further improve consistency and comparability of the PCs for the next price review. This further work would take the form of various studies, working groups or other actions. Below we suggest some potential timescales involved should this further work be required for PR24 based on the recommendations which are references and can be found in section 4 of this report. The timeline assumes that the revised guidance is effectively now fixed for PR19 and AMP 7 but that there may be work on shadow reporting of the new guidance ahead of AMP 7 and that any further work to amend or improve the revised guidance should take place during the early part of AMP 7. Whilst there is obviously substantial time ahead of AMP 7, we would note the lead in time for any UKWIR work should that be requested as shown in the timeline.

Figure 3: Potential timescales to incorporate further work prior to PR24



Throughout the course of our work several companies noted that changes to the PC reporting and definitions would change the overall reported levels of these metrics across the industry and that the messaging around this change would need very careful handling. For example, companies considered that under the new definition of leakage there is a high risk that values across the industry were likely to increase, purely as a result of methodological reporting improvements. This review has been focussed on driving consistency in the reporting of these measures and not whether the changes would increase or decrease PC reporting. However, these are often sensitive topics and the transition to this new reporting in AMP 7 is therefore likely to require very careful handling and communication across the sector.

1.4 Further considerations

Throughout the course of our work on this review some other points have been raised with us that are tangential but important to this exercise.

Some companies raised concerns around the incentive properties of some of the PCs, for example whether they promoted behaviours that would always be in the customer interest. These metrics have now been established by Ofwat and generally companies we spoke to did not argue with the rationale for the metrics chosen (e.g. to understand asset health) albeit that some did raise this concern about the broader incentive properties particularly for the newer metrics. The concerns raised do seem to us to have merit and in our own recommendations we have tried to address some of these incentive issues as far as possible. However,

we would suggest that as part of any ongoing work it would be sensible to consider the incentive properties of these metrics and whether the reporting of them could address any perverse incentives that may be created by the current or revised definitions and reporting. The overarching purpose must surely be to improve outcomes for customers.

Finally, some companies also raised concerns over the extent to which they could achieve similar levels of performance to their peers. We would note that there is a rich and positive history of comparative benchmarking in the water sector to drive improved outcomes for customers but wherever it has been used there have often been amendments to take account of the 'special' nature of different companies. Comparative PCs may be no different to this.

2 Introduction

2.1 Background and scope

As part of its methodology for PR19[1] Ofwat has established a series of common measures. These relate to certain aspects of operational performance or service. Companies have been asked to set certain Performance Commitments (PCs) or levels of performance or service that they will meet annually over the course of the five year price control period (AMP7). For example, a company may commit to ensuring that the level of leakage it has remains below a particular level for each year of the AMP. These 'common' PCs have been established because they are considered to reflect the key priorities and outcomes that customers and society have told companies that they want to see delivered over the AMP and so they have been made a core part of each companies' business plan submissions. The move to common PCs represents an evolution of the outcomes framework that Ofwat established at the last price review in 2014[2] and reflects the lessons from the new framework and earlier Ofwat consultations[3], 14 common PCs are required in total, seven of these measures have been the focus of this targeted review and they include:

1. Leakage: the amount of water lost from water company supply systems;
2. Per capita consumption: the average amount of water consumed per person per day in a water company area;
3. Supply interruptions: the combined length of each interruption to supply affecting each property each year as a proportion of total properties;
4. Sewer flooding: the number of instances where there is flooding from sewers at customers' properties, particularly both internal and external sewer flooding being reported.
5. Sewer Collapses - the number of sewer collapses in the report year (seen as a measure of the health of the assets);
6. Mains repairs: the number of burst water mains that a company experiences in a given period (seen as a measure of the health of the assets); and
7. Unplanned outages: the extent which unplanned events lead to a reduction in the maximum sustainable production capacity of a company and the length of time and impact of those events (also seen as a measure of asset health).

Establishing these common PCs and reporting on them will enable customers and other stakeholders to understand the performance or service levels that each company is seeking to achieve, compared with their peers. Ofwat's approach is

[1] Ofwat, 2017, Delivering Water 2020: Our final methodology for the 2019 price review
[2] Ofwat, 2014 Price Review
[3] Ofwat, 2016, A consultation on the outcomes framework for PR19

designed to help ensure that companies set stretching commitments for all aspects of customer service. This targeted review is focussed on these seven PCs only.

The study has been commissioned by Ofwat and Water UK as a joint-targeted review of the seven performance commitments set out above. Water UK is a membership organisation which represents and works with the major water and wastewater service providers in England, Scotland, Wales and Northern Ireland. Its vision is of a trusted water sector, providing customers and communities with world-class services and enhancing the UK's quality of life. Ofwat is the independent economic regulator of the water and wastewater sectors in England and Wales. Its strategic vision is to promote and improve levels of trust and confidence in the water sector amongst customers and the wider public and it operates according to a set of statutory duties that are set out in the Water Act 19914. Improving the consistency of reporting on the common performance commitments will help promote trust and the legitimacy of the sector and as such is an area of common interest amongst the sponsors on which there has already been some collaborative working.

2.2 Objectives of this targeted review

In seeking to develop these common performance commitments it has become clear that, whilst most companies in the sector already collect and report information on many of the PCs, different approaches are taken across companies in the collection, calculation, reporting and assurance of these PCs and this affects the ability to sensibly compare service levels.

Ofwat and Water UK have appointed KPMG and Jacobs to carry out targeted reviews of the seven common PCs listed above in order to understand how the companies currently plan to approach and calculate the metrics these relate to. This will provide an understanding of companies' readiness for the implementation of the common PCs, the diversity that exists, and to develop more consistent definitions which are practical for all companies to implement. Collectively this will help to ensure that the common performance commitments are implemented most effectively at PR19. Specifically the targeted review will seek to:

1. **Explain companies' current approaches to reporting on a number of the common performance commitments.**
2. **Highlight any areas where there are inconsistencies in approaches or calculations.**
3. **Develop consistent reporting requirements for those common performance commitments currently without them.**
4. **Provide more detail to support the consistent reporting requirements for those common performance commitments that currently have them.**

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[4] Section 2: General duties with respect to water industry, Water Industry Act 1991

5 Send a strong signal to stakeholders about the sector's collective commitment to common performance commitments that currently have them.

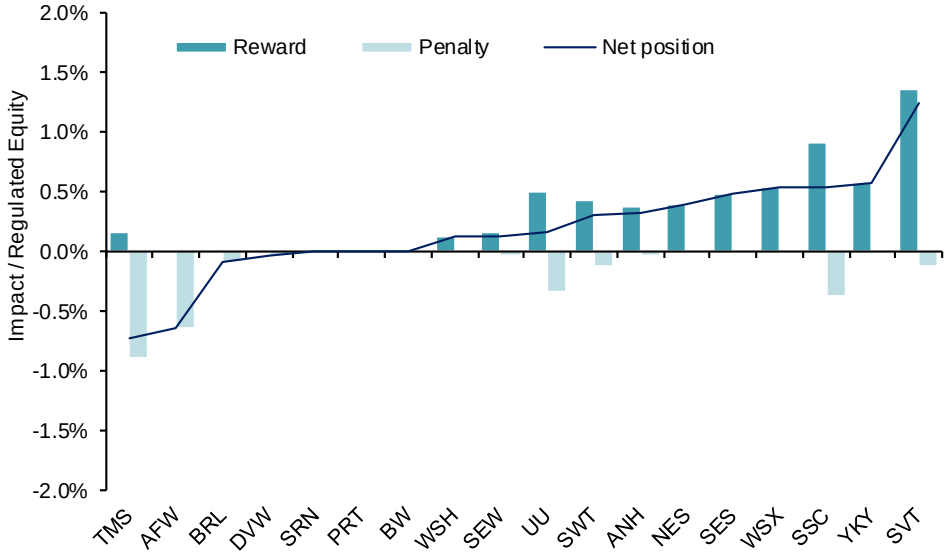
2.3 Background to performance commitments

As part of its methodology for the 2014 Price Review (PR14)[5] Ofwat introduced the concept of customer 'outcomes'. These were designed to represent measures of the operational performance that customers wanted from their local water companies. Companies were also able to talk to their customers about their priorities and the value that they placed on those outcomes and to set out certain PCs or performance metrics that they were committed to meeting in order to deliver the overall outcome that customers wanted. Companies were also then free to suggest financial or reputational rewards and penalties that they would apply to the delivery of those outcomes, again based on engagement with their customers and the valuations that they placed on the achievement of those PCs and outcomes. Importantly, Ofwat did not prescribe the type and form of these outcomes or PCs. Instead they allowed companies to set their own in consultation with their customers and these were ratified through the PR14 process, in some cases through some comparative benchmarking of different performance commitment levels across companies, and finalised in the Final Determinations[6].

Since April 2015, during the current five year control period (AMP 6), companies have been seeking to deliver the outcomes agreed with Ofwat and their customers. At the time of writing companies have reported their performance for the first two years of AMP 6 (2015-17) and the relative financial outperformance payments and penalties incurred are set out below as a proportion of their Return on Regulated Equity (RoRE)[7]. As part of the setting of price limits at PR14, reflecting the novelty of the outcomes approach, Ofwat set a cap and collar for financial outperformance payments and penalties at 2% of RoRE.

[5] 'Setting price controls for 2015-20 – final methodology and expectations for companies' business plans,' Section 3.6: the Risk Based Review in detail & Section 4: Focusing on delivery, Ofwat, July 2013
[6] PR14 Final Determinations, Ofwat
[7] Ofwat, 2017, RAG 3.10

Figure 4: AMP 6 outperformance payments and penalties incurred / accrued 2015-17



Where companies have PCs that have financial outperformance payments and penalties attached, those outperformance payments and penalties can be taken either as adjustments to revenue and prices to customers or as adjustments to their Regulatory Capital Value (which will also affect prices but over a longer time period). Most companies receive their financial outperformance payments and penalties in a single set of adjustments at the end of the AMP period but a small number of companies had their licences amended during PR14 in order to allow for these outperformance payments and penalties to be paid 'in-period', these include Severn Trent, South West Water and Anglian Water.

As part of Ofwat's approach to monitoring and assuring delivery[8] companies are required (under condition F of their instruments of appointment) to report their performance against each of their agreed outcomes and associated Performance Commitments from PR14 in their Annual Performance Reports (APRs)[9]. Companies are required to provide this information in accordance with certain Regulatory Accounting Guidelines (RAGs) set out by Ofwat and undertake assurance on these submissions. Ofwat operates a varied and risk-based approach to assurance under its company monitoring framework[10] and levels and forms of assurance can vary across companies.

At the same time, Water UK has developed an educational online resource (www.discoverwater.co.uk) that allows customers and other stakeholders to

[8] Ofwat, 2015, Monitoring and Assuring Delivery
[9] Ofwat, 2017, RAG 3.10
[10] Ofwat, 2017, Company monitoring framework – final position

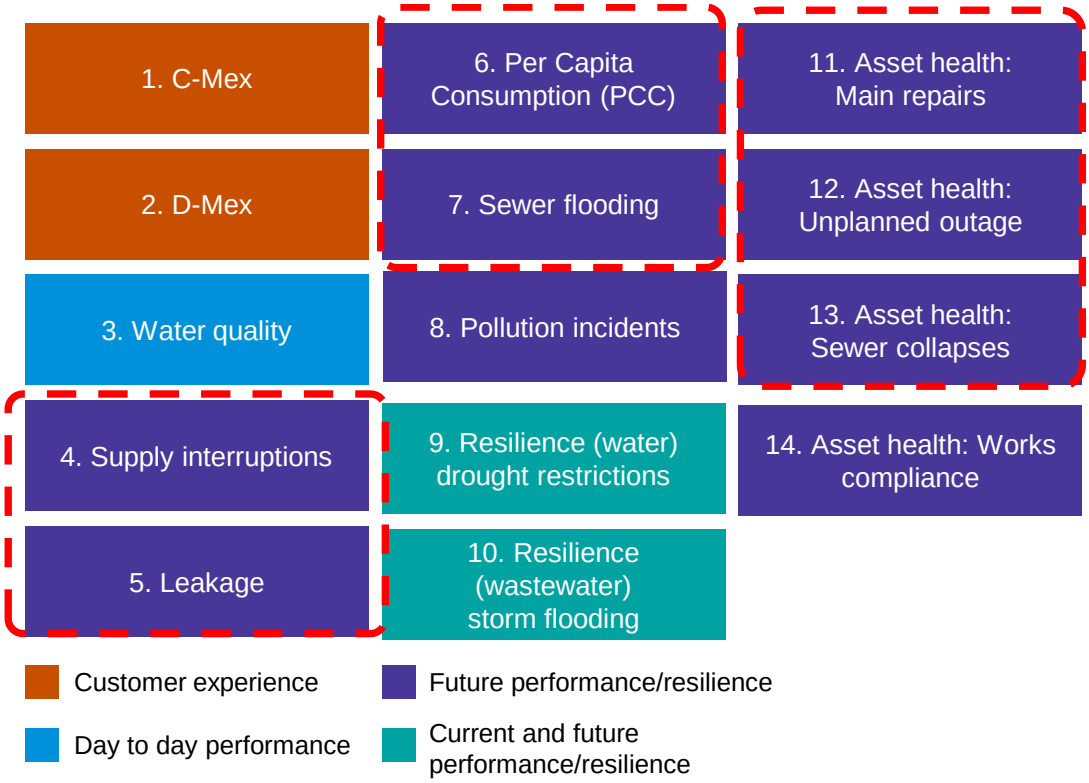
understand certain aspects of the operational performance of companies based on the current AMP 6 performance framework and definitions. The site also allows comparative assessment of certain metrics.

2.4 Ofwat's proposed approach for AMP 7

For PR19 Ofwat has set out fourteen common performance commitments. These cover those issues most commonly cited by customers from the experience at PR14. Ofwat has consulted extensively on these measures and whilst Ofwat will continue to encourage bespoke measures the common PCs are comprehensive.

Below are set out the common PCs that Ofwat has proposed for AMP 7 and the nature of each PC, those circled in red are covered by this review.

Figure 5: Ofwat's common PCs for AMP 7



Ofwat published some initial guidance setting out how these common PCs could be assessed and reported[11] alongside its July 2017 methodology consultation.

Ofwat has set an expectation of challenging service performance improvements for customers in AMP 7. It has stated that it expects companies to use a wide range

[11] 'Delivering Water 2020: consultation on PR19 methodology

of information on customer preferences to set Outcome Delivery Incentive (ODI) levels and for those levels of be 'stretching'.

For a number of the common performance commitments, Ofwat expects companies to set their targets at least at upper quartile level with this to be ascertained based on comparative assessment of companies. For leakage, they expect companies to justify their proposals against options including a 15% reduction by 2025. They also set out their intention to use league tables to strengthen reputational incentives.

Ofwat is seeking to place greater financial weight on these performance metrics and will not set a ±2% cap and collar on outcome performance in AMP 7. Instead Ofwat has suggested that an indicative range of ±1% to ±3% of RoRE may be appropriate but has emphasised that companies should set these performance levels following consultation with their customers. Following a series of licence changes, Ofwat also now expects financial outperformance payments/penalties to be paid 'in period' generally.

Some important conclusions from Ofwat's methodology in relation to this exercise are that:

- The common performance commitments allow customers, customer challenge groups (CCGs), other stakeholders and Ofwat to compare performance and to challenge companies on their proposed performance commitment levels more effectively;
- Comparative assessments of these common PCs are expected to take place at PR19 to aid in the assessment of common PC targets and during AMP 7 as part of the Discover Water site;
- Performance targets set against these common PCs are expected to be 'stretching';
- The financial outperformance payments (rewards) and penalties attached to company performance against these PCs are likely to increase in strength;
- These financial outperformance payments and penalties are likely to be incurred in period;
- Time is now very short to finalise any new definitions for the common PCs ahead of companies' business plan submissions for PR19 (September). This means that companies will be submitting their plans only a few months after these new consistent definitions are agreed and without a clear view of their comparative performance, albeit that there is more time to improve reporting before the start of AMP 7 (April 2020); and

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Appendix 2: Delivering outcomes for customers,' Ofwat, July 2017

- Company performance against these common PC metrics is likely to be increasingly transparent to customers and other stakeholders both through companies' APRs and also the Discover Water site.

The above points all serve to emphasise the importance of consistent reporting between companies.

2.5 Convergence and previous company reporting on common PCs

At various points since privatisation companies have had legal requirements to collect and publish information on certain aspects of their operational performance and clearly companies will be concerned about their performance and the underlying health of their assets in any event. Many of the seven measures reviewed have therefore historically been measured through previous reporting requirements either as part of a broader established process for another metric (for example Water Resource Management Planning) or in their own right.

Figure 6: Common PCs and historic reporting

Common PC	Historic reporting
1. Leakage	Leakage is covered by the WRMP process and a suite of associated UWKIR guidance, companies were required to report leakage previously under June returns and leakage formed part of the OPA.
2. Per Capital Consumption (PCC)	The calculation of PCC uses much of the same information that is required for the assessment of leakage as part of WRMP (e.g. measured HH and unmeasured HH consumption and the total population).
3. Supply interruptions	Companies will historically have had to collect and report information in their June Returns on this measure as part of their DG3 reporting (although this was a slightly different metric). Supply interruptions also previously formed part of the OPA and represents an element of GSS.
4. Sewer flooding	Companies will historically have had to collect and report information in their June Returns on this measure as part of their DG5 reporting. Sewer flooding also previously formed part of the OPA and represents an element of GSS.
5. Sewer collapses	This is a relatively new measure but companies previously reported sewer collapses in the June Return (JR) in Table 16 and they were included in the Serviceability Assessment.
6. Mains repairs	This measure was part of companies' historic serviceability assessments and they will have historically been required to collect and report this information in their June Returns.
7. Unplanned outages	Some similar issues are covered as part of companies WRMP work but this is a new measure for companies to develop and report.

The link to historic reporting is helpful in providing a starting point in driving a degree of common understanding and consistency in the definitions and the fact that companies have been benchmarked comparatively on some of the measures for example via the Overall Performance Assessment (OPA) provides further confidence that comparative assessment should be achievable for AMP 7. However, as can be seen, some of the measures have changed, most have not been comparatively assessed and some are still relatively new making comparative assessment much more challenging.

Therefore, whilst it is helpful to have some historic reporting arrangements in providing a starting point it cannot be assumed that this is sufficient to ensure consistency.

2.6 Previous work on convergence of PC reporting

Given the understood importance of consistency in PC reporting, Ofwat, Water UK and the rest of the industry have already undertaken some significant work in order to improve consistency and 'convergence' between companies in the setting of these definitions.

In particular:

- for three of the common PCs we are reviewing as part of this exercise, notably leakage, supply interruptions and sewer flooding, there has been a significant piece of work undertaken by UKWIR on the differences and inconsistencies between companies and the development of some guidance for common reporting between companies;
- Ofwat has also required companies to provide shadow reporting information for the same three of the proposed common PCs for the 2016-17 reporting year and to self-report as part of that exercise the extent to which they consider that they are fully compliant with the guidance; and
- other work has been undertaken by Ofwat in conjunction with the companies to develop an initial draft of guidance for the newly proposed asset health measures.

There are also other reports and work that is relevant in the context of different PCs, for example a recent report by Artesia in relation to reporting of Per Capita Consumption (PCC) and various historical UKWIR reports.

In general it can be observed that for some of the measures there is a reasonably strong history of common reporting definitions and convergence work but for some others, particularly the newer asset health measures, there is relatively little from which to build.

2.7 Constraints and limitations

The work has been undertaken according to an approach, methodology and timetable that we have agreed with the sponsors. There are some key constraints to this work that we have sought to highlight:

1 **The timeline has constrained the depth of the work**- The timeline has involved issuing seven questionnaires to companies, reviewing the responses to those questionnaires, completing and writing up a series of 17 company visits as well as moderating the feedback from those visits to identify key issues and finally considering how those issues could be addressed in a report with updated guidance. All of this has been completed during a seven week period. We have found the timeline to be extremely challenging and this has inevitably created a trade off with the depth of this review. To address this constraint we have focussed our work on the more material areas of inconsistency.

2 **Full convergence is not possible through a one off exercise like this -** There is a rich history of comparative benchmarking in the economic regulation of the water sector of England and Wales as well as other regulated utility networks. This comparative benchmarking has covered both costs and also service levels, for example the Service Incentive Mechanism (SIM) is a comparative assessment of customer experience and service and the Overall Performance Assessment (OPA) that preceded the SIM included a comparative assessment of both customer service and some aspects of operational performance (for example supply interruptions and sewer flooding). Experience of these exercises suggests to us that there is always a degree of inconsistency in the assessment and that no comparison is ever perfect between companies. Instead, what is important is that regulators are aware of the materiality of any inconsistency, for example through the use of confidence grades or some other qualitative assessment of the accuracy and consistency across companies, and are able to take account of that inconsistency in how the information is used. For example, where a regulator is aware of material issues driving inconsistencies across companies they may wish to place less weight on the comparative assessment across companies in setting performance targets and where the reporting is considered to be very consistent they may wish to place greater weight on comparative assessments.

3 **We have applied expert judgement and focussed principally on consistency over quality**- This targeted review exercise has required us to review and consider conflicting approaches and suggestions from different companies to how the definition of these common PCs should be taken forward. In taking these decisions we have sought to apply expert judgement and focus principally on the consistency of the PC measure definitions in line with the objectives of this work.

3 Methodology and approach

3.1 Overall approach

Our methodology and approach for this targeted review has involved four key sources of evidence:

- a desk review of companies' shadow reporting for three of the PCs (leakage, sewer flooding and supply interruptions) and some elements of published reports where necessary;
- a review of a series of questionnaire responses from companies relating to each of the common PCs;
- structured visits to each of the companies and a review of certain evidence provided as part of those visits[12]; and
- a workshop where draft guidance was discussed and challenged by companies and other stakeholders.

The approach was designed to provide both breadth and depth in the assessment of company consistency in PC reporting but we have not been able to review the underlying calculations and assumptions companies' use in their reporting of these PCs.

3.2 Desk research

The shadow reporting for 2016-17 that has been provided by companies is concerned principally with companies' own assessments of their relative compliance with the new guidance. As part of our desk review we have reviewed this information in order to identify material areas of inconsistency with the current guidance and when companies may be ready to meet that guidance. Our findings are reported in the following section for each of the relevant PCs.

As part of our desk research we have also reviewed on an exception basis various elements of historical guidance issued by UKWIR and other reports on different aspects of the PCs considered as part of this review. These historical reports either form the basis of old and generally more detailed guidance not covered by the current Ofwat definitions or are relevant in the development of different PCs.

3.3 Questionnaire responses

Upon commencing the project the sponsors provided us with a series of detailed questionnaires that we understand were prepared by various company

[12] Note 17 visits were completed with separate visits to each company and Dee Valley and Severn Trent Water separately following their recent merger.

representatives through Water UK and Ofwat. The questionnaires seek to expose in detail companies' current approaches to reporting and measuring their common metrics and to identify any areas of potential inconsistency.

We conducted a brief review of these questionnaires before finalising them and issuing them to companies. Appendix B provides the questionnaires that were issued to companies. We analysed the responses to the questionnaires in order to understand the more material and important areas of inconsistency between companies and to inform the questions that we later wished to raise during the company visits. Our findings from the review of questionnaires are reported in the following sections on the desk top review for each of the relevant PCs.

3.4 Company visits

As part of the review we visited each of the companies. Visits to Water only Companies (WoCs) typically took place over a single day and visits to Water and Sewerage Companies (WaSCs) took place over two days.

During each visit we discussed all of the common PCs relevant to each company, for WaSCs this included all seven PCs, for WoCs this excluded sewer flooding and sewer collapses but included all other measures. As part of each visit we proposed a standard day with timings as shown below but we allowed companies to amend the timings depending on the availability of key experts or elements that they wanted to discuss. These generic timings are shown below, they applied greater time to leakage and per capita consumption than other measures. This was based on the responses received to the questionnaires and the extent of the issues that we deemed likely to be discussed in the time available. Each PC generally required a different group of experts from each company.

The visits were undertaken between the 22nd of January and the 5th of February. To maximise consistency across the companies' common teams were used to undertake the visits including one member of staff from KPMG and one from Jacobs. To ensure that all the visits could be undertaken in the timescales required three teams were used.

Figure 7: Generic timings for a Water only Company one day

Time	Topics
9.00-10.00am	Leakage and PCC (2.5hrs)
10.00-11.00am	
11.00-12.00am	
	Asset health: outage (1hr)

12.00-1.00pm	
	Lunch (1hr)
1.00-2.00pm	
	Supply interruptions (1.5hrs)
2.00-3.00pm	
3.00-4.00pm	Asset health: Mains repairs (1hr)
4.00-5.00pm	Extra time (1hr)

Figure 8: Generic timings for a Water and Sewerage Company two days

Time	Day 1	Day 2
9.00-10.00am	Leakage and PCC (4hrs)	Asset health: sewer collapses (1hr)
10.00-11.00am		Supply interruptions (2hrs)
11.00-12.00am		
12.00-1.00pm		Lunch (1hr)
1.00-2.00pm	Lunch (1hr)	Sewer flooding (2hrs)
2.00-3.00pm	Asset health: Mains repairs (2hrs)	
3.00-4.00pm		Asset health: outage (2hrs)
4.00-5.00pm	Extra time (1hr)	

The intention was for the visits to take a common approach. The following outline brief and agenda was suggested in advance of the meetings to companies:

- A brief introduction from KPMG and Jacobs setting out the purpose and approach to the targeted reviews.

- A short presentation (no more than 4 slides) ideally in the form of a process flow explaining the company's entire end-to-end approach to reporting the PC measure. This presentation generally:
  - Highlighted the more material elements of the process for the PC metric/reporting as the company saw them (i.e. the material parts of the PC process/calculation); and
  - Any key areas of concern in that process with the guidance that might drive inconsistency.
- Where companies had reporting in place for the PC currently, they were then asked to explain (in c.2 pages/slides), when this was established and whether there are any material deviations from the existing (in some cases new guidance) with references to that guidance and why those deviations existed.
- If companies had not yet established reporting for the PC measure they were then asked to explain (as required but ideally no more than 4 pages/slides) their expected timeline to comply with the reporting requirements and any further information that they thought it might be helpful for us to understand their ability to comply with the reporting requirements.
- A short presentation from the company describing the key aspects of current guidance (ideally no more than 2 pages/slide per issue) that they considered could be improved, for example by providing further detail or amended drafting to improve clarity and consistency. As part of this companies were advised to focus on the most material elements.
- Where issues were not previously covered by the presentations provided a set of structured questions were provided by KPMG/Jacobs to each of the PCs based on the response from the company to the questionnaire.
- Any further observations / questions not covered previously were discussed and the sessions closed.

As part of each visit or following the visit we requested and reviewed some limited evidence including:

- Companies internal guidance statements setting out how they reported each PC; and
- Assurance reports into their PC reporting.

In some instances we also reviewed other evidence provided by companies in relation to particular issues raised or discussed at the visits.

A short summary was prepared of each visit noting down the key points and issues raised and companies were given the opportunity to comment on this and highlight any important points that they considered were missed or incorrectly identified.

3.5 Moderation and draft reporting

A moderation session was held on the 6th of February with all our team who had undertaken the company visits in order to identify the material issues of inconsistency between companies for each PC and identify how each of those issues could be resolved. Following the moderation session a draft report was prepared to document our findings, including revised PC guidance. This draft report was sent to all the companies, Ofwat, Water UK, EA and other stakeholders for comment.

3.6 Workshop and final reporting

Following the draft report all companies and stakeholders were invited to attend an all day workshop. During the workshop the key findings of the report and in particular the new guidance was discussed through a series of working sessions on each of the PCs.

Following feedback received at the all-company workshop, this final report was produced.

4 Key findings

The following sections summarise the findings from our desk research and site visits to the companies and the all-company workshop focussing on the more materials issues raised.

4.1 PCs subject to shadow reporting

4.1.1 Supply interruptions

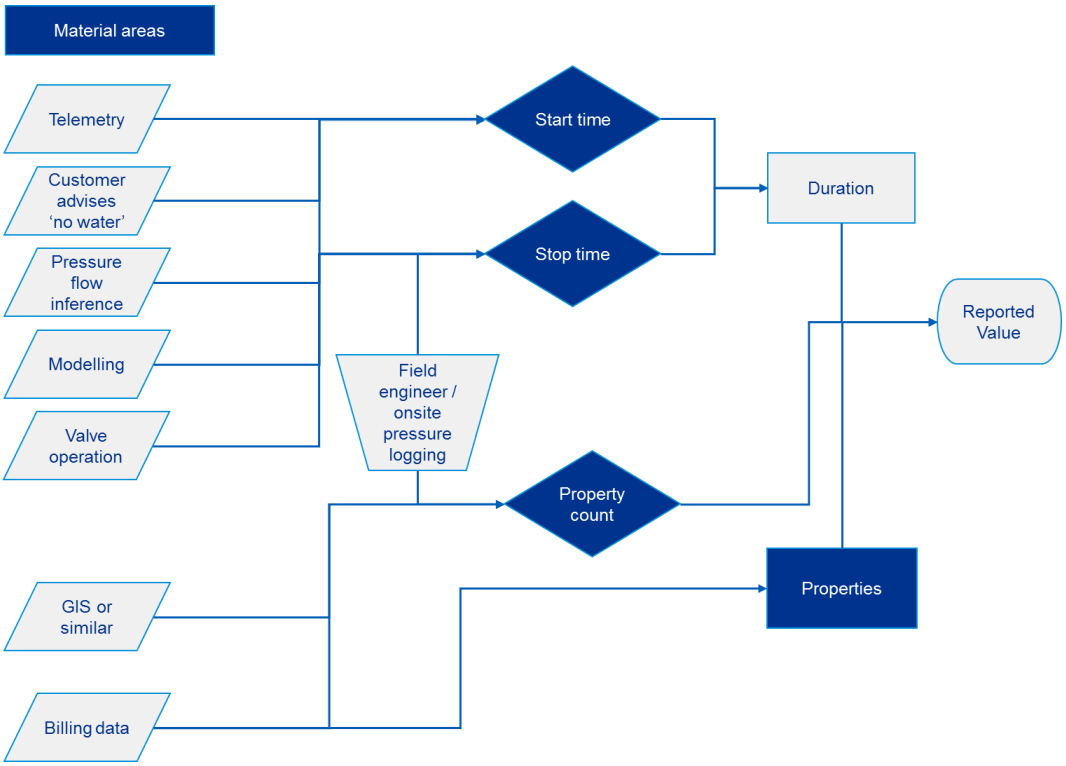
Current status	
Summary	■ The existing changes as part of the UKWIR work and proposed further changes to the guidelines should significantly improve consistency. ■ Companies are generally expecting to be fully compliant with the current guidance by the start of AMP7.

Description and process flow map

The supply interruptions performance commitment is a measure of properties suffering a loss of supply greater than or equal to 180 minutes as a proportion of the total number of properties. This measure builds upon the previous DG3 measure of supply interruptions.

Companies report supply interruptions by ascertaining a start time and a stop time of the interruption. This can come from a number of sources. The number of properties affected is then multiplied by this duration. Finally this is normalised across companies by dividing by the total number of supplied properties (year-end). Highlighted in blue are the material areas which have the greatest impact on the calculation.

Figure 9: High level process map of the supply interruptions calculation



The reported value is calculated as,

$$\sum \frac{(Properties\ with\ interrupted\ supply\ \geq 180\ mins)\ \times Full\ duration\ of\ interruption}{Total\ number\ of\ properties\ supplied\ (year\ end)}$$

There are no exclusions from this measure, since the cause of the interruption is not considered relevant to the calculation.

The relevant guidance for this measure is 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017', which in turn references 'Consistency of reporting performance measures. Reporting guidance – Supply Interruptions. UKWIR, report ref no. 17/RG/04/5'.

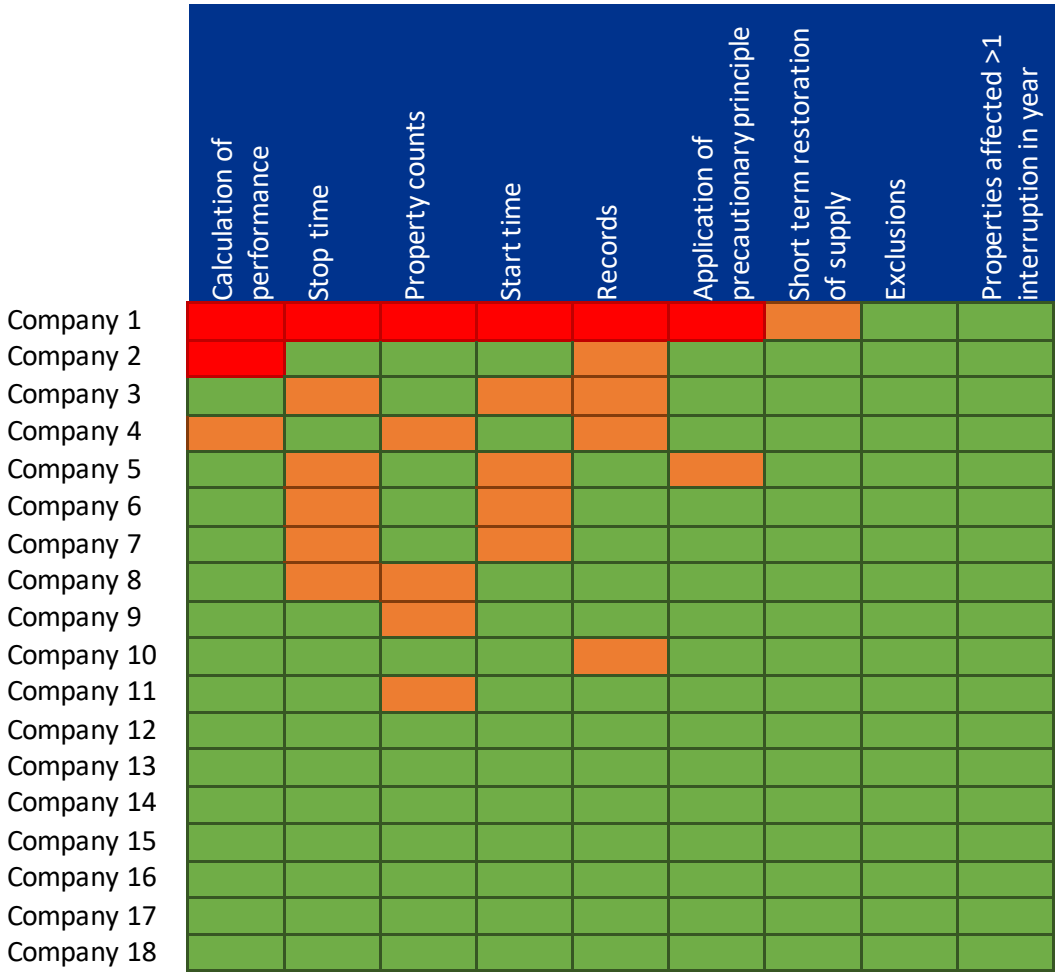
<u>Summary of desk top review</u>

As part of our process to understand companies' current approaches and to highlight any material areas of inconsistency, we reviewed companies shadow

reports for 2016-17 and undertook a review of companies' responses to the December questionnaires.

We analysed companies' shadow reporting RAG status and their commentaries. An anonymised version, sorted to show the components with the highest proportion of reds and ambers is below:

Figure 10: Supply interruptions shadow reporting RAG status



The questionnaires and shadow reporting provided insight into key areas of difference in current approach between companies.

The majority of ambers and reds identified in the shadow reporting were recorded against stop times, with start times also seeing a high number. In general it was noted by companies that this was mainly due to a lack of pressure and flow logging being available on their networks or timings not being fully validated.

Property counts also saw companies reporting a similar number of ambers and reds. Companies generally reported this was due to properties being counted

regardless of whether they bill the property, or issues due to the number of connections and bills for the property.

The following key differences in approach between the companies were identified from their questionnaire responses:

- Validation of start and stop times;
- Identifying and capturing supply interruption data;
- Assessing the incremental nature of supply loss;
- Application of the precautionary principle;
- Updating property data in corporate systems; and
- Data retention for all reportable incidents of supply interruptions as well as what evidence of challenge has been recorded and available for review.

Some companies responded with issues related to network pressure logging coverage and their coverage relative to others. Companies with a greater coverage of logging felt that this would increase their interruption time relative to companies that relied upon customer contact.

Material areas raised by companies

During our visits we discussed their processes and sought feedback on where companies considered there was potential for inconsistency. In general we focussed on the material areas highlighted in the process map above.

The following material areas of potential inconsistency and potential improvement were raised during our visits:

General comments

Companies have been recording a measure 'supply interruptions' as part of DG3 and GSS, however in the past they have used different pressure thresholds and made different exclusions. During our visits the companies generally stated that they felt the recent changes to the measure would improve consistency.

Companies have different pressure and flow logging coverage. Some companies raised a concern that this affected comparability and a prescribed minimum coverage should be set. Other companies were concerned that prescribed coverage would result in a significant new investment. On balance this report does not state a prescriptive coverage threshold, and notes that the guidance requires the most conservative data should be used when telemetry is not available. We do

however make a recommendation that companies should report what proportion of start / stop times come from each source.

Companies also discussed how their topographies and network layouts may still result in differences between supply interruption figures.

In addition some companies voiced concerns that a single major event could unduly affect their result, again reducing the comparability between companies. Sometimes major events occur that can cause companies to fail their target for the year. If there is no penalty cap in place, this can create a material liability for the company. If a penalty cap is in place, then the company has no financial incentive to perform well on the metric for the rest of the year (after the event). The study is not looking at Ofwat's incentive framework and the setting of targets and incentive rates is for companies to propose in their business plan submissions.

Properties and property count

The guidance states that properties in this measure are 'billed mains pressure fed household and non-household properties … they should only be considered as a single property if a single bill covers the whole property'. Some companies are reporting that they are using address point data from Ordnance Survey for property counts. Other companies are using billing address data. There is therefore some inconsistency in company approaches, including how void properties are accounted for. The guidance does currently state billed properties should be used. We therefore make no recommendation as it should be covered by reporting assurance. Again the guidance does currently state the voids should be excluded, and again we make no recommendation as it should be covered by reporting assurance.

In addition the guidance also requires that multiple-storey buildings 'shall be considered on a case-by-case basis and a floor-by-floor basis'. It was noted by many companies that they do not separately model multiple-storey buildings on a floor by floor basis. Several companies stated that they assume the use of a private booster pumping station, which would rule out the potential for properties on higher floors to have insufficient pressure when lower level properties have been restored. One company noted that they would not have height data to accurately model multiple-storey buildings, however most companies reported that they did not consider this a material issue. This report does not make any recommendations on the issue of multiple-storey buildings other than to place the onus on companies to provide adequate evidence to their assurer that they are compliant with the measure.

One company requested an on-going working group be established to ensure commonality in the use of topography when calculating properties affected.

Duration (including start time and stop time)

A variety of different approaches have been taken by companies due to the level of pressure and flow logging on their networks. Companies are using different data

to record start and stop times. Several companies did note that they felt that the measure would dis-incentivise the plans for increased logging, as they felt that companies using customer 'no water' reports only would record later start times than times recorded from telemetry on the network, and would therefore have shorter recorded interruptions.

Some companies also reported that they made efforts to include social media 'no water' reports in addition to customer calls.

Short term restoration of supply

Companies reported two broad approaches to short-term restoration of supply. Some companies reported that they believed that if they could restore customers even for a short time then customers' would be happy, as for example it would allow them to fill a bath or boil the kettle. Other companies reported that they did not attempt short-term restorations as they believed their customers would not find it acceptable and requested a change to the guidance accordingly.

This report does not recommend any changes to the guidelines to remove short term restoration of supply. Allowing short term restoration does allow customers to be given a temporary supply, but also allows for interruptions to be staggered, potentially providing an incentive on companies to game the measure by providing short term supply and avoiding the three hour threshold.

It is noted that keeping short term restoration does allow gaming in extreme cases.

Records

It was noted that as a result of the different data sources used to report this measure, companies are applying differing levels of rigour to internal assurance processes.

Proposed immediate changes to the guidance

For the following material issues raised we propose a number of immediate changes to guidance to improve clarity or consistency:

#	Issue	Proposal
SPI1	Some companies are receiving 'no water' contacts from social media. If companies are omitting this source of notification then their supply interruption values may be lower.	We propose that section 8, page 10 of the guidance be amended to include 'Customer service data may also include social media contact with customers'[13].
SPI2	Using telemetry/pressure flow data may be more accurate than customer data but may lead to longer reported times.	We propose that alongside their performance, companies should report on what proportion of their start/stop times have been informed by each data source (customer contact/pressure and flow data/modelled data/valve operation). This could help inform assessments of the validity of comparing different companies.

[13] Page 10 of 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017'

#	Issue	Proposal
SPI3	There is inconsistency in the way companies have applied the RAG assessment for shadow reporting and therefore further guidance is required if this it to continue to accompany annual submissions for the remainder of AMP6. It was suggested by a number of companies that the Ofwat confidence grades used in the old June Return would be more meaningful than RAG status.	1. For each of the components of the shadow reporting RAG a list of key elements which feed into each component be proposed. 2. The approach to overall assessment of each component of the shadow reporting to be specified based on materiality of each sub element. Consideration to be given to moving to old JR confidence grades.

Proposed immediate changes to assurance or other work

None identified.

4.1.2 Sewer flooding

Current status	
Summary	■ Some changes are required to the definition of the metric, as well as further guidance on the process that companies should use in recording and investigating flooding events. ■ Companies are generally expecting to be fully compliant with the current guidance by the start of AMP7.

Description and process flow diagram

The common sewer flooding performance commitment is comprised of two measures: the number of internal flooding incidents per year and the number of external sewer flooding incidents per year. These two measures include flooding due to overloaded sewers (hydraulic flooding) and due to other causes (FOC).

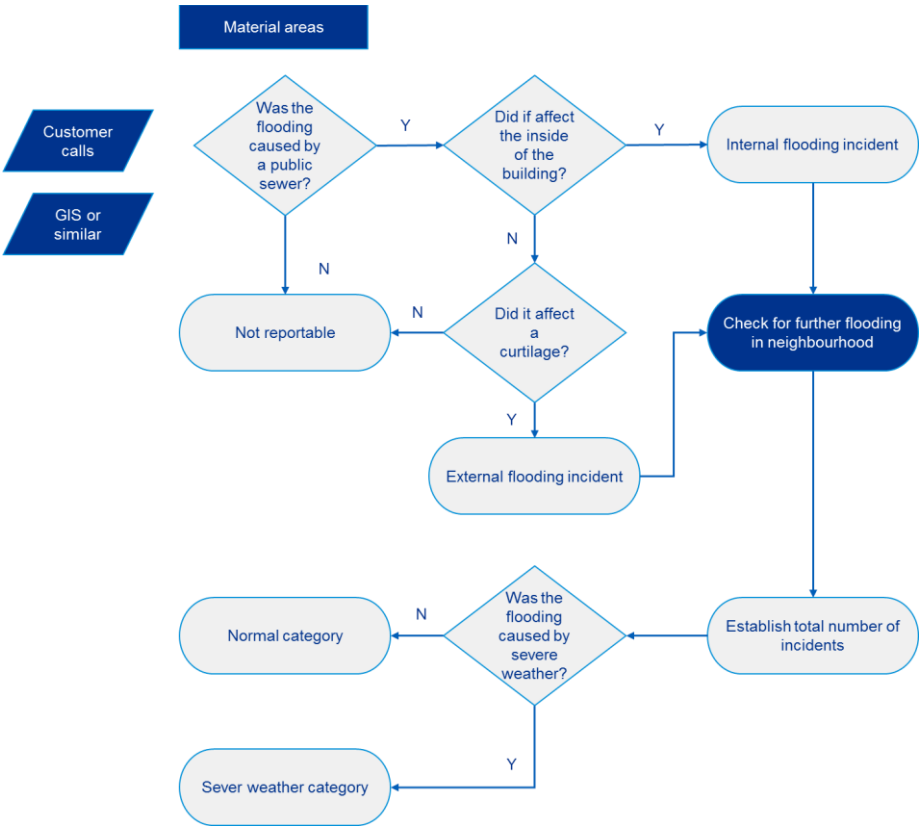
In reporting on their performance each year companies will be required to report the number of incidents including and excluding severe weather, although Ofwat is only using the metric including severe weather for the common performance commitment.

This measure builds upon internal and external sewer flooding metrics under the DG5 methodology.

The relevant guidance for this measure is 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017', which in turn references 'Consistency of reporting performance measures. Reporting guidance – Sewer flooding. UKWIR, report ref no. 17/RG/04/5'.

The process used in reporting against the measure is shown below:

Figure 11: High level process map of the sewer flooding calculation



<u>Summary of desk top review</u>

The questionnaire responses and review of shadow reporting submissions highlighted issues to be explored further during company interviews. The most material of these issues fall into the areas of:

- Customer contact;
- Neighbouring properties, and;
- Severe weather.

As part of our desk top review, we analysed companies' shadow reporting RAG status and their commentaries. An anonymised version, sorted to show the components with the highest proportion of reds and ambers is below:

Figure 12: Internal sewer flooding shadow reporting RAG status

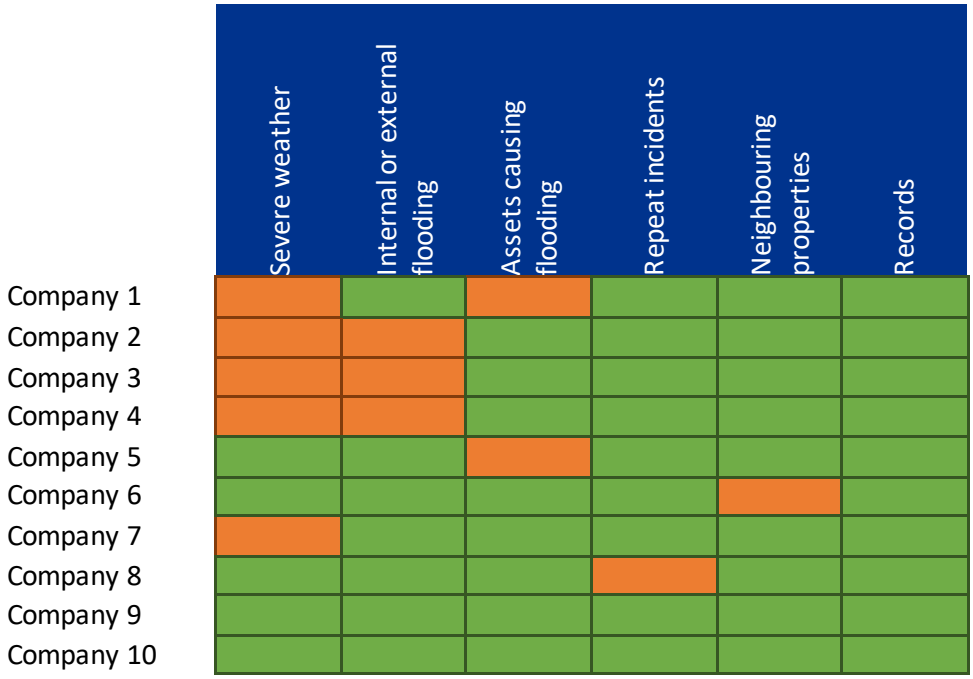
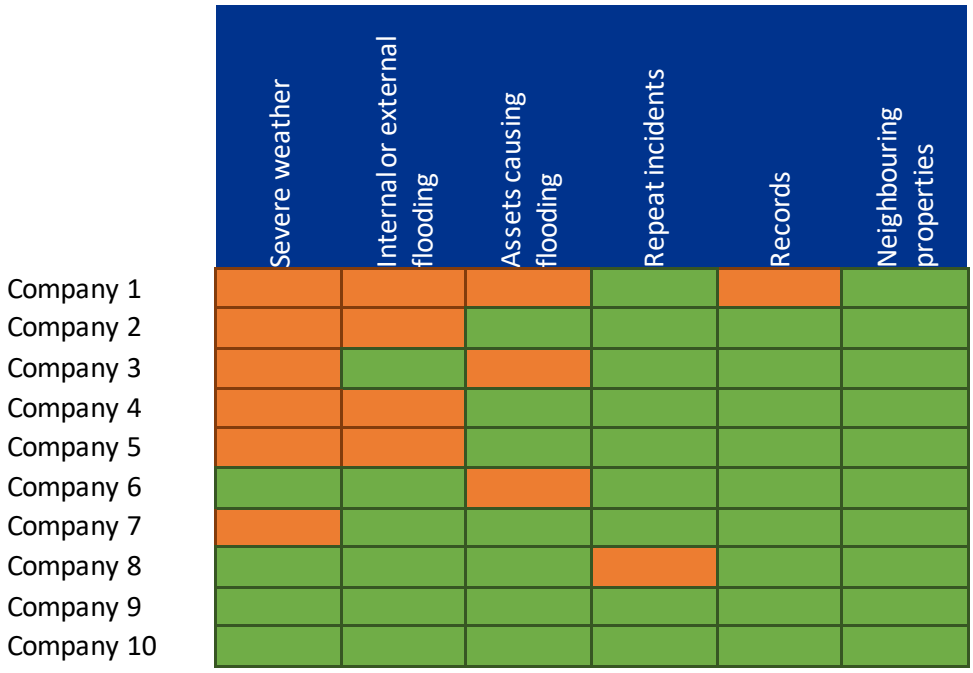


Figure 13: External sewer flooding shadow reporting RAG status



No companies reported a red status for any subcomponent of either internal or external sewer flooding.

Some companies reported an amber status against severe weather, with these companies reporting that being unable to adopt or fully adopt FEH13 being the primary reason. This was reiterated during out site visits.

In their questionnaire responses, all companies were generally in agreement that the methodology is appropriate, albeit with some concern on details such as severe weather and non-curtilage flooding.

Companies have different methods for call handling. The processes reported for handling high volumes of calls also varied.

Companies reported some differences in classifying internal and external flooding in some cases, for example car parks.

A number of companies reported issues with full compliance at the time of responding to the questionnaire. In addition, companies also responded with the following issues related to the measure:

- Some companies raise the issue of FEH13, which was also discussed during site visits.
- Some companies also raised that they felt there are insufficient river gauges to be able to exclude events where an outfall has been locked by receiving courses being at or above 1 in 100 year flood levels.
- Flooding caused by surface water entering networks upstream was also raised.
- Other companies raised specific curtilage issues.
- Some companies raised the issue of when to count repeat incidents.

Material areas raised by companies

The following material areas of potential inconsistency and potential improvement were raised during our site visits to the companies and the all-company workshop.

General comments

Companies noted that they had been reporting ‘sewer flooding’ historically for some time as part of DG5 requirements.

Some companies stated they believed that customer call scripts were an important factor in correctly determining sewer flooding, with some suggesting that customer call scripts should be published. The particular concerns in this area appeared to be that during periods of high call volumes, for example during extreme weather events, customers may not be encouraged to report incidents of sewer flooding. There was also a concern that events might not be categorised as sewer flooding

events or indeed categorised as internal events rather than external events. Other companies did not see differentiation in call centre scripts as a particular issue of concern, noting that they have procedures in place to encourage customers to stay on the line during periods of high call volumes and that they would expect customers to call back given the severity of the issue. Other companies discussed how they were occasionally referred incidents from the local authority.

The filtering and categorisation of customer call incidents is clearly an important part of the process of identifying sewer flooding incidents in that issues here would clearly drive a difference in the number of reported incidents. Customer call centre scripts are a key part of this categorisation. This report has not been able to review all customer call centre scripts in the time available.

Some companies noted that the quality of records for internal flooding is generally higher than for external. Concerns were expressed regarding the suitability of this information for target setting.

Assets causing flooding

Some companies reported that references to the private sewers should be clarified to refer to transferred private sewers.

Severe weather

All companies reported that they had not fully adopted FEH13 although some stated that they were using it in some limited cases. Many companies used the MET office for severe weather reports, and some companies reported that they understood the MET office itself was using FEH99. Some companies who had sampled FEH13 reported that it made small changes to their 1 in 20 year results. This report notes that companies have largely not adopted FEH13 for a variety of reasons, however all companies interviewed state they expect to be compliant by the start of the next AMP and impacts of the change are expected to generally be immaterial.

During the workshop several companies were concerned that companies were taking different approaches to the measurement and reporting of severe weather events.

It was also discussed that requesting different sized areas for the severe weather calculation from the MET office – or when using in-house solutions – may result in inconsistent results across companies. It was noted that there are differences in radar, rain and river gauge coverage across the country. The ownership of river gauges was also mentioned as an issue.

It also reported that the 1 in 20 year threshold does not match the 1 in 30 threshold used for GSS payments and therefore one company noted that it may be sensible

to align the thresholds. (Note: GSS refers to "exceptional weather" rather a specific return period).

Some companies reported issues with locked-out outfalls potentially due to mechanical faults as well as due to flooding levels. A mechanical failure would be reported as equipment failure.

Some companies reported issues with providing evidence for flooding linked to surface water entering upstream parts of the network and causing flooding elsewhere.

We also heard strong views from a small number of companies that sewer flooding measure should include an exemption for severe weather, based on concerns that this would result in a more volatile measure.

Determining whether flooding is internal or external

In general companies stated that they felt the guidance on the classification between internal and external flooding was clear. One company did state that they felt the definition of 'damp patches' was somewhat unclear.

Many companies reported that either they were unclear or they believed that others could be unclear on the guidance for curtilage and some external spaces.

Some companies stated that they believed there was room for clarification on highway flooding affecting properties, while others stated areas such as carparks that were separated from a building was also unclear.

The wording of 'In the case of farms, golf clubs etc.; flooding of the immediate curtilage of the main buildings (gardens, patios etc.) shall be included'[14] was also reported to be unclear.

Repeat incidents

Several companies reported that they believed that it may be unclear to others when repeat incidents begin, for example when customers have already started cleaning up the incident themselves. In general however companies stated that they did understand when a repeat incident should be counted and stated they believed they were either compliant or moving towards compliance.

[14] Page 41 of 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017'

Neighbouring properties

Several companies reported that 'reasonable efforts to determine the number'[15] of neighbouring properties is unclear. Some companies use prescriptive rules to determine which neighbouring properties have been affected while it was noted that many companies rely on field engineer judgement.

Whilst many of the companies considered that the guidance around neighbouring properties was sufficient and clear, a small number of companies were concerned that the guidance was too flexible and would drive an inconsistent approach. Indeed we saw evidence from one company that had adopted a different approach to reporting neighbouring properties in its sewer flooding reporting in the past, where both approaches would be consistent with the current guidance, and that this change in approach had led to an increase in reported sewer flooding incidents of more than 20%.

Records

It was noted by several companies that they included customer contact through social media. One company also noted that records should be held to clearly demonstrate potential sewer flooding incidents had been excluded.

[15] Page 42 of 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017'

Proposed immediate changes to the guidance

For the following material issues raised we propose a number of immediate changes to guidance to improve clarity or consistency:

#	Issue	Proposal
SFD1	Current guidelines require 'all reasonable efforts' to check neighbouring properties for sewer flooding. There is an issue that companies maybe under reporting sewer flooding incidents by not checking adequately. Some companies have prescriptive processes to check neighbouring properties others rely on field engineer judgement.	Companies should provide a separate count of how many neighbouring properties have been included on to a sewer flooding event.
SFD2	Current guidelines are unclear if overflow car parks associated with industrial parks, retail parks, hospital sites and university sites etc. but which are separated by a road or similar should also be included within sewer flooding events.	The guidance should be amended to state that overflow carparks physically separated from other associated sites such as industrial parks, retail parks, hospital sites and university sites etc. should be counted as separate car parks and therefore excluded from sewer flooding counts.

#	Issue	Proposal
SFD3	The wording on Page 4 section 7 'In the case of farms, golf clubs etc.; flooding of the immediate curtilage of the main buildings (gardens, patios etc.) shall be included' is unclear. The extent of the 'immediate' curtilage is unclear.	Proposed rewording: 'In the case of farms, golf clubs or facilities similar in type etc.; flooding of the area immediately adjacent to the club house immediate curtilage of the main buildings (paths gardens, patios verandas etc.) and therefore the areas used by people accessing only the facilities in the clubhouse shall be included as external flooding. Each situation needs to be considered on its own merits but it is unlikely that any greens, fairways or rough would be included. With respect to farms, if there isn't a defined farmhouse and garden boundary akin to a typical domestic property, an appropriate allowance should be made for land that would equate to a garden.'
SFD4	There is inconsistency in the way companies have applied the RAG assessment for shadow reporting and therefore further guidance is required if this it to continue to accompany annual submissions for the remainder of AMP6. It was suggested by a number of companies that the Ofwat confidence grades used in the old June Return would be more meaningful than RAG status.	a) For each of the components of the shadow reporting RAG a list of key elements which feed into each component be proposed. b) The approach to overall assessment of each component of the shadow reporting to be specified based on materiality of each sub element. Consideration to be given to moving to old JR confidence grades.

Proposed immediate changes to assurance

None identified

Potential changes to be taken forward after this report

For the following material issues raised we propose potential changes that may require further work after this report:

#	Issue	Proposal
SFD5	It is difficult to provide evidence for sewer flooding caused by surface water entering the upstream network	This report recommends a further working group study to investigate suitable ways of deriving this evidence consistently across all companies.
SFD6	Companies have reported issues with calculating flooding caused as a result of outfalls being locked out by receiving watercourses being at or above their 1 in 100 year flood levels. No guidance has been given regarding what level of evidence would be acceptable.	This report recommends a further working group study to investigate suitable ways of deriving this evidence consistently across all companies.
SFD7	Companies may be requesting inconsistent MET office reports e.g. reports coverage different sized areas.	This report recommends a further working group study to investigate suitable ways of deriving this evidence consistently across all companies.

#	Issue	Proposal
SFD8	Customer call centre scripts have not been reviewed as part of this exercise. We note that if the approach to categorising incidents at the contact centre is materially different then this may be driving material differences in categorisation of events.	This report recommends a further investigation into the consistency of customer call scripts and their impact on categorisation is undertaken or that this is a focus of future assurance work.

4.1.3 Leakage

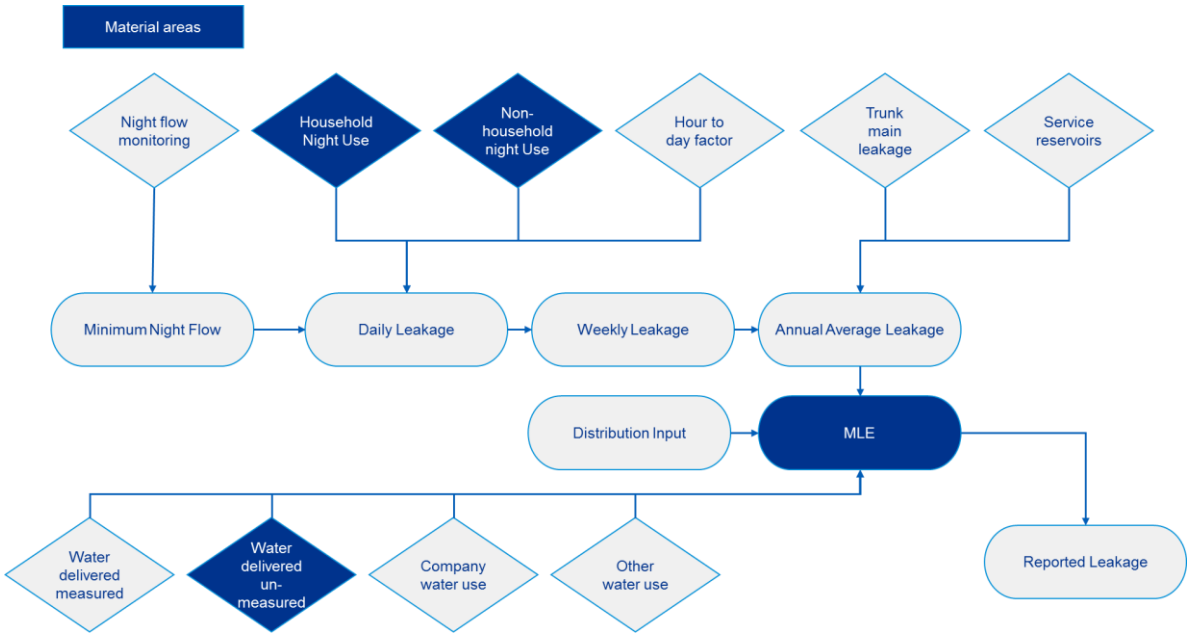
Current status	
Summary	■ The existing guidelines should significantly improve consistency but it will not result in full convergence. ■ There are some specific areas within the guidance that can be improved easily. Other areas require further independent research to develop revised or new approaches that will now need to be undertaken in AMP 7. ■ Companies are reporting areas that may result in them not being fully compliant with the methodology as currently defined.

Description and process flow map

The leakage performance commitment is defined as the sum of distribution system leakage, customer supply pipe leakage, service reservoir losses and trunk main leakage. It is reported as the annual arithmetic mean (referred to as 'average' in the guidance) daily leakage expressed in mega-litres per day (Ml/d).

The relevant guidance for this measure is 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017', which in turn references 'Consistency of reporting performance measures. Reporting guidance – Leakage. UKWIR, report ref no. 17/RG/04/5'.

The current process used in reporting against the measure is shown below:

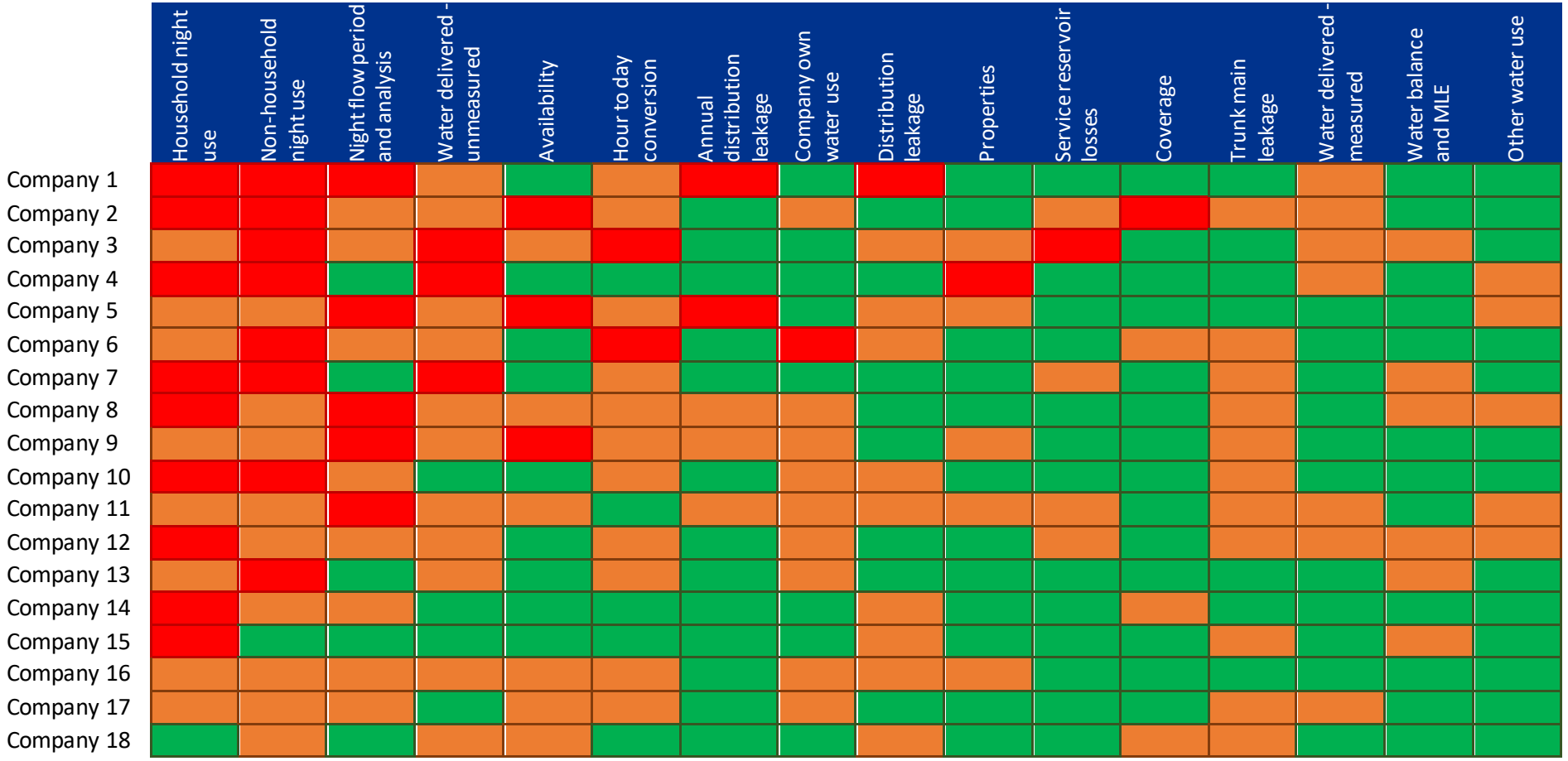


<u>Summary of desk top review</u>

The questionnaire responses and review of shadow reporting submissions highlighted issues which were identified to be further explored during company interviews. The most material of these issues fall into the areas of:

- Night use estimates;
- Night flow period;
- Estimation of plumbing losses and supply pipe leakage;
- Sample size, stratification and representativeness of night use, consumption monitors and hour day factor calculations;
- Data exclusions;
- Water delivered unmeasured; and
- MLE and confidence intervals.

Companies have reported their compliance with the consistency methodology as part of the shadow reporting of 2016/17 data. The following table summarises companies own assessments of their current compliance.


Household night use
Non-household night use
Night flow period and analysis
Water delivered - unmeasured
Availability
Hour to day conversion
Annual distribution leakage
Company own water use
Distribution leakage
Properties
Service reservoir losses
Coverage
Trunk main leakage
Water delivered - measured
Water balance and MLE
Other water use
Company 1
Company 2
Company 3
Company 4
Company 5
Company 6
Company 7
Company 8
Company 9
Company 10
Company 11
Company 12
Company 13
Company 14
Company 15
Company 16
Company 17
Company 18

Company 19																
Company 20																

In general, the shadow reporting RAG assessments confirm that night use and unmeasured consumption are key components of the leakage methodology. It also identifies a number of other components where companies are not currently compliant.

In addition to highlighting issues the questionnaires and shadow reporting provided insight into key areas of difference in current approach between companies.

Leakage is a measure which has been reported for many years but it is a complex process to derive the estimate and there has not been consistent overarching good practice guidance for all aspects of the calculation. As a result, companies have developed different approaches in a number of areas. Many of these differences have given rise to the issues raised by companies and the request for more defined guidance in specific areas.

Many companies have already addressed areas of inconsistency where these relate to methods of calculation rather than data collection. For example, they have moved to use of fixed hour or two hour periods for minimum night flow and night use estimation, they have moved to using weekly averages for night flow instead of minimum seven days and no longer use a rolling percentile approach.

One of the key areas of inconsistency is that companies are at various stages of implementing the methodology for convergence. However, it is not clear exactly where each company is on this time line due to the inconsistency in the way the RAG assessment has been completed. Some believe they are compliant because they have started implementation of a component even if data is not yet available to use. Others believe they will not be compliant until the data is available and used within the leakage calculation. In some cases data collection will take 12 – 24 months and therefore companies cannot currently be compliant. Timelines for achieving compliance were also therefore inconsistently reported.

There are a number of companies who are relying on industry default figures for some elements of the calculations. Most propose to replace these with company derived data but further guidance is required for some elements before proposals can be confirmed.

There is divergence in the way that uncertainty is managed and reported. The derivation of confidence intervals within the MLE is not well understood by companies and therefore there is a range of approaches to this.

Key areas of divergence include:

- Interpretation of the RAG assessment for shadow reporting;
- Application of rules regarding operability for night flow;
- Use of IHMs versus SAMs for unmeasured consumption estimation;
- Amount of continuous logging for NHHNU assessment; and

- Deployment of fast logging for HHNU.

Material areas identified by companies

The following material areas of potential inconsistency and potential improvement were raised during our site visits to the companies and the all-company workshop.

General comments

In general companies reported that they believed that the leakage consistency methodology has already improved the standardisation of reporting across the industry and will continue to do so as companies implement further changes. However, they believe that within the guidance there remains opportunity for divergence within the detail of individual components of the leakage reporting. The guidance 17/RAG/04/5 is a good overall summary but there is a need for individual elements to be expanded and further work is required via independent research in some areas in order to do this.

Several companies identified components of leakage reporting which potentially require high cost and time to achieve consistency through data collection with potentially low benefit in terms of improving the accuracy of the reported leakage figure. There are practical considerations: it can take several months to scope out projects and get them up and running followed by 12 to 24 months of data collection and analysis. Even with new guidance released in July 2017 it will not be possible to be fully compliant for PR19 submissions Sep 2018, and there is therefore considerable uncertainty regarding what the impact of such data changes will be. Some companies have found that the calculation changes have pushed leakage values up, and anticipate that data improvements will result in a downward trend over a longer period of time.

For some areas where thresholds have been set for consistency (e.g. 95% coverage and 90% availability for DMAs and 95% trunk main metering by volume) companies questioned the justification for these levels. They believe they were not always evidence based. Companies have also questioned whether the costs associated with achieving the thresholds were justifiable and proportionate. Key areas where these concerns were raised include operability, continuous logging of NHHs for NU and monitoring of all wastewater treatment works using more than 10m^3/d.

The question of how PC targets can be set for AMP7 was raised by several companies, although Appendix 2 to the Ofwat PR19 methodology provides guidance on how to set performance commitment levels for new metric and metrics with new data. Companies are at different stages of implementation and as stated above some of the measures already implemented have increased the shadow leakage figures whilst it is anticipated that implementation of some other areas of the guidance may reduce the shadow figure. There is concern that targets cannot

reliably be set using an uncertain base and many companies will not be able to back-cast data with an appropriate level of accuracy.

The consistency methodology will lead to changes in leakage estimates arising from data improvements and methodological improvements. One company pointed out that it will be important that these can be disaggregated from changes in real losses and that there is alignment on what companies report as changes due to these categories. They believe it is extremely important that all companies use a similar definition for real losses, data improvement and methodology change for leakage, given expectations outlined in the Ofwat's methodology document. If methodological improvements and guidance definitions continue to evolve over the coming years a consistent approach to assessing the effect on reported leakage estimates will be needed.

There was overall agreement around what the main areas with the potential to significantly impact on the leakage figure are; plumbing losses, supply pipe leakage (SPL), household night use (HHNU), hour day factor, unmeasured water use and maximum likelihood estimation (MLE) uncertainty.

<u>RAG assessment</u>

Many companies questioned whether all companies had applied the RAG assessment to the components of the leakage shadow reporting in the same way. From the questionnaire responses and the interviews it was evident that this was not the case. Detailed guidance around the RAG assessment was requested in order to compare each company's progress towards consistency more accurately.

<u>Further guidance sought</u>

There was agreement from many companies that further guidance in the following areas would assist consistency:

- Operability rules
- Data exclusion and infilling approaches
- Sample size and stratification for night use monitors, hour day factors and unmeasured household consumption monitors
- Updated good practice for night use monitors,
- Derivation of confidence intervals for use in the MLE.

A complete independent review of the approach to non-household night use was identified as being of value

A detailed methodology for trunk mains leakage assessment was identified by several companies as being required.

Retail market opening

A number of companies expressed concern regarding ongoing availability and quality of data for non-household properties as a result of retail market separation. Companies were concerned that while data update and improvement was being undertaken by the retailers there was a lag in this information being passed across. There was a view that this may manifest itself in the 2017/18 reported data. There was a concern that there would be an increase in the percentage of estimated data and therefore a deterioration in the quality of data available to companies. There was also some confusion expressed over the definition of non-household properties.

Plumbing losses and supply pipe leakage

Most companies expressed the view that improved guidance on the approach to estimating plumbing losses and supply pipe leakage was needed. It is noted that an UKWIR study on plumbing losses is in progress. Some companies would be happy to make use of a national data set for plumbing losses and others still thought company own data would be needed.

Night use

Leakage estimates are sensitive to night use assumptions and many companies felt the current guidance does not provide sufficient information on this. For household night use many felt an approach setting out a minimum standard for sample size and stratification would be helpful.

It was noted that the UKWIR report on fast logging had not yet been published so compliance with this approach cannot be assessed at this stage. The use of fast logging for night use estimates resolves the issues of sample size and stratification.

Companies also noted that guidance should reflect the increasing deployment of smart meters which could be used for night use studies. Night use monitors are closely linked to a company's unmeasured consumption monitor. One company suggested that SAMs are not appropriate for measuring household night use because they think that there is a risk that the customers captured within the small area are not representative of the licenced area as a whole, whereas IHMs can be deployed in a manner that allows for better stratification. That company believes that IHMs should be used exclusively for night use estimates. Conversely, a number of companies felt that SAMs offered benefits in terms of sample size and data outliers.

For non-household night use the bias error was noted by many but it was also noted that there is no clear guidance providing a common approach on correcting

for this. A full review and update of the methodology for non-household night use was suggested as being required.

Annual distribution leakage

One company appeared to be confused by the requirement for there to be a minimum of 3 days of data for a DMA to be used. They believed this part of the guidance meant they could select 3 days per week which they believed to be most representative.

One company did not consider that back-filling data is significant, proposing the requirement should be removed. They believed that interpolation of back-filled data reduces certainty of figures month on month.

Trunk mains

Companies that derive their leakage estimate at the zonal level do not have to consider trunk mains leakage separately. However, if DMA level data is used then companies must estimate trunk mains leakage and service reservoir leakage separately. Companies expressed a number of concerns around trunk mains leakage including the contradictory views on use of BABE vs metered data.

The 2015 UKWIR report on Leakage Upstream of DMA Meters states that the use of BABE is an acceptable method where companies do not have sufficient trunk mains metering. However, the current guidance for the leakage convergence states that the use of BABE is not acceptable if a company has more than 5% trunk mains leakage. A number of companies requested clarification regarding whether the intention is that companies need to obtain metered data and that BABE cannot be used. Companies questioned the value of this as the cost could be disproportionately large compared to the benefit in terms of the accuracy of the leakage estimate. The predominant view was that it was acceptable to continue to use BABE.

Unmeasured household consumption monitors

Several companies expressed the view that unmeasured household consumption could be better derived using SAMs which had been implemented for HHNU than IHMs. SAMs were believed to be more conducive to better coverage and less liable to outliers / anomalous readings. However, it was recognised that it can be difficult to select areas which contain single-usage properties, have minimal non household properties, have minimal measured households and are representative of the overall catchment area. The issue of minimal measured households within SAMs becomes increasingly relevant as meter penetration increases and this tends to push companies towards much smaller areas (single streets) or IHMs. For high meter penetration companies there was a suggestion that a national data set may be acceptable for unmeasured household consumption.

The choice of SAMs versus IHMs is linked to company night use monitors. As noted above, one company suggested that SAMs are not appropriate for

measuring household night use because they think that there is a risk that the customers captured within the small area are not representative of the licenced area as a whole. Other companies believe that SAMs offer better coverage and less potential for impact from data outliers.

UKWIR 99/WM/08/25 – Best practice for unmeasured per capita consumption monitors, sets out how unmeasured household consumption should be estimated. It is now quite old and UKWIR 17/WR/01/16 – Future estimation of unmeasured household consumption, provides some update. Some companies expressed a view that a review of both of these reports to produce a revised overall guidance document was needed.

MLE

Most companies expressed a view that guidance around how to derive confidence intervals for use in the MLE would be beneficial in improving consistency.

Proposed immediate changes to the guidance

For the following issues raised we propose a number of immediate changes to guidance to improve clarity or consistency.

#	Issue	Proposal
LKG1	There is inconsistency in the way companies have applied the RAG assessment for shadow reporting and therefore further guidance is required if this it to continue to accompany annual submissions for the remainder of AMP6. It was suggested by a number of companies that the Ofwat confidence grades used in the old June Return would be more meaningful than RAG status.	a) For each of the sixteen components of the shadow reporting RAG a list of key elements which feed into each component be proposed. b) The approach to overall assessment of each component of the shadow reporting to be specified based on materiality of each sub element. Consideration to be given to moving to old JR confidence grades. c) Companies should continue to report timelines for compliance with the convergent methodology.
LKG2	**Night flow monitoring - coverage, availability, operability** Some companies requested further clarification around the definitions of each of these and whether the thresholds are evidence based. For coverage, the consistency methodology states that 95% of a company's network should be covered by night flow	a) The guidance should be amended to specify that trunk mains are not included in the availability definition and within the operability definition. b) A company must set out the operability rules (methodology and thresholds) they use and provide supporting justification for these during annual assurance. Company submissions on this could be shared across all companies for consideration of

#	Issue	Proposal
	monitoring i.e. monitoring is in place for 95% of all billed properties. For availability, the consistency methodology states that 90% of a company's night flow data should be available for use in the leakage calculation i.e. data has been collected for 90% of the time i.e. meters and loggers are operable and the boundary to the areas has not been breached. The consistency methodology states that a company should apply its own operability tests to the available data. These are the checks that consider whether the data is sensible and should be included in the analysis. There are a range of approaches to operability testing including rules inbuilt into software such as Netbase or LMARS and manual checking. It is common that a PCC range is used to test validity of data but there is divergence around the range that is set – such as a numeric range or a range based on standard deviations. There may be difficulties applying standard rules in small DMA areas where there may be wide variability in data. How can manual checks be audited and confirmed as being applied in a consistent manner?	development of a set of common methods and thresholds.

#	Issue	Proposal
	It is not clear whether all companies report operability including trunk mains and whether they include trunk mains in DMA coverage.	
LKG3	**Night flow - data infilling** If data is excluded for operability reasons then the question of how to infill the data arises. The consistency methodology defines guidelines on how data infilling should be applied to night flow data but it is not clear in all circumstances how to apply the guideline e.g. how can you interpolate when the data gap is at the end of the year and there is no post data to use. Interpolation is not possible within some versions of software models used and new versions may have to be purchased to enable this.	The guidance should be amended to describe how to infill data at the end of a year when interpolation is not possible i.e. use last good value carried forward.
LKG4	**Properties** There is still some inconsistency around definitions of HH and NHH under retail separation. Eligibility may have been interpreted differently. Some companies have used best judgement and others principal water use to categorise customers. There is some concern over access to accurate property and consumption data for NHHs going forwards.	a) The guidance to be updated to specify that non-household properties should be consistent with the retail separation definition of eligibility. b) The guidance to be updated to state that differences between property data sets can be evidenced and explained.

#	Issue	Proposal
	There was some inconsistency with the use of address point data for properties versus use of billing system data.	
LKG5	**Night flow** Concern was raised by one company regarding the requirement to move to area average after 6 months of non-operability, as this could result in a step change in values. Concern was raised that the current guidance does not allow for an approach based on a calculation of DMA-level water balances.	As these were not widely noted concerns, no action is proposed.
LKG6	**Night flow period** There is common agreement that alignment of the period for night flow analysis with night use allowances is an improvement. However, there is debate regarding whether the current flexibility for using one hour or two hours within the period 2am – 4am is acceptable. Some companies suggest one single hour should be specified for all to use. Others suggest the current flexibility is acceptable and necessary so long as there is evidence to support the choice. With increased fast logging the importance of flexibility was stressed as fast logging provides the opportunity for increased accuracy of	a) The guidance should be amended to note that companies must justify their selected night flow period and why it is one or two hours. b) The guidance should be amended to note that companies must justify any seasonal adjustments they make. This must be evidence based and subject to independent assurance.

#	Issue	Proposal
	estimation of minimum night flow provided that there is flexibility over the choice of the period selected. The ability to change the period for seasonal use including events such as Ramadan also introduces the opportunity for divergence in approach. However, strong views were expressed that this is important to reflect local demographics.	
LKG7	**Annual distribution leakage** The wording in the guidance (Section 5.8) says 'The average weekly data shall be derived from the valid daily values of leakage using data points which are representative of the week. Where valid data is not available from three or more data points then the weekly data should be backfilled using the methods described in Section 5.4. This suggests that valid data for only 2 days may be sufficient. It is believed the intention from the workshops was for the wording to say you could use the data only if you had three days or more valid data.	The guidance to be amended to make it clear that a minimum of three days valid data is required and that all valid data must be used.
LKG8	**Service reservoir losses** It is not clear how often the service reservoir losses figure should be updated. Drop tests once every 5 or 10 years are	The guidance should be updated to specify that an annual update is expected but that this does not include annual drop tests of all service reservoirs but that where a new drop test

#	Issue	Proposal
	specified but it is not specified if an overall annual review is expected. This is a relatively small component of the water balance therefore this is not a priority area.	has been done that year the results should be included in the overall estimate.
LKG9	**Water delivered – unmeasured** Issues associated with unmeasured household water delivered are addressed in the PCC summary Generally unmeasured NHH water delivered is a very small component of the water balance for each company and therefore is not a priority area. There are some variations in approach such as using standard allowances per property versus applying use volumes from similar measured NHHs. No recommendations are proposed relating to unmeasured NHH use.	See PCC proposals The new PCC guidance is based on consumption not water delivered. To assist consistency between the leakage and PCC guidance documents the leakage guidance is to be revised to describe unmeasured consumption not water delivered.
LKG10	**Water delivered – measured** Generally, companies use billed data for both HH and NHH measured water delivered. The quality of data for NHH consumption from retailers must be maintained for consistent reporting and this is an area of concern expressed by some companies.	Recommendations for NHH property (LKG4) and metered use data are applicable here. Recommendation for void properties (LKG15) are applicable here.

#	Issue	Proposal
	There is some inconsistency in the way companies assess and account for void properties. See recommendations under voids.	No change to the guidance regarding use of billed data instead of metered data. Use of metered data to remain unchanged. The new PCC guidance is based on consumption not water delivered. To assist consistency between the leakage and PCC guidance documents the leakage guidance is to be revised to describe measured consumption not water delivered.
LKG11	**Company own use** The guidance states that a company must monitor (continuously log) its own use of water at its own sites where the volume is greater than 10m3/d. This can be a costly requirement for a very small component of the water balance. It was suggested that a sample of different types of works could be metered and used to assess the total volume. It was also suggested that companies should consider the PR aspects of not metering and monitoring their own water use when many have proactive metering programmes for their customers. The guidance says a company must justify its own use if the estimate is above 0.6% of DI. Companies suggested justification is required whatever the value otherwise	See recommendation for LKG17 and LKG18 regarding justification of the estimate. On balance it was felt that monitoring company own use at waste water treatment works is the right thing to do irrespective of the immateriality of it to the water balance and therefore no change to the guidance is proposed.

#	Issue	Proposal
	companies may be tempted to default to a figure below the threshold as the level of justification required is less.	
LKG12	**Other water use** The guidance says a company must justify its own use if the estimate is above 1.8% of DI. Companies suggested justification is required for whatever figure otherwise companies may be tempted to default to a figure below the threshold as the level of justification required is less.	See recommendation for LKG 17 and LKG18 regarding justification of the estimate.
LKG13	**Water balance and MLE** Most companies use the same components within the MLE. The main area of divergence is whether SPL is considered separately to consumption or included within water delivered. In some cases it is not included in MLE at all. To exclude SPL from MLE implies certainty in the SPL estimate. Confidence intervals used in the MLE are largely within similar ranges as indicated in the guidance but there is divergence on how these are derived. The final leakage figure is sensitive to the confidence intervals assigned to the components in the MLE. Guidance on how to set confidence intervals for the	a) The guidance to be amended to include the list of components for inclusion in the MLE. b) Guidance should state that companies should set out and justify how they derive the CI they use for each component in the MLE even if within the expected range.

#	Issue	Proposal
	components of the MLE is required. Proportionality of the CIs is important to maintain.	
LKG14	**Meter under-registration** MUR is dealt with inconsistently across components of the water balance within companies. Metered data is taken from: ■ DI meters ■ Customer meters ■ Night use monitor meters ■ PCC monitor meters ■ Night flow meters Therefore, there is potential for MUR to impact on estimates for night flow, HHNU, NHHNU, unmeasured consumption, measured consumption and the water balance. Dependant on meter technology and flow through the meter there may be no bias in either direction and therefore there should be no MUR applied. Calibration and verification should still be undertaken. For other meters where there is a bias for	The guidance should be updated to make the requirements for inclusion of meter under-registration clear. The need for justification for the figure used should be specified and the frequency expected for this to be revised. The guidance should also require a company to set out its approach to stopped meters and demonstrate that there is no double counting between stopped meters in consumption from billing data and MUR.

#	Issue	Proposal
	under registration then this should be accounted for in calculations.	
LKG15	**Void properties** Voids are not accounted for in a consistent manner. Some companies account for voids in PCC monitors but not in NU calculations. Some companies exclude all voids from property counts and only include a component of SPL. Other companies make some assumptions about some of those voids being occupied and assigning some consumption to them. These assumptions on occupation are not always based on recent estimates. Justification of these estimates could be more robust.	a) The guidance should be amended to state that void properties should be accounted for in all monitors. b) The guidance should be amended to stipulate the need for evidence for any allowance for use by void properties. The process for companies to maintain their record of voids on which this evidence is based should be subject to independent assurance.
LKG16	**Accruals** Companies deal with accruals for measured water delivered in different ways. Most referred to this as a finance process and that they used the data from their accounting systems.	The guidance should be amended to state that companies are required to demonstrate a robust process for dealing with accruals for measured water delivered.
LKG17	**Justification / assurance** In a number of areas the guidance specifies expected ranges for figures. Justification is required for figures outside of these	The guidance should be amended to make it clear that justification of all estimates and figures used is required. The

#	Issue	Proposal
	ranges. A number of companies expressed the view that justification for figures within the ranges was still required otherwise a company may be tempted to just pick a figure from the range with no justification. An example of this in the guidance is in section 5.7 where it specifies 'An N1 value of 1.0 to 1.2 in the leakage-pressure power law relationship unless a company is able to demonstrate a higher or lower value would be more appropriate using its own data.'	evidence base for company own estimates outside of expected ranges should be higher and requires independent assurance.

Proposed immediate changes to assurance

For the following issues raised we propose immediate changes to assurance to improve confidence in the PC.

#	Issue	Proposal
LKG18	**Justification of estimates** See LKG17	This report does not make any recommendations other than to place the onus on companies to provide adequate evidence to their assurance auditor that they are compliant with the measure and can justify estimates used. Even when estimates are within expected ranges companies must provide justification for the figures used. This should be part of the assurance process.

Potential changes to be taken forward after this report

For the following issues raised we propose potential changes that may require further work after this report.

#	Issue	Proposal
LKG19	**Night flow monitoring - coverage, availability, operability** See LKG2	Further work to set out a framework of acceptable operability tests for night flow data and the level of justification for these to be considered.
LKG20	**Properties** See LKG4	The impact of the opening of the retail market on data availability and quality to be monitored. Consideration to be given to the percentage of estimated data before market opening compared to the percentage after market opening.
LKG21	**Night flow period** See LKG 6	As the use of the fixed period becomes better understood the impact and benefit of moving to a single fixed specified hour for all should be considered. This should be considered during AMP7 as better NU data becomes available.

LKG22	**Hour to day conversion** Frequency for updating this was queried. There was a view that the hour to day conversion would only change when the pressure management of an area changed and therefore an update should only be triggered when a change has occurred. The guidance within Section 5.7 already specifies that updates should be triggered by significant changes or at least annually using pressure logging. An alternative of using hydraulic models is already specified if it is not possible to do pressure logging annually. Therefore, no change to guidance is proposed for this. More guidance around what constitutes a representative sample for pressure data was requested by a number of companies and clarity on what coverage of pressure logging is sufficient to be representative for each DMA was sought. For large companies with several thousand DMAs how do you assess the N1 factor? Is a sample acceptable? How to define sample size? Should there be a link to the materials of the network in question? The expectation is that there would be a higher factor for plastic networks than metal as pressure makes the pipe expand. Prescriptive guidelines may not be beneficial in this area as there are many factors to consider including sample of DMAs, how often the data is collected, or if hydraulic models are used,	Further work to agree minimum standards on sample size and representativeness to be considered. The output from this to be included in the guidance as a revision. Further work to set out how to derive 'N' factor to be considered.

#	Issue	Proposal
	how often calibrated, how much change there is in the overall pressure regimes. Setting out a 'minimum standard' may be more appropriate. Recent guidance (UKWIR 2017 – key parameters of leakage) states that hour day conversion factors should be company specific using pressure logging or well calibrated hydraulic models. The report does not set out how to derive the 'N' factor.	
LKG23	**Plumbing losses** HHNU is sensitive to the plumbing losses estimate used. A robust methodology to determining this is required. Indications from smart metering trials is that plumbing losses may be higher than previously thought. Accounting for plumbing losses within NHHNU is also difficult due to lack of data. The recently started UKWIR study by Invenio should help with this. A number of companies have also started their own studies into plumbing losses and have suggested they would be willing to share data. Others would support a national study on this to improve data sets but some companies expressed a view that whilst plumbing fittings are likely to be the same nationally there is still a need to reflect demographic context	The outcome of the UKWIR study on plumbing losses to be reviewed and agreement sought on whether to recommend a further study to look at measured households or a national data set.

#	Issue	Proposal
	and how water efficiency initiatives have influenced this and would therefore still want to collect company specific data.	
LKG24	**Supply pipe leakage** HHNU and other components of the water balance are sensitive to the supply pipe losses estimate used. There is inconsistency in how companies estimate this and how they keep the estimates up to date. Some use separate allowances for internally metered properties and others just use one estimate for all properties. A robust methodology to determining this is required.	A future study to determine a robust methodology to derive company specific supply pipe leakage estimates should be considered.
LKG25	**Non household night use** Several companies suggested that the requirement to monitor NHHs based on volume usage should consider variability in night use not just overall volume. The current threshold based on usage greater than 24-48m3/day or > 25% of DMA night flow does not consider whether night usage is constant or variable. As the guidance currently stands there is a potential significant cost driver associated with continuous monitoring of all large NHH customers regardless of whether use is constant or variable. However, it was also recognised that it would be	The Artesia project for Severn Trent Water and Affinity Water to be reviewed and fed into updated guidance on NHHNU. Further independent research to develop guiding principles and recommendations for NHHNU building on this work to be considered.

#	Issue	Proposal
	difficult to assess the variability without at least undertaking temporary logging which is also costly. The guidance currently says not to undertake logging over the summer. This can miss a significant legitimate component of NHHNU for rural / agricultural areas. The view was expressed by several companies that the current guidance on NHHNU would benefit from an update focussing on proportionate and efficient levels of data collection and analysis. The UKWIR methodology on which this is based is from 1999 and is outdated and has a bias transformation error in it. This was discussed at a recent working group meeting. The bias underestimates some SIC groups. It is unclear if all companies know about this and are correcting for it. Artesia have undertaken some work on this for Severn Trent and Affinity and this is due to be published shortly. Sample size, impact of stratification on small samples and impact on uncertainty need further consideration. Some companies have started looking at this and others are considering it. The guidance for non-household night use requires a review and revision to set out guiding principles and	

#	Issue	Proposal
	recommendations covering all issues. In the longer-term better data should become more widely available as automated meter reading (AMR) and advanced metering infrastructure (AMI) technology becomes more widely used.	
LKG26	**Water balance and MLE** See LKG13	Further work to set out how CIs should be derived should be considered.
LKG27	**Household night use** The sample size and approach to sample stratification needs more definition. Section 5.5 of the guidance states 'The HHNU survey needs to have a sufficient number of samples, representative of a company's demographic factors to identify both continuous and a significant number of intermittent flow events.' The guidance leaves it to a company to demonstrate that its survey is representative but the majority of companies raised issues about how to define this and sought further guidance. The increasing deployment of smart meters provides additional opportunity for data for night use studies.	An UKWIR report on fast logging is due to be published imminently. This report recommends that this should be reviewed when published and potentially fed into updated guidance on household night use prior to PR19. Current guidance to state that companies should follow the principles of fast logging. Future independent research to develop a minimum standard for HHNU sample representativeness including size, stratification etc. to be considered. The use of data from smart meters should also be reviewed.

#	Issue	Proposal
LKG28	**Night use – data exclusion rules** Further guidance on data exclusion for both HHNU and NHHNU monitors is required to improve consistency of approach. However, this should not be prescriptive as there is new data from fast logging and AMR/AMI and pressure transients which might not fit strict rules. Any guidance here should not preclude the introduction and use of new data.	Future work to develop acceptable data exclusion and infilling guidelines should be considered. This should not be overly prescriptive such that it precludes use of new data.
LKG29	**Trunk main leakage** There is a lack of a robust methodology and a conflict between the 2015 UKWIR report on Leakage Upstream of DMA Meters which says use of BABE is acceptable and the convergence guidance which says metered data must be used where trunk mains leakage is more than 5%. It is widely acknowledged that this is a difficult area but further guidance would be beneficial. This is a relatively small component of the water balance and the uncertainty is generally reflected in the confidence intervals used in the MLE.	Future independent research to define a methodology for trunk mains leakage estimation to be considered.

4.2 Other PCs

4.2.1 PCC

Current status	
Summary	■ There are inconsistencies in how PCC is calculated across companies. ■ Companies are reporting that there are potential issues that may result in them not being fully compliant with the current methodology. ■ Some companies suggested a review of methodology is required for circumstances where meter penetration is high. ■ In general companies support the use of PHC over PCC.

Description and process flow map

The common per capita consumption performance commitment is defined as the (three-year average) amount of water used by each person that lives in a residential property expressed in litres per person per day and excludes supply pipe leakage.

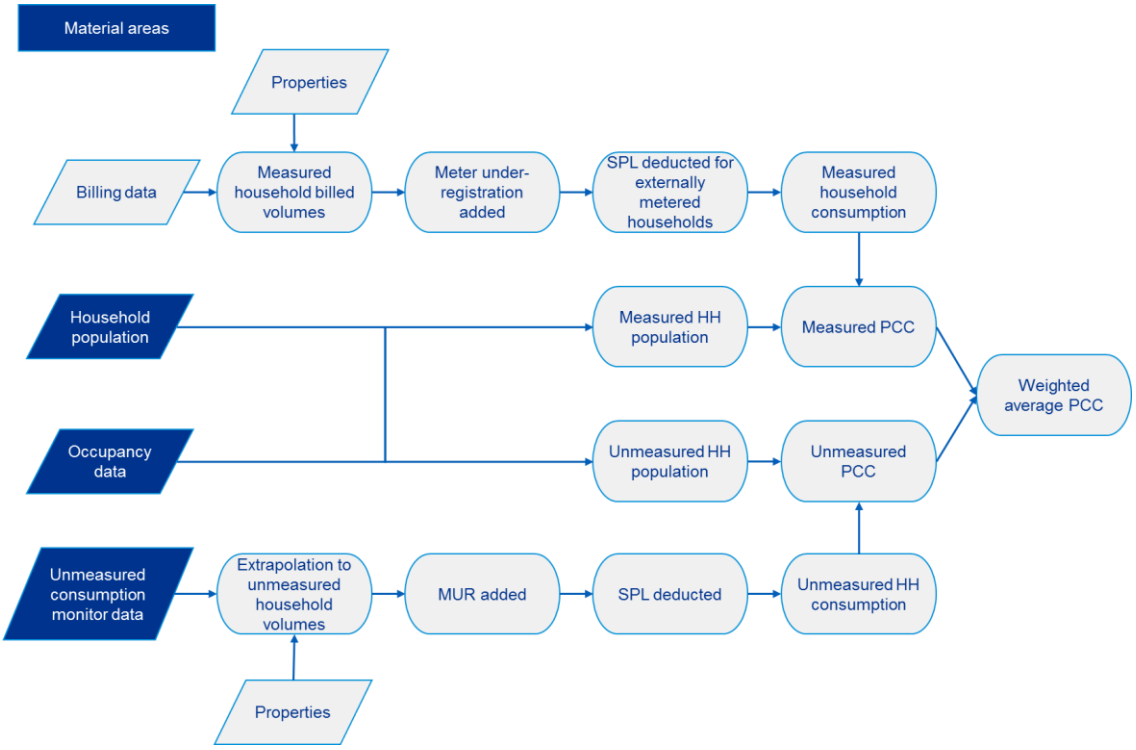
The intention is for forecast data to be consistent with WRMP data and for outturn data to be consistent with the WRMP annual review returns.

The relevant guidance for this measure is 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017'.

The average household PCC as proposed by Ofwat is calculated as:

$$\frac{Measured\ household\ consumption + Unmeasured\ household\ consumption}{Measured\ household\ population + Unmeasured\ household\ population}$$

The usual process used in reporting measured and unmeasured PCC is shown below:



Summary of desk top review

The questionnaire responses highlighted issues which were identified to be further explored during company interviews. The most material of these issues are discussed in later sections and fall into the areas of:

- Population updates;
- Occupancy estimates;
- Unmeasured household consumption monitors;
- Sample size, stratification and representativeness; and
- Data exclusions.

In addition to highlighting issues the questionnaires and the leakage shadow reporting provided insight into key areas of difference in current approach between companies.

Per capita consumption is a measure which has been used in demand forecasting for many years and has been reported annually. The estimation of per capita consumption is very closely linked to the process of determining leakage. There have been various UKWIR reports considering good practice for household consumption monitors and household demand forecasting over time but there is no single overarching guidance report for reporting annual per capita consumption estimates. As a result, companies have developed different approaches in a

number of areas. Many of these differences have given rise to the issues raised by companies and the request for more defined guidance.

All, but one of the companies have unmeasured household consumption monitors to derive unmeasured household consumption. There is an approximately equal split between those that have IHMs and those that use SAMs.

Key areas of divergence include:

- Frequency of population updates: once every five years versus every year;
- Method of derivation of occupancy data;
- Use of IHMs versus SAMs for unmeasured consumption estimation;
- Sample size and stratification of consumption monitors based on ACORN, occupancy or other variable; and
- Use of billed volumes versus meter readings for measured household consumption.

Material areas identified by companies

The following material areas of potential inconsistency and potential improvement were raised during our site visits to the companies and the all-company workshop.

General comments

The use of PCC as a performance commitment is generally not supported by companies due to the difficulty in obtaining accurate occupancy data. However, it is accepted that occupancy is one of the main determinants of water consumption and that PCC is important in measuring companies' performance against Government targets for reducing personal water use. The use of PHC removes the problems associated with occupancy data. The recent Artesia report supports the use of PHC as a more accurate figure. It could be appropriate for the guidance to stipulate that PHC should be used within the water balance and that PCC is derived post MLE on the final household consumption figures purely for reporting purposes. At least one company suggested the PCC calculation could be simplified to the following sum where population is not split into measured and unmeasured:

$$\frac{Measured\ HH\ consumption + Unmeasured\ HH\ consumption}{Total\ household\ population}$$

Companies generally felt that derivation of unmeasured household consumption would benefit from a well-defined methodology. This may have to reflect different approaches as a company's meter penetration increases. The potential for a national data set for companies with high meter penetration was raised. It was not clear what an appropriate threshold for this might be. A threshold of 75% could be

set for example, but further discussion would be needed to define this threshold and base it on some evidence.

There is a concern that explanatory factors such as meter penetration and demographic or socioeconomic factors make comparisons of overall PCC difficult to understand. Measured PCC is generally lower than unmeasured PCC and therefore there was a view that companies with higher meter penetration would have lower PCC. However, it does not appear that current reporting practices bear this out. For example, South Staffs Water has low meter penetration at around 30% and yet has the lowest overall PCC reported for 2016/17.

The implementation of the revised leakage methodology and how this impacts on the water balance and post MLE household consumption was highlighted by a number of companies as an unknown. Companies generally suggested back-casting data would be difficult.

At least one company suggested a Water UK working group would be beneficial for development of a consistent approach to PCC reporting.

Occupancy

There was general agreement that occupancy data is difficult to accurately obtain and there are a range of different approaches used to both obtaining the estimate and then reconciling data to the total HH population level. Frequency of updates also varies greatly. Occupancy figures can significantly impact the reported PCC figure if used to produce separate measured and unmeasured PCCs.

Population

A number of companies highlighted concerns with different approaches to population estimates, sources of data, frequency of updates and adjustments for unaccounted for population.

Unmeasured consumption monitors

The key findings noted in the leakage section relating to unmeasured consumption monitors are also relevant here. This is repeated below.

Several companies expressed the view that unmeasured household consumption could be better derived using SAMs which had been implemented for HHNU than IHMs. SAMs were believed to be more conducive to better coverage and less liable to outliers / anomalous readings. However, it was recognised that it can be difficult to select areas which contain single-usage properties, have minimal non household properties, have minimal measured households and are representative of the overall catchment area. The issue of minimal measured households within SAMs becomes more and more relevant as meter penetration increases and this tends to push companies towards much smaller areas (single streets) or IHMs. For

high meter penetration companies there was a suggestion that a national data set may be acceptable for unmeasured household consumption.

Further guidance setting out good practice on sample size and representativeness for both SAMs and IHMs was requested by several companies.

Proposed immediate changes to the guidance

The proposed immediate changes to guidance are set out in the table below.

Recommendations for leakage on data exclusions and data infilling, accruals, plumbing losses and supply pipe leakage are also relevant to the PCC PC.

#	Issue	Proposal
PCC1	**Guidance** There is no specific guidance for reporting the overall household PCC PC.	Summary guidance like that for leakage should be developed. Further independent research may be necessary to conclude guidance in all aspects.

#	Issue	Proposal
PCC2	**Measure definition** The use of PCC as a performance commitment is generally not supported by companies due to the difficulty in obtaining accurate occupancy data. The use of PHC removes the problems associated with this. The recent Artesia report supports the use of PHC as a more accurate figure. It could be appropriate for the guidance to stipulate that PHC should be used within the water balance and that PCC is derived after MLE on the final household water delivered figures purely for reporting purposes.	The PCC performance commitment should be specified as being derived from the following sum using post MLE figures: $\frac{Measured\ HH\ consumption + Unmeasured\ HH\ consumption}{Total\ household\ population}$

#	Issue	Proposal
PCC3	**<u>Population</u>** Population estimates and forecasts are generally updated once every five years for the WRMP. Some companies continue to use these figures throughout the five year period before a full update. However, some companies obtain annual updates using ONS mid-year estimates. Some companies make adjustments for 'clandestine' population. This will vary in significance from company to company. Reports by Edge Analytics were referenced in a few instances. The EA Water Resources Management Plan Guidelines set out how companies should estimate population and this should be being followed by companies for the five year updates. . There does not appear to be any real barrier to applying this approach on an annual basis. Assessment of NHH population also varies. This can be important if it interacts with the population assigned to unmeasured HHs.	Guidance to specify that population forecasts must be updated every year in line with the EA guidance for population forecasting for WRMPs. See PCC7 and PCC8

#	Issue	Proposal
PCC4	**<u>Properties</u>** There is still some inconsistency around definitions of HH and NHH under retail separation. Eligibility may have been interpreted differently. Some have used best judgement and others principle water use to categorise customers. There is some concern over access to accurate property and consumption data for NHHs going forwards. Voids: Definition of voids, derivation of void property estimates and assignment of consumption to voids are dealt with inconsistently by companies.	As per leakage recommendations for properties and voids LKG4 – the guidance to specify that non-household properties should be consistent with the retail separation definition of eligibility. LKG15a – the guidance should state that void properties should not be counted in property numbers for consumption monitors. LKG15b – the guidance should stipulate that companies must present evidence to justify exclusions for void properties and where any useage allowance is applied. The process for companies to maintain their records of voids should be subject to independent assurance.

PCC5	**Occupancy** Occupancy figures can significantly impact the reported PCC figure. Occupancy data is difficult to accurately obtain and there are a range of different approaches used to both obtaining the estimate and then reconciling data to the total HH population level. Some companies survey measured and unmeasured customers and apply a weighted reconciliation to the figures. Others survey only measured customers and unmeasured occupancy is derived from the reconciliation with total population. Others survey unmeasured occupancy and measured occupancy balances this. Others use NHH population to balance total population. Others assume the same occupancy for measured and unmeasured and divide total household population by total household properties. Approaches to occupancy surveys vary greatly – online, Facebook, telephone, postal. Frequency of updates also varies significantly.	An alternative simpler approach to the measure is proposed – see Measure Definition PCC2. See PCC10.

#	Issue	Proposal
PCC6	RAG As the PCC PC is a new measure there should be some way to assess compliance with the guidance. It was suggested by a number of companies that the Ofwat confidence grades used in the old June Return would be more meaningful than RAG status.	a) Compliance against the guidance to be assessed against a RAG status. Elements of the RAG to be consistent with relevant elements of the leakage PC i.e. unmeasured household consumption, measured household consumption. b) The approach to overall assessment of each component of the shadow reporting to be specified based on materiality of each sub element. Consideration to be given to moving to old JR confidence grades.

Proposed immediate changes to assurance

For the following issues raised we propose immediate changes to assurance to improve confidence in the PC.

#	Issue	Proposal
PCC7	**<u>Population</u>** Annual updates – see comments in PCC3	Companies must demonstrate that they are following the guidance for population updates on an annual basis. They must specify sources of data and confidence in this, and this should form part of the annual assurance process.

Potential changes to be taken forward after this report

For the following issues raised we propose potential changes that may require further work after this report.

#	Issue	Proposal
PCC8	**<u>Population</u>** Annual updates – see PCC3	Propose an independent research project to develop further guidance on approach to within period population updates. NB: this recommendation was proposed in the draft report before it was agreed that annual population updates should be adopted. It is therefore, no longer required.

PCC9	**Unmeasured household consumption** The sample size and approach to sample stratification needs more definition. Sample size for IHMs is clearly stated. It is not stated for SAMs. There is a question as to whether it is appropriate for both a small water only company and a large water and sewerage company to have the same sample size of 1000 IHMs Is this proportionate for small companies? Should large companies require a larger sample? Does this take account of data variability? Maintaining a sample size of 1000 IHMs can be difficult. How should tourist / second homes be considered within sample representativeness? How should companies consider what is the most appropriate factor on which to base stratification? UKWIR 99/WM/08/25 – Best practice for unmeasured per capita consumption monitors, is now quite old. UKWIR 17/WR/01/16 – Future estimation of unmeasured household consumption, provides some update.	Propose future independent research project to define good practice for sample representativeness including what the key factors for stratifying a sample are. Sample size for SAMs and IHMS also to be considered. A review of UKWIR 17/WR/01/16 – Future estimation of unmeasured household consumption, alongside UKWIR 99/WM/08/25 – Best practice for unmeasured per capita consumption monitors to be considered to develop revised overall guidance.
PCC10	**Occupancy** See PCC5.	Propose future independent work to determine whether any best practice approach would be good enough to overcome the significant uncertainty around occupancy estimates.

4.2.2 New asset health measures

4.2.3 Unplanned outage

Current status	
Summary	■ Companies are at an early stage of development of this new metric. Material uncertainty currently exists around core definitions such as MSPC and we have proposed a new and different approach building on existing WRMP definitions. ■ This metric will not be at a suitable stage of development to be consistent for the start of AMP7 and we recommend further development of the metric and shadow reporting.

Description and process flow map

Ofwat has proposed the introduction of this measure as a means of assessing asset health (primarily non-infrastructure – above ground assets), for water abstraction and water treatment activities. It is defined as the average unavailable flow (based on dry year peak week production capacity) for each company. This measure is proportionate to both the frequency of asset failure as well as the criticality / scale of the assets that are causing an outage.

The actual unplanned outage should be reported as the temporary loss of production capacity in the reporting year weighted by the duration of the loss (in days).

The proposed calculation is:

$$\frac{Reduction\ in\ dry\ year\ peak\ \ week\ production\ capacity\ \times Duration\ in\ days}{365}$$

Unplanned outage for each source is calculated separately and then summed over the reporting year to give a total actual outage for the water resource zone.

The company water resource zone weighted outage can then be summed and then normalised based on overall company dry year peak week production capacity to be reported as a percentage.

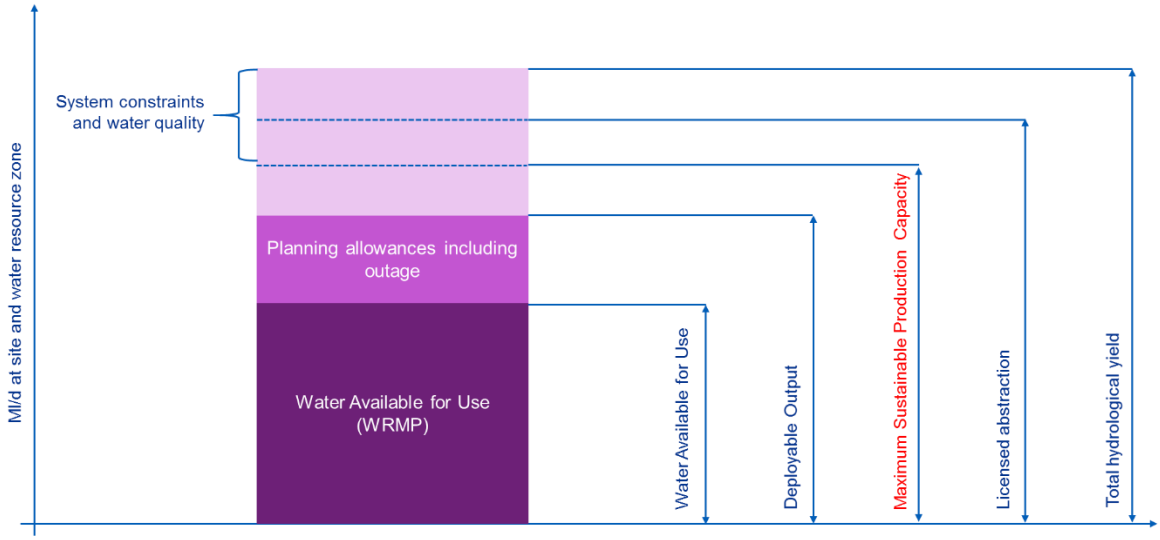
Unplanned outage for this measure is a temporary loss of dry year peak week production capacity. It is a requirement of the WRMP annual review regulatory submissions to report on actual outage in terms of deployable output. This definition aims to closely match those used for water resources planning where a statistical outage allowance is calculated for WRMP forecasts and actual outage is

reported for WRMP annual review data returns. However, where deployable output reductions are used for these (WRMP) purposes, this measure uses dry year peak week production capacity.

This definition of unplanned outage makes use of the UKWIR guidance on outages[16] and the more recent WRMP guidance for the most recent WRMP process[17].

The diagram below seeks to highlight some of the different but related measures of water production capacity and explain the difference between them.

Figure 12: Different measures of water production capacity



An unplanned outage is an unforeseen or unavoidable event which can affect either part or all of the source works which contributes to maximum production capacity. This is different to planned outages where a planned event such as planned maintenance reduces a source works output. A source works is considered to be all assets used between and including the point at which water is first fit for purpose (enters distribution network). This can include:

- source abstraction assets (e.g. abstraction pumps, screens, boreholes);
- raw water transport assets (e.g. pumping plant and mains);
- raw water storage assets (e.g. balancing reservoirs);
- water treatment assets;
- treated water storage assets (e.g. contact tanks, pre-distribution storage); and

[16] UKWIR, 1995, Outage Allowances for Water Resource Planning
[17] UKWIR, Section 2.5.3 Outage, Report Ref No 16/WR/02/11

- treated water distribution assets (e.g. treated water pumping).

Unplanned outage events can be caused by an unplanned action or event to the above components, including:

- poor source water quality / pollution;
- turbidity;
- power failure (e.g. company assets or grid); and
- system failure (e.g. unplanned asset maintenance, asset failure).

Whilst this measure has some similarities with other measures arising from WRMPs and the intention was for the definition to be closely linked it is not the same and through the course of our review we have not found any approach across companies that is common. As such there is no one clear and common process for assessing this measure. Processes varied across companies, with many having no clear process in place at this stage and citing further work they were undertaking or expecting to undertake ahead of AMP 7. Where companies did put forward processes they sometimes varied between surface water and groundwater works.

<u>Summary of desk top review</u>

The questionnaire responses and review of previous UKWIR guidance as well as feedback to the Ofwat Asset Health working groups highlighted a range of issues which were identified to be further explored during company interviews. The most material of these issues are discussed below and fall into the areas of:

- The purpose of the unplanned outages metric and the extent to which it is seen as an asset health measure or a resilience measure.
- The definition of 'Maximum Sustainable Production Capacity' and:
  - the relationship between that and Deployable Output from WRMPs and works capacity;
  - the assumptions and adjustments made to reflect issues like Water Quality, redundancy and abstraction licence changes; and
  - the appropriate geography for the measure and the extent to which it is measured on a site or system wide basis.
- Measurement issues and the consistency of approaches to tracking outages under this new measure, including for example the differential availability of telemetry data to identify and measure the timeframe and impacts of outages versus operational teams reporting of instances.
- Different definitions of planned versus unplanned events and the limited assurance over the reporting of that information.

- Whilst some companies supported the view taken in the definition of the measure in terms of exclusions only for planned events (e.g. Water Quality management, etc) others considered that extreme weather events should not be excluded from the measure.
- Finally, several companies raised concerns about the potential impact of this measure on company incentives and customer service noting that penalising companies when outages reduced the theoretical maximum production capacity without impacting on the actual production output could drive perverse incentives for example where there was excess supply or where demand and customers were unaffected.

In addition to highlighting issues the questionnaires and previous Ofwat work provided insight into key areas of difference in current approach between companies.

The questionnaire responses demonstrate wide variability in views across companies with some continuing to urge Ofwat to focus on the DO measure linked to WRMPs in order to allow greater comparability in AMP 7, even whilst a new measure is developed, whilst others are already developing their views on the application of the new guidance and taking their own views where that guidance provides flexibility.

As such across companies we find that there are extremely low levels of consistency in the approaches adopted and do not consider that this measure could sensibly be used comparatively at PR19 in its current form. Indeed a number of company responses queried the policy objective and asked whether the measure should be focussed on asset health or resilience and some suggested alternative measures to the one that appears to be envisaged by the Ofwat guidance precisely because the differences appear too material to address.

The measure would benefit from further industry working groups ahead of AMP 7 but time is now too short to run these groups effectively. Instead we would recommend that a period of shadow reporting is put in place on the new definition we have proposed. Further work in AMP 7 could then sensibly be undertaken based on the learning from the new proposed measure and reflecting the potential for perverse incentives that companies raised. Any comparative benchmarking by Ofwat during PR19 as part of the review or challenge to the targets set by companies and the associated incentives should also consider the low quality and comparability of the underlying data.

Key areas of divergence identified through the desk review include:

- **The definition of 'Maximum Sustainable Production Capacity'** - In most instances companies do not have any ready measure of MSPC and are developing them. In some instances companies appear to be defining the new MSPC on the basis of works capacity, others are more focussed on measures more closely aligned to DO based on their WRMP processes and activities and

as such are using average capacities rather than maximum. There are also different approaches to defining the 'limiting factors' that constrain the MSPC.

- **The creation of perverse incentives**- whilst not directly an issue of consistency, several companies highlighted in their responses how a PC, applied in the way envisaged could drive unwelcome behaviours in companies. For example, once in place companies may become focussed on minimising periods of unplanned outages related to the measure redirecting expenditures to maintain a low level of unplanned outages even in instances where they may have sufficient redundant capacity that the outage has no impact on the customer whatsoever. Thus the measure could drive inefficient behaviours and a weaker customer focus.
- **The clarity of the geography to which the measure is applied**- the guidance appears quite clear to us that the measure is intended to focus on assets related to abstraction right through to treatment input into the distribution system. However, the responses to the asset health working group exercise and the company responses suggest that this is not necessarily being undertaken consistently across companies and indeed to do this entirely consistently appears to us to require reporting at each stage in the value chain, including capacity assumptions for different assets that might be difficult to sensibly estimate. Only asset failures or outages which impact on maximum production capacity will be captured by this measure for example some failures of abstraction pumps where there is storage between the abstraction and the treatment process will have no impact on the maximum production capacity.
- **The definition of planned and unplanned outages**- Across companies whilst they all generally state that they follow the UKWIR guidance there are different Water Quality parameters cited that companies control for in defining planned and unplanned outages. Evidence that companies could provide varies for planned versus unplanned outages in line with the different systems that companies have in place for this reporting.
- **The different approaches to measurement that companies could adopt**- most companies have systems which automatically record data from telemetry relating to outages (e.g. SCADA) across all their sites, whilst others rely on manual reporting of outages from operational teams, sometimes with involvement from a central control centre. This not only affects the consistency of approach but also the audit trail and quality and regularity of timing data for outages, where systems based on telemetry would record the alarm within 15 minute intervals and manual reporting by operational teams could produce a delay of 2 or more hours in the recorded start time of an outage. We note that the current guidance focusses on a minimum timeframe of daily reporting which all companies should be able to report albeit across different systems. Similarly, there are different approaches to assessing the impact of the outage on current DO (and indeed on maximum production capacity under any new measure). It is also clear that not all companies report actual outage data for the annual returns with a number of companies reporting only the WRMP planning allowance for outage not the actual outage for that year.

Material areas identified by companies

The key issues raised by companies through the company visits were consistent with the findings of the desk review and the points raised in their questionnaire responses. In particular:

- **Consistency is unlikely to be achieved in time for AMP 7**- Companies do not generally consider that they will have reporting in place for AMP 7. Whilst all companies will have some historic information from DO as part of their annual returns for WRMPs and this data appears to have good coverage and is of a high quality (annually audited) this is quite different to the MSPC values assumed in the original definition. Virtually all the companies we spoke to supported a longer process through working groups to develop the Unplanned Outages measure further. One company also highlighted that they expected there to be significant variability between companies on the level of outages within a given year and that the level of comparability of the measure might be low in any event. At the workshop we discussed the new definition that we have developed and we have introduced some minor changes in the final definition. Companies were consistent in their concerns about the comparability of this measure for AMP 7 and there was not consensus that the proposed approach was the right one but several companies considered that the time is now so short that a definition needs to be reached for AMP 7 with a longer term process for PR24.
- **Defining MSPC**- Companies are already developing definitions for the MSPC in line with the Ofwat guidance but inconsistently between them. During the company visits we observed that some companies brought members of their production planning or WRMP teams whilst others brought operational teams. Several companies also highlighted the incentive properties of the measure and that it might promote inefficient behaviours by encouraging companies to reduce unplanned outage impacts on MSPC even where there may be no impact on customers or where there are legitimate reasons not to resolve the cause of the outage quickly. Companies are generally still at an early stage of defining their MSPC measure and taking different approaches to issues like reflecting seasonality, supply and demand balance, addressing changes to abstraction and some companies appear to be basing their definitions more on the works capacity, treatment capacity or some other measure more closely aligned to DO. Having observed the issues between companies we would consider that an approach to defining MSPC as peak week production capacity which some companies will have used to derive their Dry Year Critical Period DO for WRMPs might be a good position to start with for AMP 7. This would use a value that companies are familiar with, will generally have data for through WRMPs and is likely to have a high degree of consistency. Companies also highlighted that more consistent guidance is needed on how they should calculate the appropriate redundancy between the MSPC and the works capacity as well as how regularly they should be permitted to update or amend the MSPC.
- **Defining planned and unplanned events**- Companies are generally conforming to the UKWIR and other WRMP guidance on the definition of

planned and unplanned outages and the recording of events that would lead to outages is generally done across the sector albeit that the systems and approaches vary from the use of diaries or logs at assets to telemetry systems. Companies generally reported that their data could be used to identify outage events that did not lead to a reduction in DO hence data should exist that provides this albeit that it might be a very significant task for companies to capture this. Companies did raise concerns that some could be tempted to extend or transfer unplanned outage into planned outages and that further clarity was needed on this and a small number of companies suggested that the definitions of planned and unplanned events could be clearer. One company suggested that companies should be asked to report both planned and unplanned outages as well as exclusions to provide clarity across companies. We believe that this would be a sensible suggestion that could be undertaken as part of some early shadow reporting in AMP 7. One company also highlighted that they felt that there were good reasons not to bring an asset back into supply immediately following a failure, for example because there was no impact on customers and sound asset management might suggest prioritising effort and cost elsewhere.

- **Defining timing for outage events**- A small number of companies felt that the guidance could be clearer on defining the timing of outage events, including clarifying whether an outage of less than 24 hours should be excluded, what the approach should be to rounding, whether stop times should be based on when the asset was reinstated or when water is put back into supply.
- **Exclusions**- generally companies supported the current approach to exclusions, a small number of companies considered that extreme weather events should be excluded and a similarly small sample of companies suggested that there should be exclusions related to health and safety from extreme weather.
- **3 month exclusion/cap**- Several companies suggested that further clarity was needed in relation to how the three month exclusion/cap would operate in practise.

Proposed immediate changes to the guidance

For the following issues raised we propose a number of immediate changes to guidance to improve clarity or consistency.

#	Issue	Proposal
OUT1	Defining MSPC	Setting out that for MSPC companies should use dry year peak week production capacity as per their WRMP processes. However, any reductions in peak production capacity during a dry year due to restriction of resource availability (reduction in licenced abstraction volumes for example) imposed by others should be ignored as it is the dry year peak week production capacity of the works that should be used.
OUT2	Defining planned and unplanned events	Improve clarity and definition around planned and unplanned by: • Improving the level of detail in the guidance around planned and unplanned events (e.g. turbidity); and • Requiring companies to report both planned and unplanned outage figures.

OUT3	Defining timing for outage events	Improve clarity and definition around timing for outage events including clarifying that: • Outages of less than 24hours should be excluded from the reporting; • Stop times should be calculated around when the asset is reinstated.
OUT4	Clarifying exclusions	Amend the guidance to: • provide a clearer approach to exclusions and requiring companies to report any exclusions; and • add an exclusion for health and safety issues arising from extreme weather.
OUT5	3 month exclusions	This report does not make any recommendations for the guidance in this draft report. This issues is included for continuity.
OUT6	For shadow reporting it was suggested by a number of companies that the Ofwat confidence grades used in the old June Return would be more meaningful than RAG status.	a) For each of the components of the shadow reporting RAG a list of key elements which feed into each component be proposed. b) The approach to overall assessment of each component of the shadow reporting to be specified based on materiality of each sub element. Consideration to be given to using old JR confidence grades.

Proposed immediate changes to assurance

For the following issues raised we propose immediate changes to assurance to improve confidence in the PC.

#	Issue	Proposal
OUT7	Significant inconsistency in the definition of the PC measure	We have proposed a revised definition to the unplanned outages PC. We would suggest that a period of shadow reporting is undertaken on the new definition ahead of AMP 7.

Potential changes to be taken forward after this report

For the following issues raised we propose potential changes that may require further work after this report.

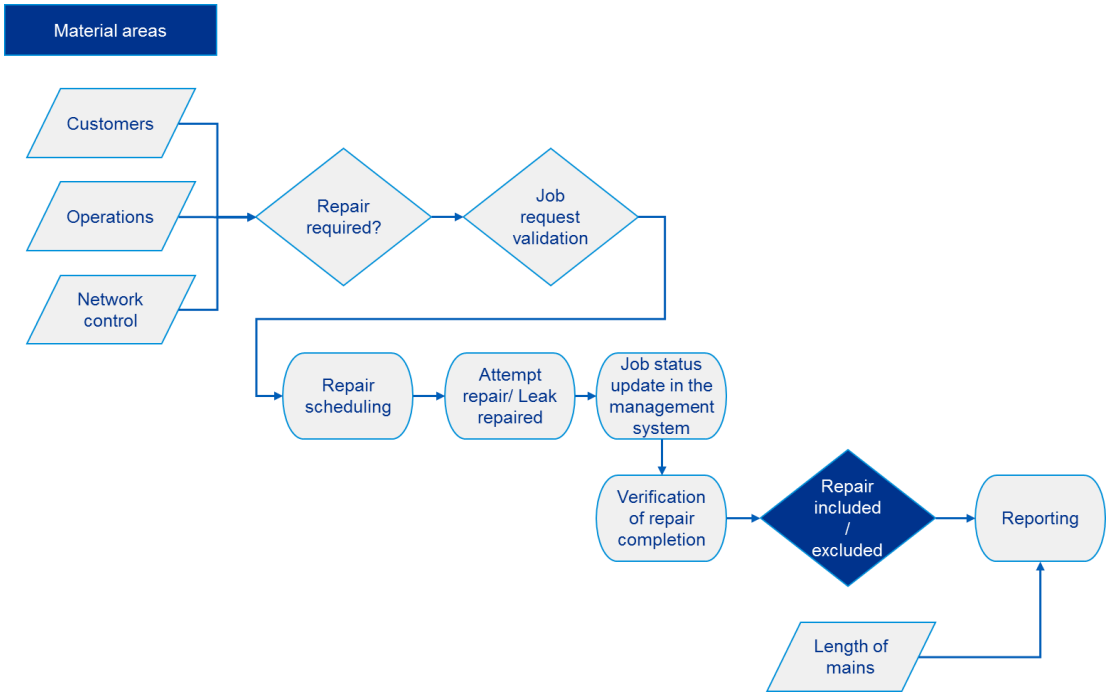
#	Issue	Proposal
OUT8	Further definition of the PC measure for PR24 through a series of industry working groups.	This should include developing an approach that provides the right incentives on companies in line with the policy objectives of the measure.

4.2.4 Mains repairs

Current status	
Summary	■ While there are refinements that can be made to the definition, there is currently a reasonable level of consistency in how companies are approaching this metric following historic reporting. ■ Companies are reporting that they expect to be compliant with the current guidance in time for AMP7.

Description and process flow map

The mains repairs per 1,000km of total mains length performance commitment is a measure of asset health. The definition chosen in the Ofwat guidance comes from the June Return reporting requirements.



The relevant guidance for this measure is 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017', which in turn

references 'JR11 Reporting requirements Issue 1.1 0 March 2011, June Returns 2011'.

Summary of desk top review

As part of our process to understand companies' current approaches and to highlight any material areas of inconsistency, we undertook a review of companies' responses to the December questionnaires. There is no shadow reporting for this measure.

In general it was noted that few companies raised issues in their questionnaire responses and there were none considered to materially impact the measure. Most companies felt they were in compliance with the JR11 methodology in full.

Companies generally reported that they recorded and monitored repair work using different codes in their IT system. Jobs reported by customers and third parties are generally classified as reactive / reported, while jobs reported by operational teams (as a result of leakage detection activity) are generally classified as proactive / detected. One company did report that it did not make this distinction.

Generally companies reported that they kept records of repairs which are assessed for inclusion or exclusion under this measure. While several companies did report that they have extensive historic data, this may not fully align with new definitions.

The most material areas which could affect this measure relate to exclusions (specifically the type of work excluded and if the work is a repeat incident).

Material areas raised by companies

During our visits with the companies we discussed their processes and potential issues with mains repairs. In general we focussed on the material areas highlighted in the process map above.

The following material areas of potential inconsistency and potential improvement were raised during our site visits to the companies and the all-company workshop.

General comments

In general companies stated that they had well established reporting processes in place to measure mains repairs, as they had largely continued to use the June Return methodology.

Some companies did state that they felt their mains repairs value would rise if they undertook increase leakage finding work, as mains repairs does include proactively

identified repairs. Companies expressed differing opinions on how leaks identified with telemetry should be classified.

Exclusions

While companies generally reported that they had existing processes in place to report against this measure, a number of companies stated that they would have to change their internal systems to ensure that exclusions were appropriately recorded.

Many companies asked for clarification on ferrule exclusions and inclusions. In particular, some companies discussed the inclusion of ferrule failures that are 'attributable to mains material condition or local ground movement, but not incidents of ferrule failure due to ferrule materials or poor workmanship…'[18]. It was felt by some companies that this may not always be clear.

A number of companies suggested that there may be inconsistency in the treatment of self-lay/newly laid mains by third parties. In particular there was concern as to when a burst should be counted if a developer was laying their own main during their construction project.

A number of companies also requested further clarity on the exclusion of incidents due to the incident being caused by a third party. This report does not make a recommendation but does note that the guidance states that companies should only exclude repairs due to third party damage if there is clear evidence that support the view that the damage was likely caused by a third party. If there is material doubt on whether it was caused by a third party, the incident should not be excluded.

Repeat incidents

A number of companies requested further clarity on the treatment of repeat bursts. For example some companies discussed if a separate incident should be counted if a burst occurs as the mains are recharged after the initial repair.

Mains length

A number of companies highlighted that any inaccuracy in the total length of mains will reduce the accuracy of the normalised metric.

The process used for recording and reporting the total length of mains should be subject to the independent reporting and assurance process and this report does not therefore make any further recommendations.

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[18] Page 58 of 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017'

Proposed immediate changes to the guidance

For the following issues raised we propose a number of immediate changes to guidance to improve clarity or consistency.

#	Issue	Proposal
MRP1	A number of companies requested further clarity on ferrule exclusions.	Any repair work undertaken on the water mains (i.e. all pipes conveying treated water around the distribution point but not including communication pipes or supply pipes) shall be included. Any work that is not undertaken on the mains e.g. solely on a ferrule, hydrant, valve and clamp associated with the ancillary which does not involve a repair on the main shall be excluded. Clamps used to repair the main shall be included.
MRP2	A number of companies requested further clarity on the treatment of repeat bursts	Once the main is recharged, and customers are back in supply, then if there is a new incident it is counted as a separate repair. If there is a secondary burst not at the point at where the repair took place during the recharge, then it should be captured as a separate reported burst.
MRP3	A number of companies suggested that there may be inconsistency in the treatment of self-lay/newly laid mains by third parties.	Self-laid mains, or other mains adopted should be treated as part of the incumbents' network from the time of adoption. If a developer has a burst on its main prior to adoption this is not included within the metric.

MPR4	It was suggested by a number of companies that the Ofwat confidence grades used in the old June Return would be more meaningful than RAG status.	a) For each of the components of the shadow reporting RAG a list of key elements which feed into each component be proposed. b) The approach to overall assessment of each component of the shadow reporting to be specified based on materiality of each sub element. Consideration to be given to moving to old JR confidence grades.

Proposed immediate changes to assurance

None identified

Potential changes to be taken forward after this report

For the following issues raised we propose potential changes that may require further work after this report.

#	Issue	Proposal
MPR5	A number of companies highlighted the need for more guidance on defining reported/detected main repairs.	A working group is recommended to study this subject. Detected is from pro-active leakage detection activities. Reactive is from customers/ third party/ employees whose activity is not the identification of network issues, for example leakage. There was a difference in opinion in how leaks identified from telemetry should be classified (are companies reacting to an observed burst, or are they detecting the burst using their telemetry?).

4.2.5 Sewer collapses

Current status	
Summary	■ Changes are required to the metric, in particular the removal and replacement of the 50% cross sectional area assessment, as well as increased levels of consistency across companies. ■ Some companies are reporting they have issues which may result in them not being compliant with the current guidance in time for AMP7.

Description and process flow map

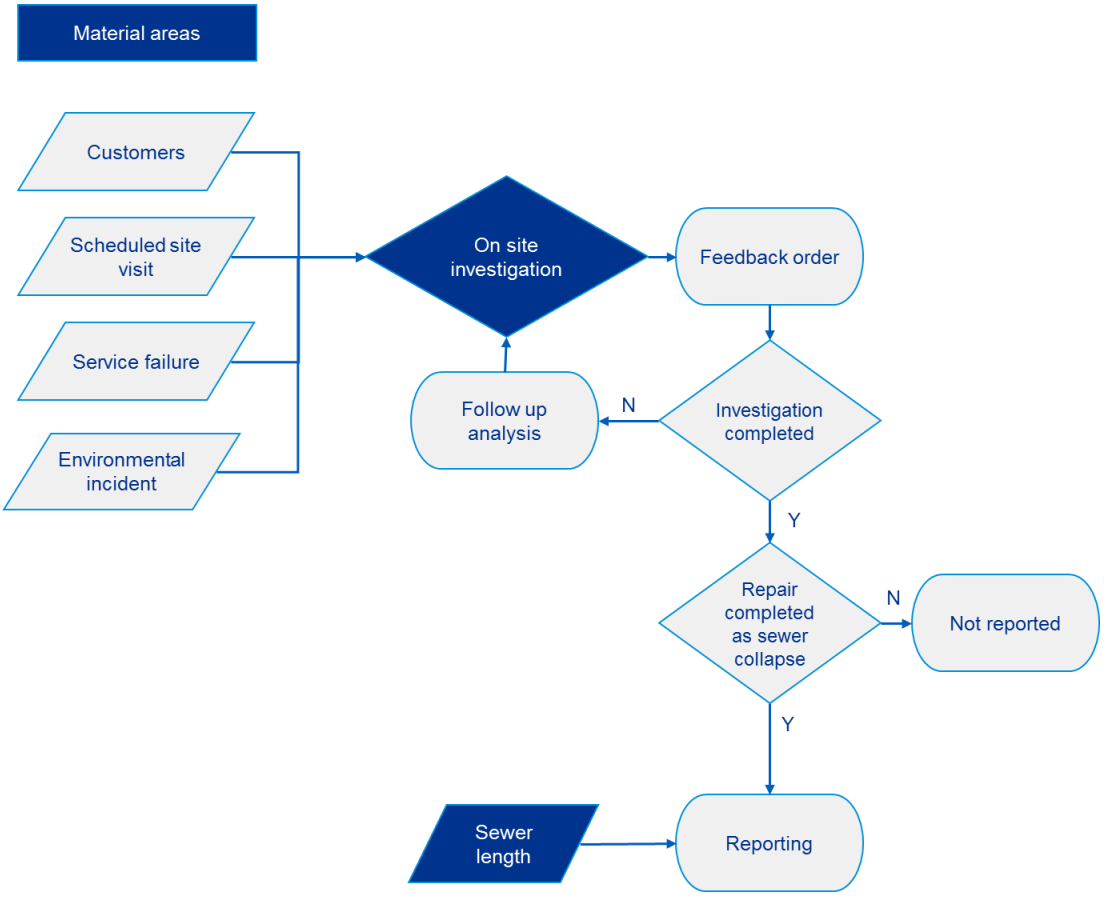
The sewer collapses per 1,000km of sewer performance commitment is a measure of asset health, defined by Ofwat using the June Return guidance. It was then further defined in the December questionnaires and is reproduced below:

The measure was defined as the number of sewer collapses per thousand kilometres of all sewers causing a reported impact on service to customers or the environment. This measure seeks to reflect failures, due to structural weakness in the asset set out the table below, causing a reported impact on service to customers or the environment.

Pipe Condition (structural)	Cross Sectional Loss
Structural failure – pipe structural integrity compromised	>50% loss
Fully collapsed pipe	>50% loss
External backdrops	>50% loss
Missing pipe (Covers all modes of failure including chemical attack e.g. H2S)	>25% loss of circumferential area
Pipe bridges	>50% loss
Rising mains (cover all infrastructure assets)	Burst (or leak causing a reportable service failure) rising main

The relevant guidance for this measure is 'Delivering Water 2020: consultation on PR19 methodology. Appendix 3: Outcomes technical definitions. Appendix to chapter 4: Delivering outcomes to customers. Ofwat, July 2017', which in turn

references 'JR11 Reporting requirements Issue 1.1 0 March 2011, June Returns 2011'. This measure was further defined in the December questionnaires.



<u>Summary of desk top review</u>

As part of our process to understand companies' current approaches and to highlight any material areas of inconsistency, we undertook a review of companies' responses to the December questionnaires. There is no shadow reporting for this measure.

The questionnaire responses highlighted issues which were identified to be further explored during company interviews. The most material of these issues fall into the areas of:

- Quantifying the cross sectional loss or circumferential area; and
- Length of sewer network.

In addition to highlighting issues the questionnaires provided insight into key areas of difference in the current approaches between companies.

Companies are generally using similar processes to identify and repair sewer collapses, but they are taking different approaches to their final reporting and data recording.

Material areas raised by companies

During our visits with the companies we discussed their processes and potential issues with sewer collapses. In general we focussed on the material areas highlighted in the process map above.

The following material areas of potential inconsistency and potential improvement were raised during our site visits to the companies and the all-company workshop.

General comments

It was noted by companies that this measure has had less time in development than some other measures. In general companies do have well established reporting processes, however there are inconsistencies in between companies.

Some companies stated that they do not want to be penalised for proactive sewer repairs. These are currently excluded under this measure.

Quantifying the cross sectional loss or circumferential area

There were differing views from companies on how accurately they could quantify the size of the cross sectional loss or circumferential area.

Some companies reported that all field crews are issued with CCTV or 'look-sees', and they maintained photographic evidence of the extent of the sewer collapse, where as other companies stated they felt that this was not feasible in their case. Companies that did not routinely use CCTV stated they felt this measure would require additional costs.

Several companies stated that they felt their own processes were more onerous that this measure. One company did state that it also recorded collapses that were less than 50% cross sectional loss which had an impact on service. They therefore expected their reported figure to reduce as a result.

During the workshop a range of alternative approaches to the cross-sectional area approach were discussed and on balance the group favoured an approach in the guidance that would:

- Focus on events that reflect a loss of service to customers or an environmental impact

- Not be linked to a particular approach or method for repairing or reinstating the pipe to restore flow (e.g. references to 'jetting' or 'digging down') that might inhibit company innovation.
- Include structural failures of the pipe (albeit without reference to the percentage of the collapse).

Length of sewer network

This measure is normalised across companies by dividing by the total length of their sewer network. Private sewers transferred under the Transfer of Private Sewers Regulations 2011 are now included within the length of sewer network. This has been a material increase to some companies' sewer network length. Some companies have reason to doubt the length quoted at the time of transfer. As a result there may be some uncertainty in the total sewer network length. This report does not make any recommendation, but does highlight this as an area for companies to consider when assuring the accuracy of their total length.

Proposed immediate changes to the guidance

For the following issues raised we propose a number of immediate changes to guidance to improve clarity or consistency.

#	Issue	Proposal
SWC1	Most companies report some level of difficulty in accurately determining a 50% cross sectional loss or 25% circumferential loss.	This report recommends that the reference to a percentage loss is removed and changed to count a sewer collapse as a loss of flow drives a loss of service to customers or an environmental impact, is not linked to a particular approach or method for repairing or reinstating the pipe to restore flow (e.g. references to 'jetting' or 'digging down') that might inhibit company innovation and includes structural failures of the pipe (albeit without reference to the percentage of the collapse).
SWC2	It was suggested by a number of companies that the Ofwat confidence grades used in the old June Return would be more meaningful than RAG status.	a) For each of the components of the shadow reporting RAG a list of key elements which feed into each component be proposed. b) The approach to overall assessment of each component of the shadow reporting to be specified based on materiality of each sub element. Consideration to be given to moving to old JR confidence grades.

Proposed immediate changes to assurance

None identified.

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5 Appendix A

Introduction

This appendix includes the compiled guidance on all seven common performance commitments.

We have complied the existing guidance, brought it into a consistent format and made changes to reflect the points raised in the main body of this report. Where changes have been made they are shown in track.

Each change to guidance includes a reference code to identify from which proposed change it originates.

5.1 Reporting guidance – Supply interruptions

Objective

The purpose of this document is to derive a metric for supply interruptions that consistently calculates the performance of water companies in terms of the average number of minutes lost per customer for the whole customer base for interruptions that lasted 3 hours or more.

This guidance seeks to enable companies to monitor and compare consistently derived and common performance measures for Supply Interruptions.

Key Principles

There are several key assumptions made in the compilation of the guidance:

- Reporting of supply interruptions shall be subject to each company's assurance process which is applied to all measures reported annually.
- Companies have a methodology or procedure in place for reporting on supply interruptions. This procedure is reviewed as part of their assurance process.

There is an assumption that there will be continued improvement by all companies in the short and medium term through innovation, new technology, data quality improvements and staff training:

- The measure assumes a clear and simple approach that can be understood by customers and regulators.
- The essential reporting requirements for reporting on supply interruptions are set out.
- The focus of the guidance is on annual reporting of supply interruptions. It is not intended as a definitive guide to managing the risk of supply interruption.
- The company shall apply the precautionary principle, using the start and finish times and the properties affected that will give the highest supply interruption value in the event of uncorroborated or conflicting data.

Applying this guidance is likely to mean that comparisons of historical performance between companies, and of individual company's previous performance, may not necessarily be valid. However, it is anticipated that future individual company year on year trends in performance will be possible.

The adoption of this metric across the industry does not preclude any company electing to have other supply interruption Performance Commitments with

company specific definitions or continued reporting against the previously reported DG3 or KPI Dashboard (post 2011) metrics.

Exclusions

The default position is that the water company manages the risk of supply interruptions and there are no exclusions. This measure covered and unplanned interruptions. The cause of the interruption is not relevant to the calculation of the reported figure. That is, asset failure caused by third parties would be treated the same as the failure of the company's assets and planned or unplanned interruptions are the same.

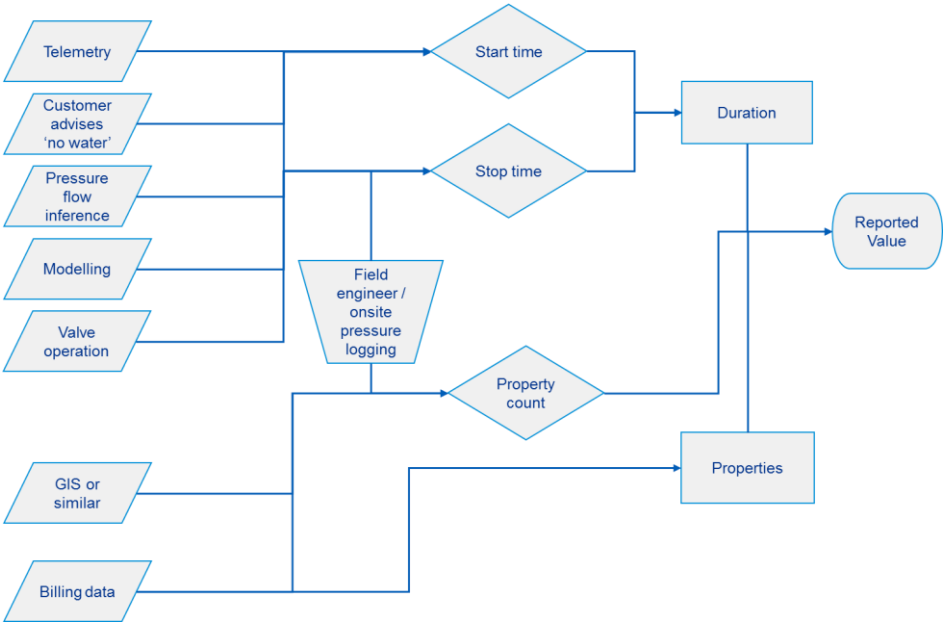
Companies may make a representation to Ofwat for an exception to be granted on the basis of a civil emergency under the Civil Contingencies Act 2004, where the supply interruption is not the cause of the emergency.

Measure Definition

Calculation of the Performance

$$\sum \frac{(Properties\ with\ interrupted\ supply\ \geq 180\ mins) \times Full\ duration\ of\ interruption}{Total\ number\ of\ properties\ supplied\ (year\ end)}$$

Process diagram



Component Definitions

To ensure consistency of reporting, the following regularly used terms are defined below:

Properties shall include billed mains pressure fed household and non-household properties connected to the distribution system. This includes properties that are connected, but not billed (for example temporarily unoccupied), but should exclude properties which have been permanently disconnected. A group of properties supplied by a single connection shall be considered as several properties. They should only be considered as a single property if a single bill covers the whole property. The total connected properties figure shall be those connected at the end of the report year. Cattle troughs shall not be included.

Supply interruptions are defined as when properties are without a continuous supply of water. The property shall be considered as without a supply when water is lost from the first cold water tap – taken as being operationally equivalent to ≤3m pressure at the main (adjusted for any difference in ground or property level). This can be inferred from local logging, network modelling or a customer contact indicating a loss of supply which was caused by the company operation and has not been demonstrably restored. Multiple-storey buildings shall be considered on a case-by-case and floor by floor basis, with properties on a particular floor being considered as receiving the same pressure.

Duration is defined as the length of time for which properties are without a continuous supply of water. The duration shall only be considered in the calculation of the metric where the duration is 3 hours or greater.

Start time is when water is lost from the first cold water tap at a property – taken as being operationally equivalent to ≤3m pressure at the main (adjusted for any difference in ground or property level). In the event of applicable telemetry data or logging being unavailable, the time should be determined from the earliest of:

- As advised by "no water" contact from customer (where not due to a customer side issue);
- Indications from flow or pressure monitoring to infer a change in supply; or
- Verified modelled data (calibrated, maintained, reflective of the network at the time of the incident and validated with contemporaneous flow and/or pressure data).

The company shall gain confirmation by consulting complainants (if any) and/or customers at high points on the system.

Stop time is when water is restored to the first cold water tap at a property – taken as being operational equivalent to >3m head of pressure at the main. In the event

of pressure logging being unavailable, the time should be determined from the latest of:

- As advised by notification from customer;
- Indications from flow or pressure monitoring to indicate return to normal supply conditions; or
- Verified modelled data (calibrated, maintained, reflective of the network at the time of the incident and validated with contemporaneous flow and/or pressure data).

It is the responsibility of the company to demonstrate that supply conditions have been restored and available to all previously affected customers from the time determined from the above. In the absence of physical evidence, the company shall gain confirmation by consulting complainants (if any) and/or customers at high points on the system.

The company shall apply the precautionary principle, using the start and finish times and the properties affected that will give the highest supply interruption value in the event of uncorroborated or conflicting data.

Property counts

Property counts shall use the best available information. This should be from the GIS, but paper records and DMA or similar data can be used where recently connected properties have not yet been input to the GIS. Properties shall count as having lost supply whether or not occupied. Properties permanently disconnected will be excluded from the count.

Attention should be paid to the incremental nature of supply loss. For example, for a burst when supply is lost progressively across an affected area, the time/properties affected relationship should be established. Where the loss is gradual, the supply interruption should be considered incrementally.

Properties affected by more than one interruption during the report year

Properties which are affected by more than one interruption during the report year should be reported separately for each interruption. This means, for example, that a property affected by three supply interruptions would be reported three times, once for each interruption.

Short term restoration of supply

For the cumulative effect of an interruption to be ignored and interruptions to be treated as separate occurrences, properties must have supplies restored for a minimum period of 1 hour. When shorter gaps occur the duration is counted from the start of the first interruption until the last restoration of supply.

Records

It should be possible to correlate and reconcile the company's reported figures for asset health and customer services data relating to reports of and complaints about interruptions to supply[19].

Evidence for subsequent challenge shall as a minimum be stored where the loss of supply has lasted greater than 150 minutes and for split time events, with the purpose of being available for assurance audit. Water companies should store supporting evidence for the quantification of the supply interruption metric for a minimum period of 10 years. This will start with the report year 2017/18 and companies will need to report on an indicative basis for 2016/17.

Companies must maintain records of all reportable incidents of supply in the form of a supply interruptions dataset. The aim of the dataset is to allow verification and audit of the reported information and to enable the identification of the properties affected. It should contain information on the timing, duration and sufficient information to enable all properties affected by interruptions lasting three hours or more to be identified. The dataset should include:

- Properties affected (by name and location or number and street or GIS polygon);
- Date and time of interruption(s);
- Duration of each interruption and time supply restored; and
- The name of the person responsible for entering records in the system.

The information in the supply interruptions dataset should be available for verification of incidents and evaluation of ODI penalties and outperformance payments.

Compliance Check List

The Compliance checklist in Annex A shall be completed and presented with the reported figure.

[SPI2] Alongside their performance, companies should report on what proportion of their start/stop times has been informed by each data source (customer contact/pressure and flow data/modelled data/valve operation). This could help inform assessments of the validity of comparing different companies.

For each component on the checklist, and for the overall performance measure, companies will report a confidence grade.

[19] [SPI1]Customer service data should also include social media contact with customers.

References

This document is based upon the Ofwat Guidance in place for the June Return 2011 submissions of water companies, Chapter 2, Key Outputs, Water Service – 2. The information pertaining to DG2, Population and DG4 has been removed and the DG3 narrative adjusted to reflect the deliberations of the Water UK Convergence in Performance Measures – Water Supply Interruptions Practitioners Group (SIPG) and the assembled view of stakeholders.

[SPI3] Annex A: Compliance Checklist

In the guidance a company is requested to complete this checklist for submission with its value for supply interruptions minutes lost.

The elements of each component to be assessed separately based on the following rules:

Compliance for elements is reported against:

R	Not compliant with the guidance and having a material impact on reporting
A	Not compliant with the guidance and having no material impact on reporting.
G	Fully-compliant with the guidance

An overall RAG to be assigned for each component based on the following rules:

Compliance for overall components is reported against:

R	There are one or more red elements in the component or the combined effect of amber elements is considered to produce a material impact.
A	Half or more of the elements in the component are amber and the combined effect of the amber elements is considered not to produce a material impact.
G	More than half of the elements in the component are green

	Component	**Compliant (R/A/G)**	**Reason for any non-compliant components**	**Confidence grade**
1	**Property Counts**			
2	**Start Time**			
a	Evidence to support start time			

b	Treatment of 3m pressure definition			
c	Treatment of blocks of flats			
3	**Stop Time**			
a	Evidence to support stop time			
b	Treatment of 3m pressure definition			
c	Treatment of blocks of flats			
4	**Short Term Restoration of Supply**			
5	**Exclusions**			
6	**Calculation of Performance**			
7	**Application of Precautionary Principle**			
8	**Records**			
9	**Properties affected >1 interruption in year**			

For each component on the checklist, and for the overall performance measure, companies will report a confidence grade.

Confidence grades provide a reasoned basis for companies to qualify the reliability and accuracy of the data. Companies should employ a quality-assured approach in the methodology used to assign confidence grades, particularly if sampling techniques are in place.

The confidence grade combines elements of reliability and accuracy, for example:

- A2 Data based on sound records etc. (A, highly reliable) and estimated to be within +/- 5% (accuracy band 2)

Reliability and accuracy bands are shown in the tables below.

Reliability Band	Description
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from limited sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Accuracy band	Accuracy to or within +/-	But outside +/-
1	1%	-
2	5%	1%
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Accuracy outside +/- 100 %, small numbers or otherwise incompatible (see table below)	

Certain reliability and accuracy band combinations are considered to be incompatible and these are blocked out in the table below.

Compatible confidence grades				
Accuracy band	**Reliability band**			
	A	B	C	D
1	A1			
2	A2	B2	C2	
3	A3	B3	C3	D3
4	A4	B4	C4	D4
5			C5	D5
6				D6
X	AX	BX	CX	DX

5.2 Reporting guidance – Sewer flooding

Objective

This guidance seeks to enable all companies to report on sewer flooding for the defined year with confidence and at a reasonable level of accuracy and with a common approach. Companies shall apply consistent and robust methods and common assumptions. This will facilitate the comparison of performance across companies by customers, regulators and other companies with reasonable confidence.

Key principles

There are several key assumptions made in the compilation of the guidance:

- Reporting of flooding incidents shall be subject to each company's assurance process which is applied to all measures reported annually;
- Companies have a methodology or procedure in place for reporting on flooding incidents. This procedure is reviewed as part of their assurance process.

There is an assumption that there will be continued improvement by all companies in the short and medium term through innovation, new technology, data quality improvements and staff training:

- The measure assumes a clear and simple approach that can be understood by customers and regulators;
- The essential reporting requirements for reporting on sewer flooding are set out;
- The focus of the guidance is on annual reporting of sewer flooding incidents. It is not intended as a definitive guide to managing the risk of flooding from sewers;
- Exclusions are to be kept to a minimum and shall be consistent with the reasonable expectations of an affected customer.

This is likely to mean that comparisons of historical performance between companies, and of individual companies, may not necessarily be valid. However, it is anticipated that analysis of future individual company year on year trends in performance will be possible.

Measure Definition

There shall be two measures of flooding incidents, both of which shall include flooding due to overloaded sewers (hydraulic flooding) and due to other causes (FOC). The two measures are:

1) The number of internal flooding incidents per year;

2) The number of external flooding incidents per year.

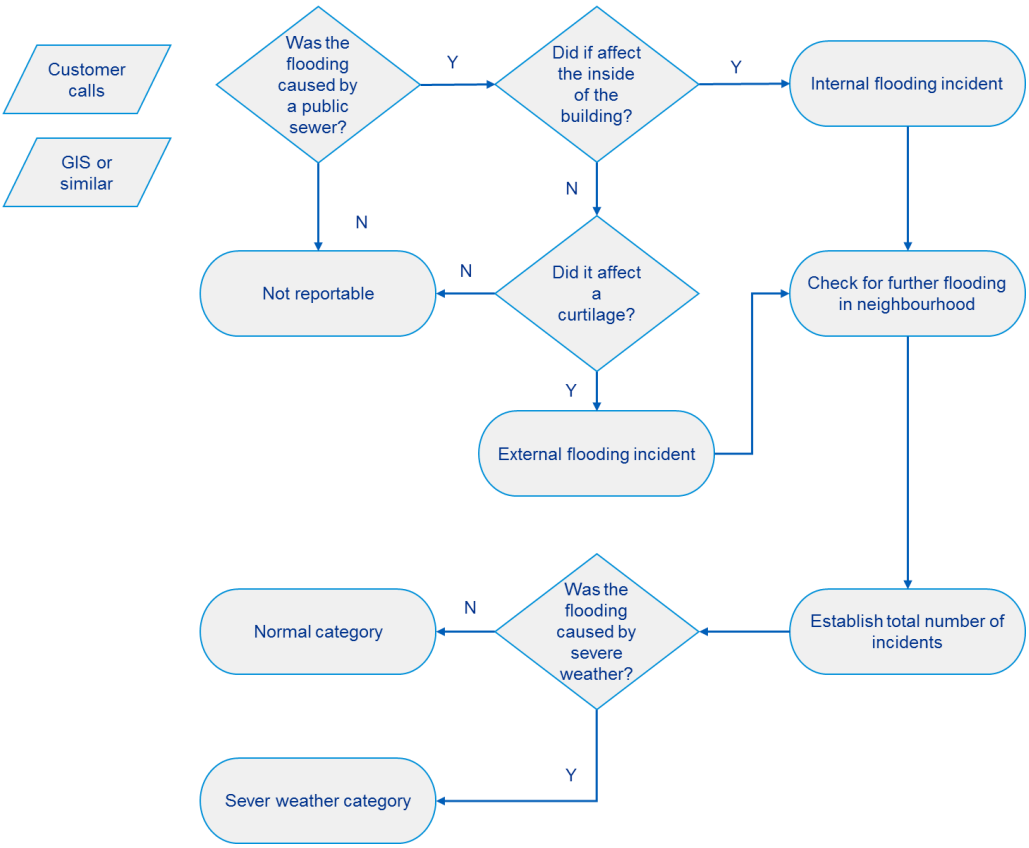
For both measures, companies will report the number of incidents a) including and b) excluding the impact of severe weather. [SFD1] Companies should also report how many incidents have been included as a result of activities which were carried out to determine neighbouring properties affected.

For the purpose of the return, a flooding incident is defined as the number of properties (or curtilages) flooded during each flooding event from a public sewer. For example, five properties which suffered two flooding events during a year, would count as ten incidents. Where a property floods both internally and externally during the same event it shall only be recorded as an internal flooding incident.

A flooding event is the escape of water from a sewerage system, irrespective of size as evidenced by standing water, running water or visible deposits of silt or sewage solids.

Process diagram

The diagram below shows a simplified version of the process:



Assets causing flooding

Incidents caused by an escape from public sewers (whether foul, combined or surface water); including pumping stations, sewage treatment works and other assets under the control of the sewerage undertaker shall be reported. Incidents caused by sewers and laterals transferred under the Transfer of Private Sewers Regulations 2011 and pumping stations transferred in 2016 shall be included.

For the purposes of consistent reporting, flooding caused by the blockage or failure of a gully, shared by two or more properties and connected to a public sewer, or blockage of the gully grating, or the failure of any pipework above ground, shall be excluded. It should be noted that this is not to be taken as an opinion on the legal status of these aspects of drainage apparatus.

Flooding caused by assets which are beyond the undertaker's control is excluded, for example:

Flooding due to surface water run off which has not originated from public sewers:

- Fluvial flooding,
- Coastal flooding,
- Ground water which has not originated from a public sewer,
- Flooding from water mains etc.; or
- Incidents caused by highway drains
- Incidents caused by ~~and~~ private assets (including drains). The Water UK "Guide to Transfer of Private Sewers Regulations 2011", published on 30th September 2011 shall be applied to assess if the flooding incident should be attributed to the undertaker or a private asset such as a drain.

Severe weather

Individual rainfall events with a storm return period greater than 1 in 20 years shall be classed as severe weather. The Flood Estimation Handbook, FEH13 model shall be used to estimate the return periods of individual events, using radar or rain gauge data.

Hydraulic overloading of sewers ~~Flooding incidents~~ caused by severe weather shall be identified and recorded separately to other reported incidents.

Flooding caused as a result of outfalls being locked out by receiving watercourses being at or above their 1 in 100 year flood levels, shall also be included in this category.

On an exceptional basis, consideration may be given to include incidents as having been caused by severe weather ~~in this category~~ where flooding is caused by the impact of multiple rainfall events with individual return periods of less than 1 in 20

years but with a cumulative rarity of greater than 1 in 20 years. Any proposal for such categorisation must be supported by robust evidence, tested by the company's assurance process, and be fully transparent to customers and regulators.

It is the responsibility of the company to evidence why any individual incidents are to be included in this category.

Determining whether flooding is internal or external

Internal flooding

Internal Flooding is defined as flooding which enters a building or passes below a suspended floor. In this context, buildings are defined as those normally used for residential, public, community, commercial, business or industrial purposes. The list below gives examples of what parts of buildings shall be included in the internal flooding category. It is not designed to be an exhaustive list.

- The main parts of the building;
- Conservatories;
- Basements and cellars (even if unoccupied);
- Areas below suspended floors;
- Lift shafts;
- Stairwell/lobby area of flats (to be counted as 1 flooded property);
- Any shared car parking areas beneath the main building where access to the parking area is from within the building (to be counted as 1 flooded property);
- Studios and workshops, which are an integral part of the main building.
- Porches;
- Garages which are an integral part of the house with an adjoining door to the occupied building.

External Flooding

External flooding is defined as flooding within the curtilage of a building normally used for residential, public, community and business purposes. It includes buildings in those curtilages which do not comply with the definition for internal flooding. For example:

- buildings where the prime purpose is for storage or installation of domestic appliances and is not accessed from the house by means of an adjoining door to the habitable building;

- detached garages (whether situated inside the boundary of the property and separated from the main building or outside the boundary but with common access as in a garage block);
- linked detached garages (i.e. garages which are attached to a property but separated from it by an external passageway);
- sheds and outbuildings (e.g. stables, kennels, coal houses, outside toilets);
- summer houses.

[SFD3] In the case of ~~farms,~~ golf clubs or ~~-~~facilities similar in type~~etc.~~; flooding of the area immediately adjacent to the club house ~~immediate curtilage of the main buildings~~ (paths~~gardens~~, patios verandas etc.) and therefore the areas used by people accessing only the facilities in the clubhouse shall be included as external flooding. Each situation needs to be considered on its own merits but it is unlikely that any greens, fairways or rough would be included.

With respect to farms, if there isn't a defined farmhouse and garden boundary akin to a typical domestic property, an appropriate allowance should be made for land that would equate to a garden.

In the case of a flooding event affecting a~~n~~ multiple use area in the same ownership, such as an industrial park, retail park, hospital site, university site etc., it shall be counted as one incident.~~-~~ [SFD2] This includes sections of car parking (possibly termed overflow carparks) that are separated from the main carpark or a facility by a road.

The following areas shall be excluded from the reported numbers:

- ~~-~~'highways' – including footpaths; and
- 'public' open space; agricultural land; car parks including overflow carparks.

~~Where a property floods both internally and externally during the same event it shall only be recorded as an internal flooding incident.~~

Repeat incidents

Where a flooding has occurred, and flooding subsides ~~and/or any clean-up has started,~~ any subsequent flooding shall be counted as a separate incident. This shall be regardless of the time between events and if any ~~clean-up,~~ investigation or follow on work ~~i~~has started or been completed.

Further clarification

Flooding due to third party action shall be included in all cases.

Any flooding due to jetting shall be included, unless the water is fully contained within a toilet bowl.

Damp patches caused by seepage through walls or floors shall be excluded, but any area which has visible standing or running water or which has visible deposits of silt or sewage solids shall be included.

If there is a strong suspicion of potentially fraudulent reports of flooding made with the intention to gain GSS payments or receive increased service, and there is no evidence of flooding, companies should exclude the incidents unless the customer provides substantiation that the flooding occurred. Any proposal for such categorisation must be supported by robust evidence, tested by the company's assurance process, and be fully transparent to customers and regulators.

Neighbouring properties

Companies shall make all reasonable efforts to determine the number of properties affected by flooding. This should include site visits to the affected property and all neighbouring properties that may have been affected taking into account factors such as topography and the proximity of adjacent properties. The company shall actively seek evidence of flooding. It should include the use of modelling where this is appropriate. Calling cards shall be left, if the customer is unavailable~~necessary~~.

It is recognised that a prescriptive methodology that is appropriate for all circumstances cannot be defined. Companies are therefore expected to be able to demonstrate that the processes that they have in place could and would be consistently applied if different personnel attended a similar incident in a similar location.

[SFD1] As noted in Measure Definition, additional neighbouring properties identified by a company should be flagged as such and the percentage found in this way reported.

If there is clear site evidence that a property has flooded then the incident shall be included despite the absence of a customer report, or a denial by a customer that flooding occurred. Where the customer is not present, companies should leave a calling card stating that they have enquired about a recent incident and encouraging the customer to make contact with the company.

Records

Companies shall maintain verifiable records for all reported flooding incidents irrespective of whether they are included. The aim of the records is to provide an auditable method for identifying the specific incidents that are included and excluded from the return.

Risk

Companies shall develop their own approach to managing the risk of flooding from sewers.

Methodology statement

Companies shall maintain a methodology statement. It shall be used as a decision support tool to expand on this document as necessary. It should record any changes in approach compared to previous years.

Compliance Check List

The compliance checklist in Annex A shall be completed and presented with the reported figure.

[SFD4] Annex A: Compliance Checklist

In the guidance, a company is requested to complete this checklist for submission with the number of sewer flooding incidents

The elements of each component to be assessed separately based on the following rules:

Compliance for elements is reported against:

R	Not compliant with the guidance and having a material impact on reporting
A	Not compliant with the guidance and having no material impact on reporting.
G	Fully-compliant with the guidance

An overall RAG to be assigned for each component based on the following rules:

Compliance for overall components is reported against:

R	There are one or more red elements in the component or the combined effect of amber elements is considered to produce a material impact.
A	Half or more of the elements in the component are amber and the combined effect of the amber elements is considered not to produce a material impact.
G	More than half of the elements in the component are green

	Component	Compliant (R/A/G)	Reason for any non-compliant components	Confidence grade
1	Assets causing flooding			
2	Severe weather			

a	Individual rainfall events > 1 in 20 years			
b	Multiple rainfall events			
c	Surface water run-off not originated from public sewer			
d	River levels > 1 in 100 year return period			
e	FEH13			
3	Internal or external flooding			
a	Internal			
b	External			
4	Repeat incidents			
5	Neighbouring properties			
6	Records			

For each component on the checklist, and for the overall performance measure, companies will report a confidence grade.

Confidence grades provide a reasoned basis for companies to qualify the reliability and accuracy of the data. Companies should employ a quality-assured approach in the methodology used to assign confidence grades, particularly if sampling techniques are in place.

The confidence grade combines elements of reliability and accuracy, for example:

- A2 Data based on sound records etc. (A, highly reliable) and estimated to be within +/- 5% (accuracy band 2)

Reliability and accuracy bands are shown in the tables below.

Reliability Band	**Description**
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from limited sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Accuracy band	*Accuracy to or within +/-*	**But outside +/-**
1	1%	-
2	5%	1%
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Accuracy outside +/- 100 %, small numbers or otherwise incompatible (see table below)	

Certain reliability and accuracy band combinations are considered to be incompatible and these are blocked out in the table below.

Compatible confidence grades				
Accuracy band	**Reliability band**			
	A	B	C	D
1	A1			
2	A2	B2	C2	
3	A3	B3	C3	D3
4	A4	B4	C4	D4
5			C5	D5
6				D6
X	AX	BX	CX	DX

5.3 Reporting guidance – Leakage

Objective

The guidance has been developed to enable all companies to report annual average leakage for the defined year following good practice and a reasonable level of accuracy, applying consistent and reliable methods and common assumptions. This is to facilitate consistency of reporting by companies and comparisons of performance by customer representatives, regulators and other companies with reasonable confidence.

Key Principles

There are several key principles applied in the compilation of the guidance:

- Reporting of annual average leakage forms part of each company's assurance process applied to all measures reported annually by companies;
- [LKG17] [LKG18] Where this guidance specifies expected ranges for estimates this does not preclude the need for a company to justify all estimates used.
- A company needs to have a written methodology or procedure in place for reporting total leakage. This procedure is reviewed annually and updated as required;
- The reporting guidance for annual average leakage reporting is set out as a consistent good practice baseline for the industry which companies should achieve now or in the short and medium term;
- The guidance sets out the good practice concepts of a consistent approach companies are expected to comply with, a focus on data quality and application of valid statistical approaches. They are not intended to prescribe approaches to leakage reporting. Where a company is not able to meet any part of the good practice methods then it is required to explain any shortfalls and its plans to address this;
- The measure assumes a clear approach to be applied through defined regulatory periods;
- There is an assumption of continuing improvement in analysis by all companies in the short and medium term through innovation, new technology and data quality improvements. The context of consistency of reporting for this measure does not preclude companies from applying more innovative measures based on improving data quality. Some areas of reporting including the calculation process can be addressed now or in the short term. Improving data quality is likely to be achieved over a longer period;
- The established water balance concept is applied to balance estimated leakage with the other components. Re-balancing is applied to close any gap in the sum of components;

- The focus of the guidance is on annual average leakage reporting. It is not intended as a definitive guide to leakage operational management, targeting or in-year reporting although many elements of the guidance would be applicable so there are 'no surprises' between operational and annual reporting.~~;~~

Applying this methodology is likely to change reported leakage and comparisons of historic data may no longer be valid.

Background information on preparing this guidance is included in the UKWIR Report 'Consistency of Performance Reporting Measures[20].

Measure Definition

Annual average leakage is defined as the sum of distribution system leakage, including ~~customer supply pipe leakage,~~ service reservoir losses and trunk main leakage plus customer supply pipe leakage. It is reported as the annual arithmetic mean (referred to as 'average' in the guidance) daily leakage expressed in mega-litres per day (Ml/d).

A company is required to report against this definition and:

- Report a post-MLE average leakage value expressed as Ml/d to one decimal place~~s~~;
- Disclose where its methodology does not comply with this guidance using the checklist in Annex A;
- Explain the reasons for any non-compliance;
- Set out its plans and programme to comply with the guidance; and
- Disclose any other factors which have an impact on the methodology for reporting leakage.

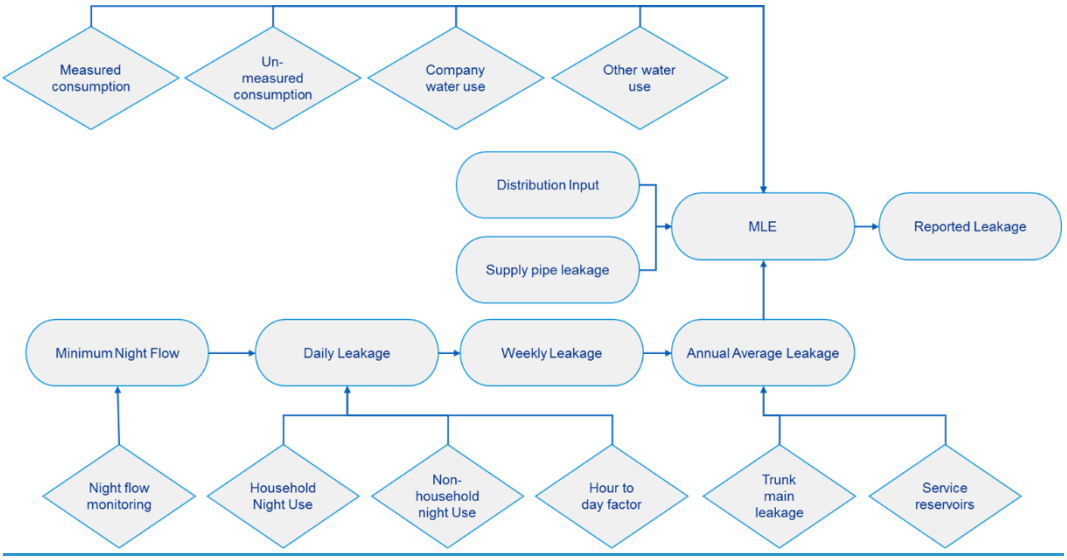
Reporting Process

The guidance is structured in the way that leakage is normally estimated and comprises:

- Components of leakage estimation (commonly referred to as bottom-up) in Section 5.
- Components of the water balance (commonly referred to as top-down) in Section 6.
- The water balance reconciliation using the MLE methodology and adjustments in Section 7.

[20] Consistency of Performance Reporting Measures, UKWIR 2017

The process is shown in the following diagram.



Components of Leakage Estimation

Reporting level

The main objective is to achieve and maintain a high level of valid data to report a statistically robust measure of annual average leakage.

A company can select to ~~report~~estimate leakage based on different ~~at~~reporting levels:

- District Meter Area (DMA) using district meters;
- Water resource zone level using distribution input meters; or
- An intermediate zone level using meters installed on reservoir outlets or trunk mains within the distribution network.

It is for a company to decide the level of reporting based on its own network characteristics and risk of meeting operability targets as defined below.

The subsequent sections of the guidance are addressed mainly to DMA monitoring although the principles may equally apply to reporting at zone level.

Night Flow Monitoring

Reporting of leakage from water networks is based on the concept of monitoring flows at a time when demand is at a minimum which is normally during the night. Allowance is made for legitimate night use for household and non-household

customers. Companies have configured their networks to be able to continuously monitor night flows using district meters. Flow data is recorded on meters and normally transmitted daily to a data centre. Data is analysed to confirm its validity and used to derive continuous night flow in each monitored area. Software systems have been developed to analyse this data, apply adjustments for legitimate night use and report daily leakage. Companies are able to set assumptions for this analysis within the software packages.

A company is expected to comply with the essential principles of the leakage reporting process for estimates of annual average leakage.

- At least 95% coverage of all properties served by a company within networks having continuous night flow monitoring through the year;
- At least 90% of all properties within continuous night flow monitoring networks shall be available for reporting night flow data through the year;
- Valid data for reporting leakage shall be derived using available night flow data and estimates of legitimate night use and a company's own validity assessments;
- Assessments of legitimate night use for households and non-households shall be applied as detailed in Sections 5.5 and 5.6;
- The statistical assumptions for determining night flows, legitimate night use and hence leakage shall be based on good practice statistics and consistently applied;
- The components of reporting shall be based on a company's own data.

To apply these principles, definitions of 'Coverage' and 'Availability' need to be applied.

Coverage is defined as: 'The percentage of a Company's billed households and non-households within designated network areas where night flows can be continuously monitored and reported on a regular frequency. Coverage is measured as an annual average for the whole company.'

This represent the extent of the coverage of networks with designed import and export meters, boundary valves, counts of households and non-households and other asset and performance data.

Availability is defined as: 'Where the designated network area is available to report a reliable estimate of night flow for leakage reporting; the installed meters and loggers are working correctly, the boundary is watertight and continuous data is provided. Availability is measured as a property-weighted annual average for the

whole company. [LKG2a] Trunk mains should not be included in the measure of availability.'

A company is expected to apply its own automated validity checks, or Operability tests, within its leakage analysis software to accept or reject data for reporting. This is expected to be supported with manual detailed checks to detect any data inconsistencies on at least a weekly basis. [LKG2b] A company must set out the operability rules (the methods and thresholds) they use and provide supporting justification for these during annual assurance.

Operability is defined as: 'Where leakage data derived from night flow monitoring and the application of legitimate night use data is within a company's accepted validity criteria for use in leakage reporting.'

~~A definition of operability is not appropriate for companies using a zonal approach to leakage reporting~~

Where a company is not able to meet the Availability measure because, for example, of DMA or zone remodelling or capital works then it is to disclose this in its supporting statement.

An estimate of leakage in areas not covered by continuous monitoring can be extrapolated using leakage per property from the adjacent monitored area on the assumption that a similar level of leakage management activity is applied in these areas; otherwise a separate assessment is needed. Leakage in monitored areas failing validity checks is expected to be infilled using guidance defined in Section 5.4.

~~Reporting level~~

~~The main objective is to achieve and maintain a high level of operability as defined in Section 5.1 to report a statistically valid measure of annual average leakage.~~

~~A company can select to report leakage at:~~

- ~~District Meter Area (DMA) using district meters;~~
- ~~Water resource zone level using distribution input meters; or~~
- ~~An intermediate zone level using meters installed on reservoir outlets or trunk mains within the distribution network.~~

~~It is for a company to decide the level of reporting based on its own network characteristics and risk of meeting operability targets.~~

~~The subsequent sections of the guidance are addressed mainly to DMA monitoring although the principles apply equally to reporting at zone level.~~

Properties

Household and non-household properties are used in the estimation of total night use in any DMA or zone. Properties are also used as a denominator in leakage comparisons and for data infilling where DMAs or zones are not operable. Any inconsistencies could impact on DMA or zone operability and hence reliable reporting.

A company is expected to:

- Map all properties to defined zones or DMAs using geo-location or similar methods available in the industry;
- Check the consistency of property numbers contained within DMAs or zones against its company's billing system to ~~ensure~~minimise ~~there is no~~any under- or over- counting. -Valid differences shall be explained;
- Exclude properties that are defined as void from night use allowances unless a company can evidence any use or losses from illegal occupation;
- Apply leakage allowance for properties not within DMAs or monitored zones consistent with other leakage estimates;
- Update property data at least annually.
- [LKG4] Ensure the classification of properties as either household or non-household is consistent with the retail market definition of eligibility.

[LKG15a] Void properties should be accounted for consistently in all aspects of the leakage calculation.

[LKG15b] A company should justify the number of void properties each year and how this is derived. If consumption is assigned to a proportion of void properties (illegal occupation) then the evidence base to support this must be considered during the assurance process. Estimates of void properties should be updated annually.

Night Flow and Leakage

Night Flow Period

There is a requirement to analyse night flow at a time when it is possible to apportion flow with confidence between leakage and customer use using consistent and valid statistical methods. This analysis can be achieved at a time

during the night when customer use is predictable and relatively low. This may not necessarily be at a time of minimum night flow into a DMA or zone.

Estimates of DMA or zone night inflow and household (HHNU) and non-household (NHHNU) customer night use need to be aligned. The UKWIR Report 'Managing Leakage 2011'[21] recommended using a fixed hour period. This approach allows average flows to be compared with average night use. While this may give rise to exceptional low or high values of leakage in particular periods, over the reporting year these are expected to average out.

For current good practice, the only practical way is to use a fixed-hour statistic for both night flow and HH and NHH night use. This was confirmed in a UKWIR Report[22]. A company may extend this period to two hours. [LKG6a] A company must justify their choice of fixed hour or fixed two hours, ensuring it aligns with the NU period, and demonstrate why this period is appropriate for their circumstances.

A company is expected to derive night flow data using the following criteria.

- Night flow data frequency shall be at least every 15 minutes;
- Leakage shall be derived from a fixed period during the night of at least a one hour period although up to two hours may be used;
- The fixed period can be varied during the year for some or all DMAs or zones to address significant changes to night use patterns such as during Ramadan. Changes to the fixed period must be justified.

Night Flow Analysis

The analysis of night flow needs to be carried out using a consistent and valid statistical methodology. Both household and non-household night use are used to derive estimates of daily leakage. The estimates of HHNU and NHHNU night use are based on average (arithmetic mean) values over time and applied to night flows. Night flows therefore also need to be average (arithmetic mean) values to derive statistically valid estimates of leakage. The use of any alternative percentile assumption is not statistically valid.

A company is expected to apply the following assumptions for night flow analysis:

- The average values of night flow data over the period defined above shall be used with average values of HHNU and NHHNU data for the same time period to derive an estimate of leakage representative for the DMA or zone;
- The value of HHNU shall be derived using methods set out in Section 5.5 and the number of properties defined within the DMA or zone;

[21] Managing Leakage 2011, 10/WM/08/42: UKWIR 2011
[22] Improved Household Night Use Allowances; 14/WM/08/53: UKWIR 2014

- The value of NHHNU shall be derived from estimates of night use by group and the number of properties in each group defined as within the DMA or zone as set out in Section 5.6;
- Apply leakage allowance for properties not within DMAs or monitored zones consistent with other leakage estimates.

The analysis will derive values of leakage for each DMA or zone expressed as leakage per hour for every day of the year. Leakage is then expressed as leakage per day following the methodology set out in Section 5.6.

Data Infilling

Where a DMA or zone is inoperable a software package will normally infill data following defined rules using historic data from the same DMA or zone or average data from adjacent DMAs. To achieve a high operability target, infilling of weekly values shall be limited to short periods of preferably no more than a month and certainly no greater than six months. While rules vary across companies, for consistency a company is expected to follow the following guideline or disclose where it has not been able to comply.

- Data infilling for a single DMA or zone shall not use more than six months of historic data before moving to area average;
- Data infilling taking the area average in which the DMA is located is valid if historic data is not available;
- When a DMA is restored to operability, for the purposes of annual average reporting, the subsequent leakage data should be used to update retrospectively the data infilling interpolating between pre- and post- data over at least one month. This is because a non-operable DMA is unlikely to be subject to detection processes and there is likely to be a natural rise in leakage over time. It is recognised that this may take time to achieve, as and when leakage software packages are updated. There is one exception where a DMA is inoperable at the end of a reporting year where alternative data infilling, [LKG3] ~~such as~~ using the last valid weekly value ~~extrapolation or use of average values,~~ may be used;
- Where NHH properties are continuously monitored, the actual values of flow over the night flow period shall be used in place of estimates within the night flow analysis.

Seasonal Variation in Night Use

Fixed night use allowances are not appropriate for many companies who observe rising night flows during warm summer periods or spring planting. There is clear evidence that customer night use increases over these periods due to a small proportion of households using overnight sprinklers or night time irrigation of golf

courses and plant nurseries. A fixed night use allowance through the year is not appropriate in capturing variations in night flow.

Some companies may use advanced modelling or enhanced logging methods to improve estimates of night use although this is not a requirement for current good practice.

A company is expected to make allowance for seasonal variance in night use:

- The night use allowance shall be adjusted regularly through summer months to allow for variable customer night use based on sample logging over the period or night use models;
- Weekly leakage estimates shall be used for annual reporting with no exclusions for summer months.

[LKG6b] A company must justify any seasonal adjustments they make. ~~This must be e~~Evidence based on data and or studies should support this.

Negative Leakage Values

Average customer night use is normally applied equally to all DMAs although actual use can be higher or lower than across individual DMAs. The impact, particularly in small or low-leakage DMAs, is that negative calculated leakage values may be reported. While this may appear anomalous, combining leakage values at zone or company level will offset these negative values while maintaining the overall value of average household use. It is therefore appropriate to include negative leakage in collating leakage data to area or company level. Capping leakage to zero would artificially reduce the resulting average value of night use and is not appropriate. This issue is not observed in larger DMAs or zones.

A company is expected to make allowance for negative leakage values:

- Where average night use values are applied across all DMAs, it is appropriate to include negative leakage values when compiling values of annual average leakage;
- The reasons for any prolonged periods of negative leakage need to be investigated and explained.

Household Night Use

Estimates of household night use are deducted from measured night flows in estimating of leakage using the method described in Section 5.4. A company can estimate night use using either an Individual Household Monitor (IHM) or a Small Area Monitor (SAM) or a combination of both. The choice of method is likely to be

related to the preferred method for deriving estimates of ~~per capita consumption (PCC) or per~~unmeasured household consumption.

A Company shall use its own data and application of national default values is not valid. This is because these default values were derived from limited data over 25 years ago. In addition, 'Socrates' loggers are no longer maintained or supported and hence are not best practice.

In the case of ~~The~~ IHMs, these were originally designed to derive estimates of unmeasured per capita consumption and usually comprise about 1000 selected properties. This is a relatively small sample for night use assessments given the likely frequency and flow of intermittent and high volume large night use customers. The IHM needs to be continually monitored to ensure any failed meters are replaced and periods of continuous night flow are quickly identified and resolved to minimise any supply pipe leakage.

SAMs normally provide a larger household sample size than IHMs and are appropriate for night use and unmeasured ~~PCC~~ household consumption assessments. SAMS may be part or full DMAs; whatever size, they shall be selected and designed to give substantial coverage of households and minimise non-household properties. A company using SAMs for the estimation of HHNU should apply the recommendations of the recent UKWIR *report*[23] on the application of a fast logging methodology for continuing monitoring and maintenance.

The HHNU survey needs to have a sufficient number of samples, representative of a company's demographic factors, to identify both continuous and a significant number of intermittent flow events. The sample size of an IHM is unlikely to be sufficient to capture intermittent use with sufficient frequency. This is because intermittent use could be attributable to a small number of customers.

A company is expected to derive weekly or monthly values of HHNU and shall retrospectively recalculate leakage each week or month as new data becomes available. Some software systems automate this process within their existing leakage data analysis.

HHNU has a significant impact on reported leakage. There is a need to continually improve the coverage of properties with a focus on the factors having greatest

[23] Fast Logging for improved estimation of household night use, UKWIR 2017

impact on night use; for example the impact of seasonal variations in use, increasing SAMs coverage and use of enhanced metering methods.

A company is expected to derive an estimate of average (arithmetic mean) household night use applying the following criteria:

- The values of HHNU night flow shall be used with values of night flow and NHHNU for the same time period and on the same statistical basis to derive an estimate of leakage representative for the DMA or zone;
- It shall use its own data or shared data with proximate companies. National default values are not valid;
- Plumbing losses shall be included and based on the company's own data;
- It shall demonstrate that its survey is representative of the company as a whole; disaggregation of the sample by demographic factors, property type or similar represents good practice;
- It shall demonstrate that the sample size is sufficient to capture continuous and intermittent night use with reasonable confidence;
- The application of IHMs, SAMS or a combination of both. It is unlikely that the IHM on its own will be of sufficient size to capture a valid sample of intermittent use;
- Continual monitoring and maintenance of IHM and SAMs monitors;
- HHNU shall be derived daily with regular, adjustment of values on a weekly or monthly frequency to reflect actual seasonal use. This may need to be done retrospectively.

Non-Household Night Use

Estimates of non-household night use are deducted from measured night flows in estimating leakage using the method described in Section 5.4. Most companies use the 1999 UKWIR methodology[24] which sets out a methodology for deriving relationships between average night use and annual billed volume (ABV). Some companies are reviewing the form of this relationship to improve the confidence of this methodology.

The methodology stratifies non-household customers by groups of industry types and range of consumption. A representative sample of the variable characteristics of non-households by group and consumption shall be identified. Data logging of

[24] Estimating Legitimate Non-household Night Use Allowances, 99/WM/06/26: UKWIR 1999

these sample customers shall be carried out for at least two weeks to derive model coefficients for each group.

Continuous monitoring of some non-households is carried out although companies apply varying thresholds of consumption above which they will install continuous monitoring. The objective for leakage reporting is to take full account of water use in the night flow analysis where total flow is significant in relation to DMA night flows or the likely variation in flow has a significant impact on DMA analysis and presents a risk to deriving valid data. The target threshold for continuous monitoring is where average demand of an individual non-household is greater than 24 to 48 m^3/day (or night flow >1000 to 2000 l/hr) or 25% of a DMA night flow. A company should define its criteria, reflecting the impact of night use on the ability of a DMA to produce consistent and valid leakage estimates.

For water and sewerage companies, the 1999 UKWIR methodology shall also be applied to sewage treatment works and other company sites using significant water volumes. The guidance for continuous monitoring of non-households shall be similarly applied to these sites.

The introduction of competition in the non-household market may impact on the source and availability of measured volumes.

A company is expected to derive estimates of non-household night use applying the following criteria:

- The values of NHHNU night flow shall be used with values of night flow and HHNU for the same time period and on the same statistical basis to derive an estimate of leakage representative for the DMA or zone;
- It shall use its own data or shared data with proximate companies. National default values are not valid;
- Application of the 1999 UKWIR methodology with the appropriate time window as used for the night flow and the published outcome of further methodology development;
- It shall demonstrate that the stratification of non-households to a number of groups and consumption bands is representative of the varying characteristics of commercial and industrial properties;
- It shall demonstrate that the sample size is sufficient to capture night use by stratification with reasonable confidence;
- Development of a reliable and representative average billed volume (ABV) model based on data logging of the representative sample sufficient to capture demand variations with further seasonal logging where relevant. Continuously logged properties are unlikely to form part of the sample as these generally have greater consumption than the stratified samples;

- Direct linkage of the ABV model to a company's billing system or replacement database of billed volumes. Update the average billed volumes at least annually;
- Continuous monitoring of selected non-households shall be carried out where average demand of an individual non-household has a material impact on the ability for a DMA or zone to provide valid and consistent data within operability limits; and
- For water and sewerage companies, apply the same ABV methodology as a separate group and continuously monitor sewage treatment works and other sites using the same criteria as for non-households.

Supply pipe leakage

HHNU and other components of the water balance are sensitive to the supply pipe losses estimate used~~ and this is also linked to plumbing losses~~. There is inconsistency in how companies estimate SPL and how they keep the estimates up to date. Some use separate allowances for internally metered properties and others just use one estimate for all properties. A robust methodology to determine this is required. ~~A recently started UKWIR study is looking at SPL (and plumbing losses) and may help with this.~~ In the meantime a company must state the supply pipe leakage allowances it uses and present the evidence on which this is based.

Hour to Day Conversion

An hour to day correction is required to take account of diurnal pressure variation in each DMA or zone. Leakage is monitored during the night when actual pressure is normally greater than other parts of the day. Daily leakage is estimated from night flow when actual pressure is likely to be greater than the average for a defined DMA unless pressure management is in place. Night leakage therefore needs a correction factor to convert to the average daily leakage rate. As leakage varies with pressure, the daily leakage flow needs to reflect the diurnal variation in flow.

A company shall take into account the findings from the UKWIR Report 'Assessment of Key parameters for Leakage Analysis[25] which addresses average zone pressure, average zone night pressure (AZNP) and hour to day factor (HDF).

A company is expected to derive the hour to day conversion using the following criteria:

- The hour-to-day factor shall be derived separately for each DMA or zone using pressure logging within each DMA. The factors shall be updated at least annually or where there are any significant changes to pressure regimes;

[25] Assessment of Key Parameter for Leakage Analysis, 17/WM/08/59, UKWIR 2017

- As an alternative, hydraulic models can be used provided they have been updated to reflect the latest network reconfiguration and any pressure changes, and provided it is dis-aggregated in sufficient detail at sub-zone level;
- An N1 value of 1.0 to 1.2 in the leakage – pressure power law relationship[26] unless a company is able to demonstrate a higher or lower value would be more appropriate using its own data. A company should set out its approach to deriving its N1 value.

Annual Distribution Leakage

Annual average distribution leakage expressed in Ml/d shall be derived from operable data with minimal data infilling. Historically there have been various rules used to derive annual average leakage expressed as Ml/d using a variety of statistical assumptions applied to weekly or monthly data. The approach set out below is to make best use of operable data. It takes into account variable daily data, captures weekly trends and minimises the extent of statistical adjustments. The weekly leakage value is used as the base measure taking an average value of daily data in the week. There may be outliers in the data which is expected in taking average values. Over the reporting year these outliers should be balanced and not impact on average annual leakage. The method captures the variance in weekly data through an average of the 52 weekly values. Monthly reporting may be appropriate for internal reporting but has no value in moving from weekly to annual average values.

A company is expected to derive the annual average distribution leakage using the following criteria:

- The average weekly data shall be derived from all available valid daily values of leakage using data points which are representative of the week. [LKG7] Valid data must be available for at least ~~minimum of~~ 3 days of the week for the DMA ~~data~~ to be ~~used~~considered operable. In this instance ~~Where valid data is not available from three or more data points then~~ the weekly data should be backfilled using the methods described in Section 5.4 – night flow analysis. Where there is less than 3 days of valid data for the week ~~available~~ then that DMA data is not considered ~~available~~operable and should not be used. In this instance the DMA data should be estimated;
- The annual value of leakage expressed as Ml/d shall be derived from an average of the 52 week data.

[26] Leakage (L) is proportional to pressure P^{N1} where N1 can vary locally between 0.5 and 1.5, but at DMA level is typically between 1.0 and 1.2.

Trunk Main and Service Reservoir Losses

Trunk Mains

For some companies who monitor leakage at zone level, trunk mains losses are included in reported leakage. A separate assessment of trunk main losses is therefore not required.

For companies estimating leakage at DMA level they must derive estimates of trunk mains leakage and service reservoir losses separately.

A proportional approach in estimating leakage shall be applied. A company with a relatively high proportion of trunk main losses to total leakage should take a proactive leakage monitoring approach with a combination of field inspections, analytical techniques, and flow balancing methods. Other companies with relatively low proportions of estimated trunk main leakage (<5% of total leakage) may apply less intensive methods but all should use their own data and not rely on national default values. It is recognised that trunk main leakage is difficult to measure; the relatively low confidence of this estimate shall be reflected in the confidence intervals applied in the MLE methodology.

Compilation of flow balances within sections of the trunk mains network is an important element to the proactive approach. Flow balances may identify either meter error or unknown connections, but in some instances they may identify significant trunk mains leakage. Flow balances should be carried out between upstream and downstream meters or groups of meters, where

- The upstream meters may be distribution input meters or trunk main network meters, or groups of such meters; and
- The downstream meters may be trunk main network meters or district meters, or groups of such meters.

~~A company should have sufficient meters installed to allow flow balances to be calculated over 95% by volume of the trunk main network.~~

Companies should follow the advice given in UKWIR report 'Leakage Upstream of District Meters[27]', which describes two alternative methods for quantification of trunk main leakage.

(i) A flow balance approach, as described above. This method is dependent on sufficient operational meters being installed. The method allows for a sample of meters and for the findings to be extrapolated. The disadvantage of

[27] Leakage Upstream of District Meters, 15/WM/08/55, UKWIR 2015

this method is that it is using the difference between two or more meters with potential meter inaccuracies; or

(ii) A BABE component approach, using data on numbers of leakage with estimated flow rates and durations, together with an estimate of background leakage.

The choice between these two methods depends on what data is available to a company. If one of these methods can be applied meaningfully on a sample of the trunk mains network, this can be extrapolated to the whole network. Company-specific data shall be used to assess the value of trunk main leakage; national default values should not be used.

~~For some companies who monitor leakage at zone level, trunk main losses are included in reported leakage. A separate assessment of trunk main losses is therefore not required.~~

A company is expected to derive values of trunk main leakage using the following criteria:

- Company-specific data shall be used to assess the value of trunk main leakage;
- A proactive leakage monitoring approach shall be applied where trunk main losses form a significant element (>5%) of total leakage or the MLE water balance gap is greater than +/-2%. This approach shall be a combination of field inspections, analytical techniques, and flow balance methods. ~~A company should have sufficient meters installed to allow flow balances to be calculated over 95% by volume of the trunk main network.~~ The selection of methodology and level of leakage monitoring activities shall reflect the proportion of estimated losses in relation to total leakage and the characteristics of the network;
- Companies with trunk main losses greater than 5% of total leakage shall review and refresh estimates annually.

Service Reservoir Losses

A proportionate approach to estimating losses is appropriate. Leakage can occur through the structure and valves; overflows may be passing water. Losses are generally less than other areas of leakage; hence the lower frequency of leakage surveys. Drop tests have been used for many years as an acceptable and proportionate method for identifying any material leakage. [LKG8] Estimates are expected to be updated annually but this does not require a company to undertake

annual drop tests of all service reservoirs. Where a new drop test has been done that year the results should be included in the overall estimate.

A company is expected to estimate service reservoir leakage using the following criteria:

- Company-specific data shall be used to assess the value of service reservoir losses;
- Reservoirs with known high leakage, structural deficiencies or are at risk of water quality failures shall be investigated on an individual basis;
- Drop tests are an appropriate approach and normally carried out every five or ten years in parallel with ongoing routine reservoir inspection programmes. Drop tests shall be carried out for at least 12 hours depending on the size of the reservoir. All valves should be checked to ensure they are closed tight; and
- The extent of losses through reservoirs overflows should be investigated. Where reservoirs are shown to be at risk of overflowing, appropriate monitoring arrangements shall be put in place to control and minimise overflow events.

Annual Average Leakage

Annual average leakage is reported as the sum of distribution leakage from continuous DMA or zone monitoring, areas not covered by continuous monitoring, trunk main leakage and service reservoir leakage. These values shall be applied with differing confidence intervals in the MLE methodology.

Water Balance Components

Distribution Input

Distribution input (DI) is a measure of the volume of potable water input to the distribution network at treatment works, boreholes and bulk supply locations. DI is reported as an annual average Ml/d.

A company is expected to report Distribution Input using the following criteria:

- Distribution input to the system shall be metered with at least daily readings at all defined locations;
- Meters shall be an appropriate size for the flow to be measured and located at appropriate inputs to the network confirmed by record plans. Any treatment works take-off downstream of a meter shall be excluded from the DI calculations;
- Data validity checks shall be carried out at least monthly;
- Any missing data shall be infilled using both pre- and post- data for the location over at least one month, extrapolated from pump hours or use of upstream or downstream meters;

- The data transfer systems from meter output to central database shall be checked and validated on a risk-based frequency from one up to two years;
    - ~~Flow checks shall be carried out on DI meters consistent with the principles of the document 'EA Abstraction Good Metering Guide'[28] and in particular the frequency of flow checking defined in Table 6.2 of the EA guide.~~

Measured Consumption

The volume of measured consumption shall include for measured household and measured non-household water use excluding supply pipe leakage and including estimates of meter under-registration.

Measured data shall be derived from the meter readings within the company's billing system including estimated reads and an adjustment for meter under-registration should be applied. For externally metered properties an allowance for supply pipe leakage should be deducted from the metered volumes.

[LKG16] Companies must undertake a process of accruing consumption at year end to account for meter reading frequency cycles. A company should justify with evidence its approach to accruals.

[LKG14] New guidance on the estimation of unmeasured household consumption[29] proposes a measured household monitor to enable the nature of consumption patterns to be better understood. If a company uses a measured household consumption monitor it must set out its approach and justify its use in this methodology.

For non-households all water delivered is assumed as consumption and is billed by the wholesaler to the retailer. No allowance is made for any supply pipe losses.

A company is expected to derive measured consumption using the following criteria:~~-~~

- Metered data as derived from a company's own billing system or from CMOS for non-households;
- A deduction for supply pipe losses for externally metered properties consistent with the company's current assumption of supply pipe losses;
- Adjustments to metered data for leakage allowances applied to individual customers can be included where a rebate has been applied to a customer's bill;

~~[28] EA Abstraction Good Metering Guideline, EA February 2002~~
[29] Future Estimation of Unmeasured Household Consumption, 17/WR/01/16, UKWIR 2017

- Meter under-registration shall be applied consistent with a company's own estimates.

Unmeasured Consumption

The volume of unmeasured consumption shall include for unmeasured household and unmeasured non-household water use excluding supply pipe leakage.

Unmeasured household consumption

There is a separate performance commitment for PCC (per capita consumption) and this has its own guidance (Consistency of Reporting Performance Measures, Reporting Guidance – Per Capita Consumption). That is based on an average PCC derived from the sum of measured household consumption plus unmeasured household consumption divided by total household population. The guidance for the PCC performance commitment includes detail around estimation of unmeasured household consumption and is consistent with this guidance for deriving the leakage estimate.

For the water balance it is not necessary to derive PCC. It is the total volume of unmeasured household consumption which is to be derived. For households this should be based on per household estimates which removes the need for occupancy data. The following guidance is repeated from the PCC guidance. Further detail is included in the separate PCC guidance.

The volume of unmeasured household consumption should include water used by each unmeasured household excluding supply pipe leakage. Dependent on the level of meter penetration a company has this can be a significant component of the water balance and therefore needs continual focus to maintain and improve the estimate. For the purposes of this PC unmeasured household consumption should be based on PHC (per household consumption).

In general, companies are expected to use company specific data for unmeasured household consumption except for companies with high meter penetration where it may be impractical to establish and maintain a sufficiently robust sample of unmeasured properties. In this case sharing of unmeasured data with neighbouring companies or companies with similar demographics may be appropriate. Companies with high meter penetration must set out their approach to estimating unmeasured household consumption.

In most cases (except perhaps where a company's meter penetration is high) it is expected that unmeasured household consumption shall be estimated from a company's own consumption monitor following good practice as defined in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors 1999'. Good practice has improved since this report with innovation and new technologies now available although the basic principles of the monitors is

unchanged. Companies can use individual household monitors (IHMs) or Small Area Monitors (SAMs).

Further work is required to determine current good practice for sample size and stratification for IHMs and SAMs. Until this is concluded companies should continue to base their approach on a sample of at least 1000 for IHMs. Representation may be by demographic group, property type or other recognised statistical group. Companies must set out the evidence to demonstrate their sample is representative of their area.

Individual monitors should have a high resolution meter and associated logger to transmit data to a control centre. Data is expected to be collected at least at hourly intervals and regularly downloaded. The IHM needs continual monitoring to limit the level of any supply pipe losses or other continuous flows. Any other continuous flows are attributable to customer use or plumbing losses and should be included in estimates for consumption at household level.

While an allowance is made for meter under-registration it is expected that meters used for these consumption monitors will have an enhanced specification compared with normal domestic meters and as they are continually monitored meter failures and drift will be identified earlier than for normal domestic meters. Meters are expected to be selected and maintained to minimise meter under-registration. A phased meter replacement programme should be in place.

Until further guidance is developed companies should continue to base SAMs on a representative sample of areas of DMAs or smaller whole DMAs which are specifically designed with one meter and permanent data loggers. They should include minimal numbers of non-household properties and have minimal measured households (no more than 50% where practical).

Consumption for non-household properties within SAMs should be deducted from the area total consumption based on metered data or where unmeasured non-households are included using the unmeasured non-household consumption allowance. Companies should set out how they have deducted non-household consumption;

Consumption for measured households within SAMs should be deducted from the area total consumption based on metered data. Companies should set out how they have deducted household consumption;

The total sample size for SAMs is dependent on the acceptable uncertainty applied to consumption estimates and assumptions on SAM outage. There is currently no specification for number of properties included in SAMs for consumption estimates. This should be included in future guidance following further work. In the meantime,

a company should set out its evidence to demonstrate the representativeness of its sample.

The IHM monitoring requirements for continual monitoring and meter under-registration shall be equally applied to SAMs.

Data will not always be available from IHMs or SAMs for a range of reasons. In these cases, data can be infilled using the following guiding principles; where a SAM or IHM property is inoperable data can be infilled using historic data from the same SAM or IHM property or average data from a SAM or IHM property with similar characteristics (from the same stratification).

Supply pipe leakage should be excluded from data for unmeasured households externally metered as part of IHM surveys. For SAMs estimates of supply pipe leakage must also be removed from the data. A company should use its own estimates of supply pipe leakage which are updated annually. A company must set out how these estimates have been derived and its approach to excluding supply pipe leakage from IHM or SAM data used in the calculation for unmeasured household consumption. This is also linked to estimates of plumbing losses. A robust methodology to determining this is required. A recently started UKWIR study is looking at plumbing losses and may help with this.

A company is expected to derive unmeasured household consumption using the following criteria:

- Unmeasured household consumption (Ml/d) for the whole company shall be calculated from average per household consumption (PHC measured as l/h/day) multiplied by the number of unmeasured households.
- Average unmeasured household consumption (PHC) shall be derived from a company's own IHM or SAM except where meter penetration is high and this makes this impractical.
- The PHC for the IHM or SAM sample shall be extrapolated to an average for the whole company based on stratification.
- The IHM or SAM shall follow the principles set out in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors' 1999 and the more recent report 'Future Estimation of Unmeasured Household Consumption', UKWIR 2017;
- IHMs and SAM monitors shall be continually monitored and maintained;
- A company shall demonstrate that its IHM or SAM is representative of the company as a whole; disaggregation of the sample by demographic factors, property type or similar factors represents good practice. Valid data from the survey shall be from at least 80% of monitors as an annual average measure. A company may develop and use an alternative monitor as defined in the 2017 UKWIR Report but it must set out the approach taken and demonstrate why this is appropriate;

- In general, it is expected that where the proportion of metered properties in a SAM exceeds 50% of total properties then the area should not be included in the estimation of unmeasured consumption. Companies with high meter penetration may not be able to comply with this and this should be considered when deciding their approach to estimating unmeasured household consumption;
- Quantify the uncertainty allocated to unmeasured household consumption and provide evidence to justify the uncertainty value used;
- Meters shall be selected to provide sufficient granularity to detect low continuous flows indicative of plumbing losses or leakage short duration flow variations. The value of meter under registration should be less than the company's average meter stock;
- Estimates of supply pipe leakage shall be based on a company's own data which is updated annually; and
- Estimates of meter under-registration shall be based on a company's own data which is updated annually.

New guidance on the estimation of unmeasured household consumption[30] has been published. This provides further guidance on monitoring processes in particular the impact of adopting models to increasing meter penetration. The report sets out several potential options for estimating unmeasured households and a framework for selection of an alternative method. For companies with high meter penetration their approach to estimating unmeasured household consumption must be consistent with this guidance and they should set out their approach.

Unmeasured non-households

This component is normally a small proportion of total non-household demand. ~~The extent of water delivered to u~~Unmeasured non-household~~s~~ consumption ~~is~~should be derived from a study of the consumption of measured non-households of similar categories and applying a recognised statistical approach.

A company is expected to report ~~water delivered to~~ unmeasured non-household~~s~~ consumption using the following criteria:

- Where th~~is~~e reported volume is less than 2% of total non-household demand, data from a per property consumption study shall be refreshed every five years;
- Where reported volumes are greater than 2% of non-household demand, data from a property study shall be refreshed every two years.

[30] Future Estimation of Unmeasured Household Consumption, 17/WR/01/16, UKWIR 2017

Company Own Water Use

Many water and sewerage companies have significant water use at their sewage treatment works and other major assets. The driver for metering is not only accounting for water in the balance but to allow use as part of leakage monitoring and reporting. Many companies have water efficiency targets to meet and metering is an enabler to achieve these.

Distribution system operational use comprises water knowingly used by a company to meet its statutory obligations particularly those related to drinking water quality. This includes, amongst other things, mains flushing, air scouring, swabbing, service reservoir cleaning, discharge to control pH and other chemical parameters in distribution. Water taken for commissioning of assets or as part of other legitimate network use shall be included. A proportionate approach is appropriate. An industry average can be applied. [LKG11] A company must justify and evidence the estimate it uses. ~~Where use is greater than 0.6% (20% above current industry average) of distribution input this is to be clearly evidenced and justified.~~

A company is expected to report using the following criteria:

- All sewage treatment sites and other key assets using greater than 10 m^3/d (0.01 Ml/d) shall be metered;
- An estimate of total company own use shall be included in the water balance, based on a clear methodology and actual data;
- Where an estimate of distribution operational use is greater than 0.6% of distribution input then this value needs to be clearly stated and justified. There should be no change to current assumptions unless clearly evidenced.

Other Water Use

This component comprises water delivered both legally and illegally.

Water taken legally unbilled shall include all water supplied to customers that is unbilled and not reported as water delivered to billed customers. It can include public supplies for which no charge is made such as some sewer flushing, uncharged church and other supplies, fire-fighting and training where not charged. The measure excludes leakage allowance rebates for measured customers. A proportionate approach is appropriate. An industry average can be applied. Where use is greater than 1.2% of distribution input (based on 20% above current industry average) this is to be clearly evidenced and justified.

Water taken illegally unbilled should only be reported here if it is based on actual occurrences using sound and auditable identification and recording procedures. This includes water use in void properties. A proportionate approach is appropriate. An industry average can be applied. Where use is greater than 0.6%

of distribution input (based on 20% above current industry average) this is to be clearly evidenced and justified.

A company is expected to report Other Water Use using the following criteria:

- Other use components should be based on a company's own data;
- [LKG12] A company must justify and evidence the estimate it uses. ~~Where an estimate of water delivered unbilled (legally and illegally) is greater than 1.8% of distribution input then this value needs to be clearly stated and justified;~~
- Estimates should be updated when there is a material increase or decrease to volumes.
- [LKG14]

Meter under-registration (MUR)

Within the calculation of leakage metered data is taken from:

- DI meters
- Customer meters
- Night use monitor meters
- PCC monitor meters
- Night flow meters

Therefore, there is potential for MUR to impact on estimates for night flow, HHNU, NHHNU, unmeasured consumption, measured consumption and the water balance.

Dependant on meter technology and flow through the meter there may be no bias in either direction and therefore there should be no MUR applied. Calibration and verification should still be undertaken. For other meters where there is a bias for under registration then this should be accounted for in calculations.

A company should include estimates of meter under-registration for all meters where there is a bias for under registration. A company should justify the MUR figure used and how it has been derived. MUR should be reviewed annually.

For water delivered measured ~~M~~meter under-registration can be applied to measured volumes. A company is expected to use its own data on under-registration. Where a metering programme has recently been completed or ongoing, a company is expected to revise its assumptions. It is recognised that information on under-registration is limited and there is a need for further work to

derive statistically representative values. It is expected that meter under-registration greater than 3% would need to be robustly evidenced.

A company should set out its approach to stopped meters and demonstrate that there is no double counting between stopped meters in consumption from billing data and MUR.

For DI, a company should set out its approach to meter verification. As a minimum, flow checks shall be carried out on DI meters consistent with the principles of the document 'EA Abstraction Good Metering Guide'[31] and in particular the frequency of flow checking defined in Table 6.2 of the EA guide. This does not require all DI meters to be verified annually: there may be a rolling programme which feeds into overall MUR where a portion of meters are verified each year.

MLE Adjustment

Concept

The basic assumption is that: Distribution Input shall equal the sum of water delivered to customers or used for other purposes and leakage from a company's network.

As this is averaged over a year, any change in service reservoir storage is not material.

The methodology for estimating water balances set out in the Demand Forecasting Methodology report[32] shall be applied. An initial balance of all components shall be applied to identify the extent of any water balance gap. The distribution is carried out by reference to the size and uncertainty surrounding each component of the water balance.

The water balance gap is defined as: 'The difference between distribution input and the sum of water delivered to customers, a company's own water use, water delivered unbilled, distribution system use and leakage. The water balance gap is positive where distribution input is >the sum of components and negative where distribution input is < the sum of components.'

A gap of ±2% is considered good practice. A water balance gap >5% or < -5% indicates a significant inconsistency in one or more of the major components. A company is required to explain the reasons for any water balance gap of greater than a lower threshold of +/-3%. A water balance gap >5% or < -5% is too wide for a valid MLE adjustment to be carried out. In this instance, any water balance gap in excess of the +5% gap, expressed as Ml/d, shall be added to the leakage

[31] EA Abstraction Good Metering Guideline, EA February 2002
[32] Demand Forecasting Methodology, NERA for UKWIR 1995: 95/WR/01/1

component. In addition, for any water balance gap >5% or < -5% a review of all material components of the water balance is required.

A company is expected to:

- Set out its approach to MLE
- Apply the MLE methodology and identify any water balance gap;
- Disclose and explain the reasons for any water balance gap exceeding 3% of distribution input;
- Any water balance gap in excess of the +5% gap, expressed as Ml/d, shall be added to the leakage component;
- Revisit all material components of the water balance where the water balance gap is >5% or < -5%.

[LKG13a] No elements of the water balance should be excluded from the MLE. The expected components of the MLE are as listed below:

For companies estimating leakage at DMA level:

- Measured household consumption (excl SPL)
- Unmeasured household consumption (excl SPL)
- Measured non-household consumption (excl SPL)
- Unmeasured non-household consumption (excl SPL)
- Distribution system operational use
- Water taken legally unbilled consumption (excl SPL)
- Water taken illegally unbilled
- ~~Total leakage~~
- DMA leakage
- Supply pipe leakage
- Trunk mains leakage
- Service reservoir leakage
- Distribution input

For companies estimating leakage at zonal level:

- Measured household consumption (excl SPL)
- Unmeasured household consumption (excl SPL)
- Measured non-household consumption (excl SPL)

- Unmeasured non-household consumption (excl SPL)
- Distribution system operational use
- Water taken legally unbilled consumption (excl SPL)
- Water taken illegally unbilled
- Distribution losses
- Supply pipe leakage
- Distribution input

~~A company may choose to input water delivered data instead of consumption data in which case SPL would be included in water delivered measured household, water delivered unmeasured household, water delivered measured non household and water delivered unmeasured non household and excluded from DMA leakage.~~

Confidence Intervals

The MLE methodology applies a confidence interval to each component of the water balance. This is to reflect the accuracy of each of the components. Best practice is to derive a statistical measure of accuracy for each component although this is difficult in practice. Applying a relative accuracy is an alternative approach.

Applying differing confidence intervals very often has a significant impact on the water balance, particularly for leakage and per capita consumption. There is therefore a need to be more prescriptive in the approach to defining the range of confidence intervals. A range of confidence intervals can be applied to each group of components.

[LKG13b] A company ~~is expected to~~must justify the confidence intervals it uses and provide evidence of how these have been derived. It is expected that most companies' ~~apply~~ confidence intervals will fall within the following ranges~~unless it has a valid statistical basis for specific components~~:

Fully measured components such as distribution input should have a range from 2% to 4%;

- Mainly measured with some estimated adjustments such as measured volumes with supply pipe losses and meter under-registration: from 2.5% to 5%;
- Estimated using detailed and reliable methods such as distribution leakage and unmeasured household (including PCC): from 8% to 12%;
- Broad estimates not fully detailed or reliable such as trunk main leakage and water delivered unbilled components: from 20% to 50%.

Reported Total Leakage

Total leakage is taken as the sum of the post MLE values for distribution leakage, including supply pipe leakage, and trunk main / service reservoir leakage. It is expressed as an annual average Ml/d value to one decimal place, consistent with the performance commitment measure.

Glossary

ABV	Annual billed volume
AZNP	Average zone night pressure
BABE	Burst and background estimating methodology
DI	Distribution input
DMA	District Meter Area
EA	Environment Agency
HDF	Hour to day factor
HHNU	Household night use
IHM	Individual household monitor
MUR	Maximum likelihood estimation
MLE	Maximum likelihood estimation
NHHNU	Non household night use
Ml/d	Mega-litres per day
PCC	Per capita consumption
SAMs	Small area monitors
UKWIR	United Kingdom water industry research

[LKG1] Annex A: Compliance Checklist

A company is required to complete this checklist for submission with its value of annual average leakage.

The elements of each component to be assessed separately based on the following rules:

Compliance for elements is reported against:

R	Not compliant with the guidance and having a material impact on annual average leakage
A	Not compliant with the guidance and having no material impact on annual average leakage. For example, a material impact might be assessed as more than 1% of the reported value. A company should set out its approach to assessing whether an impact is material or not.
G	Fully-compliant with the guidance

An overall RAG to be assigned for each component based on the following rules:

Compliance for overall components is reported against:

R	There are one or more red elements in the component or the combined effect of amber elements is considered to produce a material impact.
A	Half or more of the elements in the component are amber and the combined effect of the amber elements is considered not to produce a material impact.
G	More than half of the elements in the component are green

	Component / Element	Component R/A/G	Element R/A/G	Reason for any non-compliant components	Confidence grade
1	**Coverage**	R/A/G			
1a	95% of all properties have continuous night flow monitoring through the year		R/A/G		
2	**Availability**	R/A/G			
2a	At least 90% of all properties within continuous night flow monitoring networks available for reporting night flow data through the year		R/A/G		
3	**Properties**	R/A/G			
3a	All properties mapped to defined zones or DMAs using geo-location or similar methods		R/A/G		
3b	Consistency of property numbers contained within DMAs or zones with company billing system. Valid differences explained		R/A/G		
3c	Properties that are defined as void excluded from night use allowances unless evidence for use or losses from illegal occupation is available		R/A/G		
3d	Leakage allowance applied for properties not within DMAs or monitored zones consistent with other leakage estimates		R/A/G		
3e	Property data updated at least annually		R/A/G		
4	**Night flow period and analysis**	R/A/G			
4a	Night flow data frequency at least every 15 minutes		R/A/G		

4b	Leakage derived from a fixed period during the night of at least a one hour period and up to two hours		R/A/G		
4c	If the fixed period is varied during the year for some or all DMAs or zones to address significant changes to night use patterns such as during Ramadan evidence for this is provided.		R/A/G		
4d~~e~~	Leakage allowance applied for properties not within DMAs or monitored zones consistent with other leakage estimates		R/A/G		
4e~~d~~	Data infilling for a single DMA or zone does not use more than six months of historic data before moving to area average		R/A/G		
4f~~e~~	Data infilling where historic data is not available uses the area average in which the DMA is located		R/A/G		
4g~~f~~	When a DMA is restored to operability, the subsequent leakage data is used to retrospectively update the data infilling interpolating between pre- and post- data over at least one month		R/A/G		
4h~~g~~	Where NHH properties are continuously monitored, the actual values of flow over the night flow period are used in place of estimates within the night flow analysis		R/A/G		
4i~~h~~	Weekly leakage estimates are used for annual reporting with no exclusions for summer months		R/A/G		
4j	Negative leakage values are used in compiling values of annual average leakage		R/A/G		
4k	The reasons for any prolonged periods of negative leakage are investigated and explained.		R/A/G		
5	**Household night use**	R/A/G			
5a	The time period for ~~values of~~ HHNU ~~night flow are used with values of night flow and NHHNU for the~~is the same time period as used for night flow and NHHNU. ~~and on the same statistical basis to derive an estimate of leakage representative for the DMA or zone~~		R/A/G		

5b	Own data or shared data with proximate companies is used for HHNU.		R/A/G		
5c	Plumbing losses are included and based on own data		R/A/G		
5d	Evidence that survey is representative (based on demography, property type or other factors) of the company as a whole		R/A/G		
5e	Sample size is sufficient to capture continuous and intermittent night use with reasonable confidence		R/A/G		
5f	Continual monitoring and maintenance of IHM and SAMs monitors		R/A/G		
5g	HHNU is derived daily with regular, adjustment of values on a weekly or monthly frequency to reflect actual seasonal use. This may be done retrospectively		R/A/G		
6	**Non household night use**	R/A/G			
6a	The time period for ~~values of~~ NHHNU ~~night flow are used with values of night flow and HHNU for the~~is the same time period~~-~~ as used for night flow and HHNU~~and on the same statistical basis to derive an estimate of leakage representative for the DMA or zone~~		R/A/G		
6b	Own data or shared data with proximate companies is used for NHHNU		R/A/G		
6c	1999 UKWIR methodology with the appropriate time window as used for the night flow and the published outcome of further methodology development is applied		R/A/G		
6d	Stratification of non-households to a number of groups and consumption bands is representative of the varying characteristics of commercial and industrial properties		R/A/G		
6e	Sample size is sufficient to capture night use by stratification with reasonable confidence		R/A/G		
6f	Reliable and representative average billed volume (ABV) model based on data logging of the representative sample sufficient to capture demand variations with further seasonal logging		R/A/G		

	where relevant. Continuously logged properties not part of the sample.				
6g	ABV model linked to billing system or replacement database of billed volumes. Average billed volumes updated at least annually		R/A/G		
6h	Continuous monitoring of selected non-households is carried out where average demand of an individual non-household has a material impact on the ability for a DMA or zone to provide valid and consistent data within operability limits		R/A/G		
7	**Hour to day conversion**	R/A/G			
7a	The hour-to-day factor is derived separately for each DMA or zone using pressure logging within each DMA or zone. The factors are updated at least annually or where there are any significant changes to pressure regimes		R/A/G		
7b	As an alternative, hydraulic models reflecting latest network configuration and pressure changes, are used if they dis-aggregate in sufficient detail at sub-zone level		R/A/G		
7c	Evidence based N1 value used. Expected range is 1.0 to 1.20		R/A/G		
8	**Annual distribution leakage**	R/A/G			
8a	Average weekly data is derived from valid daily values of leakage using data points which are representative of the week. Backfilling using the methods described in Section 5.4 – night flow analysis - is done when valid data is not available for three or more data points.		R/A/G		
8b	The annual value of leakage expressed as Ml/d is be derived from an average of the 52 week data.		R/A/G		
9	**Trunk main losses (only applicable if DMA level leakage assessment used)**	R/A/G			
9a	Company-specific data is used to assess the value of trunk main leakage		R/A/G		

9b	Proactive leakage monitoring approach applied where trunk main losses form a significant element of total leakage or the MLE water balance gap is greater than +/-2%. 9cMetering coverage of the trunk main network is 95% (by volume). This is combined with field inspections, analytical techniques, and flow monitoring activities. The selection of methodology and level of leakage monitoring activities reflects the proportion of estimated losses in relation to total leakage and the characteristics of the network		R/A/G		
9c	If trunk main losses greater than 5% of total leakage estimates reviewed annually		R/A/G		
10	**Service reservoir losses (only applicable if DMA level leakage assessment used)**	R/A/G			
10a	Company-specific data is used to assess the value of service reservoir losses;		R/A/G		
10b	Reservoirs with known high leakage, structural deficiencies or at risk of water quality failures are investigated on an individual basis		R/A/G		
10c	Drop tests (12 hour duration depending on size) carried out every five or ten years. in parallel with ongoing routine reservoir inspection programmes. All valves checked for tight close; and losses through overflows investigated. Appropriate monitoring arrangements in place to control and minimise overflow events.		R/A/G		
11	**Distribution input**	R/A/G			
11a	Distribution input to the system is metered with at least daily readings at all defined locations		R/A/G		
11b	Meters are appropriate size for the flow to be measured and located at appropriate inputs to the network confirmed by record plans Any treatment works take-off downstream of a meter		R/A/G		

	are excluded from the DI calculations				
11c	Data validity checks are carried out at least monthly		R/A/G		
11d	Missing data is infilled using both pre- and post- data for the location over at least one month, extrapolated from pump hours or use of upstream or downstream meters		R/A/G		
11e	The data transfer systems from meter output to central database are checked and validated on a risk-based frequency from one up to two years		R/A/G		
11f	Flow checks are carried out on DI meters consistent with the principles of the document 'EA Abstraction Good Metering Guide' and in particular the frequency of flow checking defined in Table 6.2 of the EA guide		R/A/G		
12	**Measured consumption**	R/A/G			
12a	Metered data is derived from own billing system or from CMOS for non-households		R/A/G		
12b	Estimate of supply pipe losses is included for internally metered properties consistent with own current assumption of supply pipe losses		R/A/G		
12c	Inclusion of any leakage allowance is included where a rebate has been applied to a customer's bill		R/A/G		
12d	Meter under-registration is applied consistent with own estimates. Evidence of MUR available especially for MUR above 3%.		R/A/G		
12e	Meter replacement consistent with own replacement programme		R/A/G		
13	**Unmeasured consumption**	R/A/G			
13a	~~PCC surveys~~Monitors follow principles set out in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors 1999' and the more recent report 'Future Estimation of Unmeasured Household Consumption', UKWIR 2017		R/A/G		
13b	Consumption ~~PCC~~ is derived from own individual		R/A/G		

	household monitor or small area surveys				
13c	Evidence that survey is representative (based on demography, property type or other factors) of the company as a whole; Valid data available from at least 80% of monitors as an annual average measure.		R/A/G		
13d	For companies using SAMs - SAM comprises a representative sample of customer' characteristics. The sample size is sufficient to provide a statistically representative sample after allowing for outages. Where the proportion of metered properties in an area exceeds 50% of total properties then further data validity tests are applied For companies using IHMs – IHM comprises representative sample of customer characteristics. The sample is at least 1000 properties.		R/A/G		
13e	Uncertainty allocated to unmeasured household consumption is estimated and justified		R/A/G		
13f	There is continual monitoring and maintenance of IHMs and SAM monitors		R/A/G		
13g	Meters are selected to provide sufficient granularity to detect low continuous flows indicative of plumbing losses or leakage short duration flow variations. The value of meter under registration is less than the company's average meter stock		R/A/G		
13h	Estimate of plumbing losses is based on own data		R/A/G		
13i	Where unmeasured non-household reported volume~~s~~ is less than 2% of total non-household demand, data from a per property consumption study is refreshed every five years		R/A/G		
13j	Where unmeasured non-household reported volumes are greater than 2% of non-household demand, data from a property study is refreshed every two years		R/A/G		

14	**Company own water use**	R/A/G			
14a	All sewage treatment sites and other ~~key assets~~sites and assets supplied downstream of the DI meters using greater than 10 m3/d (0.01 Ml/d) are metered		R/A/G		
14b	An estimate of total company own use is included in the water balance, based on a clear methodology and actual data		R/A/G		
14c	Estimate of distribution operational use is evidence based and not greater than 0.6% of distribution input.		R/A/G		
15	**Other water use**	R/A/G			
15a	Other use components are based on own data		R/A/G		
15b	Estimate of water delivered unbilled (legally and illegally) is evidence based and not greater than 1.8% of distribution input.		R/A/G		
15c	Estimates are updated when there is a material increase or decrease to volumes.		R/A/G		
16	**Water balance and MLE**	R/A/G			
16a	Fully measured components have a range from 2% to 4%		R/A/G		
16b	Mainly measured with some estimated adjustments have a range from 2.5% to 5%		R/A/G		
16c	Estimated using detailed and reliable methods have a range from 8% to 12%		R/A/G		
16d	Broad estimates not fully detailed or reliable have a range from 20% to 50%.		R/A/G		
16e	Water balance discrepancy <2% = G >2% and <3% = A >3% = R		R/A/G		

~~Compliance is reported against:~~

~~R~~	~~Shortcomings against guidance having a material impact on leakage reporting~~
~~A~~	~~Some minor non-compliance no material impact on leakage reporting~~

G	Fully compliant

For each component on the checklist, and for the overall performance measure, companies will report a confidence grade.

Confidence grades provide a reasoned basis for companies to qualify the reliability and accuracy of the data. Companies should employ a quality-assured approach in the methodology used to assign confidence grades, particularly if sampling techniques are in place.

The confidence grade combines elements of reliability and accuracy, for example:

- A2 Data based on sound records etc. (A, highly reliable) and estimated to be within +/- 5% (accuracy band 2)

Reliability and accuracy bands are shown in the tables below.

Reliability Band	Description
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from limited sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Accuracy band	Accuracy to or within +/-	But outside +/-
1	1%	-
2	5%	1%
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Accuracy outside +/- 100 %, small numbers or otherwise incompatible (see table below)	

Certain reliability and accuracy band combinations are considered to be incompatible and these are blocked out in the table below.

Compatible confidence grades				
Accuracy band	**Reliability band**			
	A	B	C	D
1	A1			
2	A2	B2	C2	
3	A3	B3	C3	D3
4	A4	B4	C4	D4
5			C5	D5
6				D6
X	AX	BX	CX	DX

5.4 Reporting guidance – Per Capita Consumption

[PCC1] Objective

This guidance has been developed to enable all companies to report annual average per capita consumption for the defined year following a reasonable level of accuracy, applying consistent and reliable methods and common assumptions. This is to facilitate consistency of reporting by companies and comparisons of performance by customer representatives, regulators and other companies with reasonable confidence.

Key Principles

There are several key principles applied in the compilation of the guidance:

- Reporting of annual average per capita consumption forms part of each company's assurance process applied to all measures reported annually by companies;
- A company needs to have a written methodology or procedure in place for reporting average per capita consumption. This procedure is reviewed annually and updated as required. This will be consistent with the methodology for leakage reporting and may be included in that methodology;
- The reporting guidance for annual average per capita consumption reporting is set out as a consistent baseline for the industry which companies should achieve now or in the short and medium term;
- Where a company is not able to meet any part of the guidance then it is required to explain any shortfalls and its plans to address this;
- There are a number of areas which would benefit from future independent research to determine good practice. Proposals for further research in the future should be considered by the water industry. In the meantime, this guidance sets guiding principles and these may be refined and improved as further research is concluded.

Applying this methodology in conjunction with the leakage consistency methodology is likely to change reported PCC and comparisons of historic data may no longer be valid. There may also be a difference with the PCC figures in companies' Water Resources Management Plans (WRMPs).

Measure Definition

[PCC2] Annual average per capita consumption is defined as the sum of measured household consumption and unmeasured household consumption divided by the

total household population. This is to be reported at the whole company level for this PC.

$$\frac{Measured\ household\ consumption + Unmeasured\ household\ consumption}{Total\ household\ population}$$

It is reported as the annual arithmetic mean per capita consumption expressed in litres per person per day (l/p/d).

The measure uses post MLE[33] (maximum likelihood estimation) data for measured household consumption and unmeasured household consumption.

Companies are required to report PCC to the Environment Agency in the Annual Review of Water Resources Management Plans and this is reported at water resource zone (WRZ) level. Companies should refer to Environment Agency reporting guidance for the Annual Review to ensure compliance with that when preparing their Annual Reviews.

In order to account for weather variations and how this impacts on PCC the PC will be based on a three-year average. PCC will be reported annually and a company's performance will be measured as a three-year average of the annual figures.

A company is required to report against this definition and:

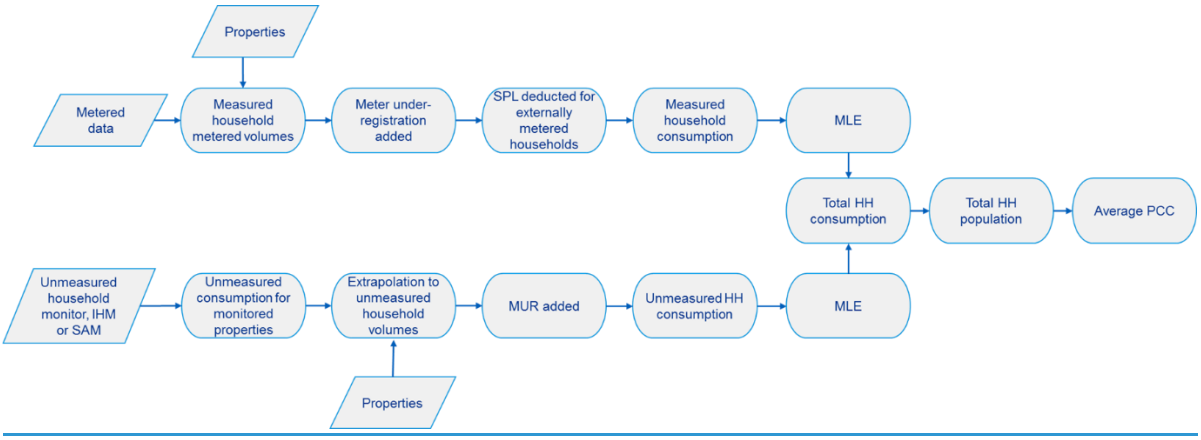
- Disclose where its methodology does not comply with this guidance using the checklist in Annex A;
- Explain the reasons for any non-compliance;
- Set out its plans and programme to comply with the guidance; and
- Disclose any other factors which have an impact on the methodology for reporting per capita consumption.
- Set out any differences with the PCC figures reported in the WRMP.

[33] MLE is a technique used in the estimation of leakage and is described in the guidance for reporting the leakage performance commitment for PR19.

Reporting Process

The guidance is structured in the way that PCC is estimated and components of PCC are described in the following sections.

The process for deriving average PCC is shown in the following diagram.



Components of Per Capita Consumption Estimation

Properties

Measured household properties are needed to derive measured household metered volumes from a company billing system.

Unmeasured household properties are used in the unmeasured household consumption monitor calculations and for extrapolation to company area.

A company is expected to:

- [PCC4] / [LKG4] Ensure the classification of properties as either household or non-household is consistent with the retail market definition of eligibility.
- Update property data at least annually.
- [PCC4] / [LKG15a] Exclude properties that are defined as void unless a company can evidence any use or losses from illegal occupation;
- [PCC4] / [LKG15b] Justify the number of void properties each year and how this is derived.

Population

Total household population is the denominator in the equation.

A company is expected to:

- [PCC3] Produce a total household population estimate every year based on the Water Resources Management Plan definition of household population as set out in the guidelines[34] and the UKWIR methodology for estimation of population.[35]
- Provide evidence to justify any adjustments made to population estimates for unaccounted for population (clandestine population such as migrant workers, tourists, holiday home owners)
- Demonstrate that the estimate is for household population only (non-household population is either estimated separately or deducted if the estimate obtained is total population for the area of supply). A company should set out its approach to excluding non-household population and demonstrate that this is consistent with the WRMP guidelines.

Occupancy

[PCC5] At this point in time it is not proposed that this average PCC measure should be derived from separate measured and unmeasured PCC estimates. It is therefore not necessary to disaggregate the total household population between measured and unmeasured households and there is no requirement for occupancy data for this measure.

Measured household consumption

The volume of measured household consumption should include water used by each measured household including meter under-registration but excluding supply pipe leakage.

Measured data shall be derived from the meter readings within the company's billing system including estimated reads and an adjustment for meter under-

[34] Final Water Resources Management Plan Guidelines, EA/ Natural Resources Wales, May 2016
[35] UKWIR 15/WR/02/8, WRMP19 Methods – Population, Household Property and Occupancy Forecasting

registration should be applied. For externally metered households an allowance for supply pipe leakage should be deducted from the metered volumes.

Companies must undertake a process of accruing consumption at year end to account for meter reading frequency cycles. A company should justify its approach to accruals and estimated reads.

New guidance on the estimation of unmeasured household consumption[36] proposes a measured household monitor to enable the nature of consumption patterns to be better understood. If a company uses a measured household consumption monitor it must set out its approach and justify its use in this methodology.

A company is expected to derive measured household consumption using the following criteria.

- Metered data taken from a company's own billing system, including actual reads and estimated reads;
- A deduction for supply pipe losses for externally metered properties consistent with the company's own current assessment of supply pipe losses;
- Adjustments to metered data for leakage allowances applied to individual customers can be included where a rebate has been applied to a customer's bill;
- Meter under-registration shall be applied consistent with a company's own estimates.

Unmeasured Household Consumption

The volume of unmeasured household consumption should include water used by each unmeasured household excluding supply pipe leakage. Dependent on the level of meter penetration a company has this can be a significant component of the water balance and therefore needs continual focus to maintain and improve the estimate. For the purposes of this PC unmeasured household consumption should be derived from PHC.

In general, companies are expected to use company specific data for unmeasured household consumption except for companies with high meter penetration where it may be impractical to establish and maintain a sufficiently robust sample of unmeasured properties. In this case sharing of unmeasured data with neighbouring companies or companies with similar demographics may be appropriate.

[36] Future Estimation of Unmeasured Household Consumption, 17/WR/01/16, UKWIR 2017

Companies with high meter penetration must set out their approach to estimating unmeasured household consumption.

In most cases (except perhaps where a company's meter penetration is high) it is expected that unmeasured household consumption shall be estimated from a company's own consumption monitor following good practice as defined in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors 1999'. Good practice has improved since this report with innovation and new technologies now available although the basic principles of the monitors is unchanged. Companies can use individual household monitors (IHMs) or Small Area Monitors (SAMs).

Further work is required to determine current good practice for sample size and stratification for IHMs and SAMs. Until this is concluded companies should continue to base their approach on a sample of at least 1000 for IHMs. Representation may be by demographic group, property type or other recognised statistical group. Companies must set out the evidence to demonstrate their sample is representative of their area.

Individual monitors should have a high resolution meter and associated logger to transmit data to a control centre. Data is expected to be collected at least at hourly intervals and regularly downloaded. The IHM needs continual monitoring to limit the level of any supply pipe losses or other continuous flows. Any other continuous flows are attributable to customer use or plumbing losses and should be included in estimates for consumption at household level.

While an allowance is made for meter under-registration it is expected that meters used for these consumption monitors will have an enhanced specification compared with normal domestic meters and as they are continually monitored meter failures and drift will be identified earlier than for normal domestic meters. Meters are expected to be selected and maintained to minimise meter under-registration. A phased meter replacement programme should be in place.

Until further guidance is developed companies should continue to base SAMs on a representative sample of areas of DMAs or smaller whole DMAs which are specifically designed with one meter and permanent data loggers. They should include minimal numbers of non-household properties and have minimal measured households (no more than 50% where practical).

Consumption for non-household properties within SAMs should be deducted from the area total consumption based on metered data or where unmeasured non-households are included using the unmeasured non-household consumption

allowance. Companies should set out how they have deducted non-household consumption;

Consumption for measured households within SAMs should be deducted from the area total consumption based on metered data. Companies should set out how they have deducted household consumption;

The total sample size for SAMs is dependent on the acceptable uncertainty applied to consumption estimates and assumptions on SAM outage. There is currently no specification for number of properties included in SAMs for consumption estimates. This should be included in future guidance following further work. In the meantime, a company should set out its evidence to demonstrate the representativeness of its sample.

The IHM monitoring requirements for continual monitoring and meter under-registration shall be equally applied to SAMs.

A company is expected to derive unmeasured household consumption using the following criteria:

- Unmeasured household consumption (Ml/d) for the whole company shall be calculated from average unmeasured per household consumption (PHC expressed in l/household/day) multiplied by the number of unmeasured households.
- Average unmeasured household consumption shall be derived from a company's own IHM or SAM except where meter penetration is high and this makes this impractical.
- The PHC for the IHM or SAM sample shall be extrapolated to an average for the whole company based on stratification.
- The IHM or SAM shall follow the principles set out in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors' 1999 and the more recent report 'Future Estimation of Unmeasured Household Consumption', UKWIR 2017;
- IHMs and SAM monitors shall be continually monitored and maintained;
- A company shall demonstrate that its IHM or SAM is representative of the company as a whole; disaggregation of the sample by demographic factors, property type or similar factors represents good practice. Valid data from the survey shall be from at least 80% of monitors as an annual average measure. A company may develop and use an alternative monitor as defined in the 2017 UKWIR Report but it must set out the approach taken and demonstrate why this is appropriate;
- In general, it is expected that where the proportion of metered properties in a SAM exceeds 50% of total properties then the area should not be included in the estimation of unmeasured consumption. Companies with high meter penetration may not be able to comply with this and this should be considered

when deciding their approach to estimating unmeasured household consumption;

- Quantify the uncertainty allocated to unmeasured household consumption and provide evidence to justify the uncertainty value used;
- Meters shall be selected to provide sufficient granularity to detect low continuous flows indicative of plumbing losses or leakage short duration flow variations. The value of meter under registration should be less than the company's average meter stock;
- Estimates of supply pipe leakage shall be based on a company's own data which is updated annually; and
- Estimates of meter under-registration shall be based on a company's own data which is updated annually.

New guidance on the estimation of unmeasured household consumption[37] has been published. This provides further guidance on monitoring processes in particular the impact of adopting models to increasing meter penetration. The report sets out several potential options for estimating unmeasured households and a framework for selection of an alternative method. For companies with high meter penetration their approach to estimating unmeasured household consumption must be consistent with this guidance and they should set out their approach.

Data Infilling

Data will not always be available from IHMs or SAMs for a range of reasons. In these cases, data can be infilled using the following guiding principles; where a SAM or IHM property is inoperable data can be infilled using historic data from the same SAM or IHM property or average data from a SAM or IHM property with similar characteristics (from the same stratification).

Supply pipe leakage and plumbing losses

Supply pipe leakage should be excluded from consumption data. For measured households which are externally metered supply pipe leakage allowances should be deducted from the metered data. For unmeasured households externally metered as part of IHM surveys supply pipe leakage should also be excluded from the data. For SAMs estimates of supply pipe leakage must also be removed from the data.

A company should use its own estimates of supply pipe leakage and must set out its approach to deriving these estimates and how it excludes supply pipe leakage from metered household consumption and IHM or SAM data used in the PCC

[37] Future Estimation of Unmeasured Household Consumption, 17/WR/01/16, UKWIR 2017

calculation. This is also linked to estimates of plumbing losses. A robust methodology to determining this is required. A recently started UKWIR study is looking at plumbing losses and may help with this.

A company is expected to:

- Take account of supply pipe leakage in the estimation of both measured household consumption and unmeasured household consumption;
- Use its own estimates of supply pipe leakage which are annually updated;
- Demonstrate how these estimates have been derived.

Meter under-registration (MUR)

Within the calculation of per capita consumption metered data is taken from:

- Customer meters;
- SAMs for unmeasured household consumption monitor meters; and
- Meters on IHM properties

Therefore, there is potential for MUR to impact on the estimates.

For meters where there is a bias for under registration then this should be accounted for in calculations.

A company should include estimates of meter under-registration for all meters where there is a bias for under registration. A company is expected to use its own data on under-registration and should justify the MUR figure used and how it has been derived. MUR should be reviewed annually.

Where a metering programme has recently been completed or ongoing, a company is expected to revise its assumptions. It is recognised that information on under-registration is limited and there is a need for further work to derive statistically representative values. It is expected that meter under-registration greater than 3% would need to be robustly evidenced.

While an allowance is made for meter under-registration for monitor meters (SAMs and IHMs) it is expected that these meters will have an enhanced specification compared with normal domestic meters and as they are continually monitored meter failures and drift will be identified earlier than for normal domestic meters.

Therefore, it is expected that MUR for monitor meters will be less than for all meters.

A company should set out its approach to estimating MUR for revenue meters and demonstrate annual updates.

A company should set out its approach to estimating MUR for monitor meters and demonstrate annual updates.

A company should set out its approach to stopped meters and demonstrate that there is no double counting between stopped meters in consumption from billing data and MUR.

Glossary

DMA	District Meter Area
IHM	Individual household monitor
Ml/d	Mega-litres per day
l/p/d	Litres per person per day
PCC	Per capita consumption (per person consumption)
l/h/d	Litres per household per day
PHC	Per household consumption
SAMs	Small area monitors
UKWIR	United Kingdom water industry research
MUR	Meter under-registration

[PCC6a] The PCC PC should be broken down into its constituent elements for assessment of compliance for reporting purposes. The compliance checklist in Annex A identifies the elements in average per capita consumption to be considered. This should be consistent with some of the elements in the water delivered components of the water balance for leakage shadow reporting.

Annex A: Compliance Checklist

A company is required to complete this checklist for submission with its value of annual average per capita consumption.

The elements of each component to be assessed separately based on the following rules:

Compliance for elements is reported against:

R	Not compliant with the guidance and having a material impact on average per capita consumption reporting
A	Not compliant with the guidance and having no material impact on average per capita consumption reporting. For example, a material impact might be assessed as more than 1% of the reported value. A company

	should set out its approach to assessing whether an impact is material or not.
G	Fully-compliant with the guidance

An overall RAG to be assigned for each component based on the following rules:

Compliance for overall components is reported against:

R	There are one or more red elements in the component or the combined effect of amber elements is considered to produce a material impact.
A	Half or more of the elements in the component are amber and the combined effect of the amber elements is considered not to produce a material impact.
G	More than half of the elements in the component are green

	Component / Element	Component R/A/G	Element RAG	Reason for any non-compliant components	Confidence grade
1	**Household population estimates**	R/A/G			
1a	Household population derived using WRMP methodology		R/A/G		
1b	Evidence for adjustments for clandestine population if any		R/A/G		
1c	Household population updated annually		R/A/G		
1d	Exclusion of non-household population in accordance with WRMP methods		R/A/G		
2	**Household property estimates**	R/A/G			
2a	Definition of household / non-household consistent with eligibility under market separation		R/A/G		
2b	Evidence of void properties updated annually		R/A/G		
2c	Property figures annually updated		R/A/G		
3	**Measured household consumption (Based on leakage PC RAG elements)**	R/A/G			
3a	Metered data is derived from own billing system		R/A/G		
3b	If leakage allowances are applied the process and evidence for this is clearly set out.		R/A/G		
3c	Average SPL deductions for externally metered households using company own data updated annually		R/A/G		
3d	Company own estimate of MUR for revenue meters which is updated annually.		R/A/G		
3e	Meter replacement consistent with own replacement programme				
4	**Unmeasured household consumption (Based on leakage PC RAG elements)**	R/A/G			

4a	Monitors follow principles set out in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors 1999' and the more recent report 'Future Estimation of Unmeasured Household Consumption', UKWIR 2017		R/A/G		
4b	Consumption is derived from own IHM or SAM or evidence to support other method appropriate for high meter penetration companies		R/A/G		
4c	Evidence that survey is representative (based on demography, property type or other factors) of the company as a whole; Valid data available from at least 80% of monitors as an annual average measure.		R/A/G		
4d	For companies using SAMs - SAM comprises a representative sample of customer' characteristics. The sample size is sufficient to provide a statistically representative sample after allowing for outages. Where the proportion of metered properties in an area exceeds 50% of total properties then further data validity tests are applied For companies using IHMs – IHM comprises representative sample of customer characteristics. The sample is at least 1000 properties.		R/A/G		
4e	Uncertainty allocated to unmeasured household consumption is estimated and justified				
4f	There is continual monitoring and maintenance of IHMs and SAM monitors				
4g	Meters are selected to provide sufficient granularity to detect low continuous flows indicative of plumbing losses or leakage short duration flow variations. The value of meter under registration is less than the company's average meter stock				
4h	Estimate of plumbing losses is based on own data				
4i	Where unmeasured non-household reported volume is less than 2% of total non-household demand, data from a per property consumption study is refreshed every five years				
4j	Where unmeasured non-household reported volumes are greater than 2% of non-household demand, data from a property study is refreshed every two years				
4k	Company own estimate of MUR for monitor meters which is updated annually				
4l	Meter replacement consistent with own replacement programme				

PCC6b: For each component on the checklist, and for the overall performance measure, companies will report a confidence grade.

Confidence grades provide a reasoned basis for companies to qualify the reliability and accuracy of the data. Companies should employ a quality-assured approach in the methodology used to assign confidence grades, particularly if sampling techniques are in place.

The confidence grade combines elements of reliability and accuracy, for example:

A2 Data based on sound records etc. (A, highly reliable) and estimated to be within +/- 5% (accuracy band 2)

Reliability and accuracy bands are shown in the tables below.

Reliability Band	Description
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from limited sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Accuracy band	Accuracy to or within +/-	But outside +/-
1	1%	-
2	5%	1%
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Accuracy outside +/- 100 %, small numbers or otherwise incompatible (see table below)	

Certain reliability and accuracy band combinations are considered to be incompatible and these are blocked out in the table below.

Compatible confidence grades				
Accuracy band	**Reliability band**			
	A	B	C	D
1	A1			
2	A2	B2	C2	
3	A3	B3	C3	D3
4	A4	B4	C4	D4
5			C5	D5
6				D6
X	AX	BX	CX	DX

~~5.4~~5.5 Reporting guidance – Outages

Objective

The guidance seeks to enable all companies to report on outages for the defined year with confidence and at a reasonable level of accuracy and with a common approach. Companies shall apply consistent and robust methods and common assumptions. This will facilitate the comparison of performance across companies by customers, regulators and other companies with reasonable confidence.

Key Principles

There are several key principles applied in the compilation of the guidance:

- Reporting of annual outage forms part of each company's assurance process applied to all measures reported annually by companies;
- A company needs to have a written methodology or procedure in place for reporting outage. This procedure is reviewed annually and updated as required;
- The reporting guidance for annual outage reporting is set out as a consistent good practice baseline for the industry which companies should achieve now or in the short and medium term; and
- Where a company is not able to meet any part of the good practice methods then it is required to explain any shortfalls and its plans to address this.~~;~~

Measure Definition

This measure is to be used as a means of assessing asset health (primarily non-infrastructure – above ground assets), for water abstraction and water treatment activities. It is defined as the annualised unavailable flow (based on dry year peak week~~maximum~~ production capacity) for each company. This measure is proportionate to both the frequency of asset failure as well as the criticality / scale of the assets that are causing an outage.

It is important to understand planned and unplanned outage as they both reflect on asset health. The actual outage should be reported as the temporary loss of production capacity in the reporting year weighted by the duration of the loss (in days). Outages arising from planned works should be recorded separately to outages arising from asset failure.

The proposed calculation for both figures is:

$$\frac{Reduction\ in\ \text{dry year}\ peak\ week\ production\ capacity\ \times Duration\ in\ days}{365}$$

Outage for each water production site is calculated separately and then summed over the reporting year to give a total actual outage for the water resource zone.

The company water resource zone weighted outage can then be summed (Ml/d) and then normalised based on overall company dry year peak week production capacity to be reported as a percentage.

A calculation example is as follow:

For a single source works:

A source works has a dry year peak week production capacity of 30 Ml/d
For 15 days the maximum output is reduced to 15Ml/d due to a temporary outage (pump failure). This is a loss of peak week production capacity of 15 Ml/d for 15 days.
The weighted outage for this source works = 15 x (15 / 365) = 0.62 Ml/d
Each weighted outage is then summed over the reporting year to give a total actual outage for the water resource zone.

For a water resource zone:

First source works in zone – weighted outage = 0.62 Ml/d
Second source works in zone – weighted outage = 2.58 Ml/d
Third source works in zone – weighted outage = 3.67 Ml/d
Zonal weighted outage = 6.87 Ml/d
The company water resource zone weighted outage can then be summed and then be normalised based on overall company peak week production capacity.

Company normalising:

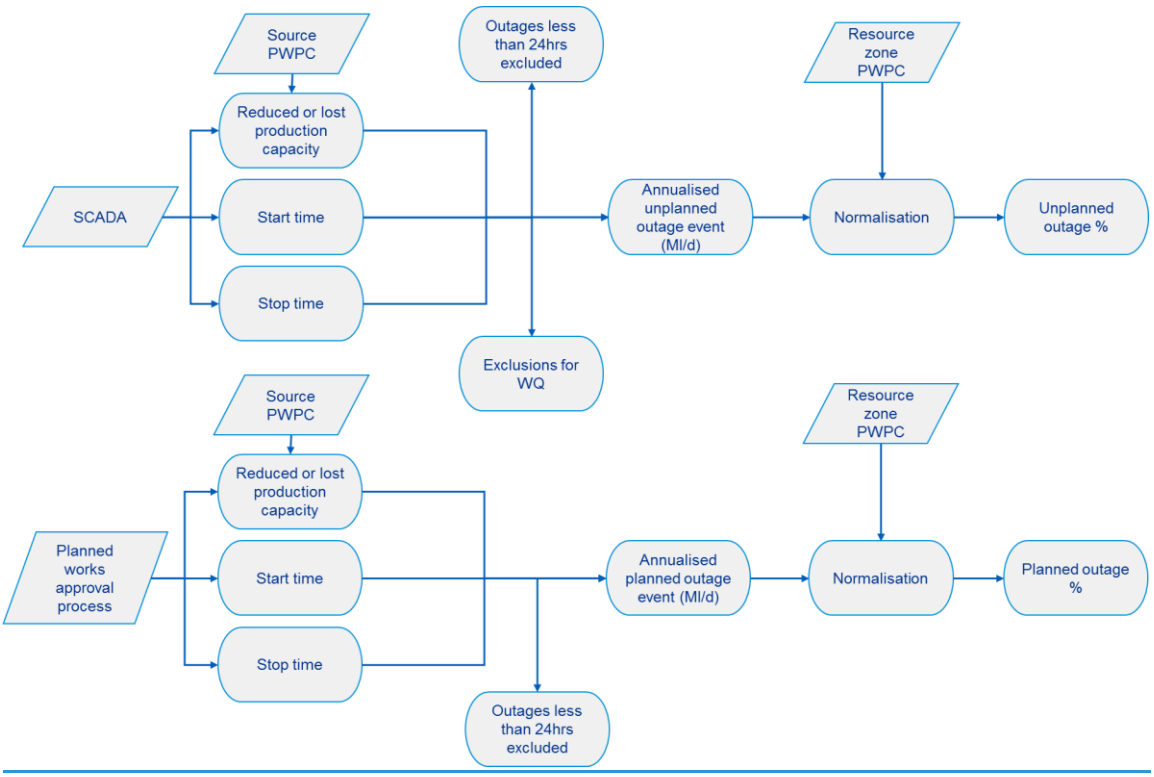
Zone 1 weighted outage = 6.87 Ml/d
Zone 2 weighted outage = 7.95 Ml/d
Company weighted outage = 14.82 Ml/d
Company peak week production capacity = 120 Ml/d
Outage proportion = 12.4%

Exclusions for water quality and other matters are permitted and described in Section 5.6. Exclusions should be reported alongside the planned and unplanned outage figures.

Reporting Process

The guidance is structured in the way that outage is normally estimated and components of outage are described in Section 5.

The process for deriving planned and unplanned outage is shown in the following diagram.



A company is required to report against this definition and:

- Disclose where its methodology does not comply with this guidance using the checklist in Annex A;
- Explain the reasons for any non-compliance;
- Set out its plans and programme to comply with the guidance; and
- Disclose any other factors which have an impact on the methodology for reporting outage.

Components of Outage Estimation

[OUT1] Peak Week Production Capacity

For each water production site included in its Water Resources Management Plan (WRMP) a company should define its dry year peak week production capacity. This is equivalent to the maximum volume of water which can be put into supply and sustained over a period of one week measured in Ml/d. This should be supported by physical tests to demonstrate capability undertaken at least once every five years. It is expected that this value should be reviewed annually and as modifications to assets and processes are completed which impact capacity.

It is expected that PWPC would be a fixed value for each production site each year unless a change to assets or process can be evidenced.

Peak week production capacity does not account for seasonal changes in yield (most commonly observed at groundwater sources) and allowed abstraction volumes (most commonly observed at river sources) which are weather dependent and not an indicator of asset health.

A company is expected to:

- Define PWPC for each water production site.
- Review PWPC annually.
- Support PWPC with evidence of capacity tests undertaken on a rolling programme each five years.
- Support revisions to PWPC with evidence of changes to assets or processes.

[OUT2] Asset Failure / Unplanned Outage

The failure of any asset which impacts on the ability to produce the peak week production capacity should be recorded as an unplanned outage. This may be a failure which impacts part or all of the production plant which contributes to peak week production capacity.

This can include:

- source abstraction assets (e.g. abstraction pumps, screens, boreholes);
- raw water transport assets (e.g. pumping plant and mains);
- raw water storage assets (e.g. balancing reservoirs);
- water treatment assets;
- treated water storage assets (e.g. contact tanks, pre-distribution storage); and
- treated water distribution assets before distribution input meter (e.g. treated water pumping).

In some circumstances the failure of assets upstream of the treated water distribution assets may not impact on the peak week production capacity. For example, where river abstraction is pumped to bankside storage and then stored water is pumped onto treatment works, the failure of an abstraction pump may not impact peak week production capacity as water onto the treatment works can be maintained from raw water storage.

Where asset failures occur at water production sites with standby assets this may also not impact peak week production capacity. For example, a groundwater site with a peak week production capacity of 10Ml/d may have three boreholes on site, all with capacity of 5Ml/d. Under normal circumstances boreholes 1 and 2 may be operated to provide the site output of 10Ml/d. If the pump in borehole 1 fails then borehole 3 is switched on to replace the lost capacity. Providing borehole 3 is switched on within 24 hours to replace the failed asset in borehole 1 there would be no unplanned outage recorded. There may need to be an outage at a later stage to repair or replace the failed pump. Whilst this can be scheduled and planned for a convenient time the reason for the need to make the repair is an unforeseen failure of an asset and therefore the outage for the scheduled repair or replacement should also be classified as unplanned.

[OUT2] Planned Outages

Where assets are taken out of supply or made unavailable for supply to enable planned maintenance or capital works to be completed then these should be recorded as planned outages. The same principles for work on standby assets apply here as for unplanned outages.

It is expected that a company will have a process whereby planned works on production assets are approved and scheduled. This may be the basis of evidence to demonstrate that the outage is planned.

Where planned work results from an asset failure any resulting outage should also be recorded as unplanned.

[OUT3] Duration

Only outage events which exceed 24 hours in duration should be included in this measure. Outage duration should be recorded to the nearest whole day with normal rounding rules applied. For the avoidance of doubt, all outages below 24 hours are excluded and rounding does not apply. The duration may span a calendar day.

By way of an example of rounding, an outage of 79 hours would be 3 days whereas an outage of 115 hours would be 5 days.

A company should identify the start of an outage period using SCADA data wherever possible. This is likely to relate to an alarm, the unexpected loss of water into supply or a planned switch off. If a company uses another source of data to

indicate the start of an outage period it should specify the data source and demonstrate auditable record keeping.

The end of the outage period should be recorded as the time when the asset was returned to a state when availability of peak week production capacity is restored. For the avoidance of doubt this should not be when the individual asset is repaired or planned work completed but when the recommissioning process is completed. For example, if a borehole pump is replaced due to an unexpected failure or planned works the end of the outage is not when the pump replacement is completed but when any subsequent pumping to waste and water quality testing is finished and full peak week capacity is restored.

Where planned work exceeds the duration of the scheduled outage any extension is to be included within the planned outage figure.

Where a company chooses not to respond immediately to an unplanned outage such as a failure at the weekend for which alternative water can be deployed the duration may be longer than it might otherwise have been. A company should make no adjustment for this in the measurement of the duration of the outage. It is recognised that this will result in reporting higher outage figures but it is not considered at this stage in the development of this measure that a consistent approach to taking account of this within duration estimates could be defined. This is something that could be reviewed as the definition of this measure is further developed.

Repeated unplanned outages at the same water production site should be treated as separate events with independent start and finish times unless the initial outage was not concluded and there was not full restoration of peak week production capacity.

A company is expected to:

- Record unplanned outages over 24 hours in duration.
- Record unplanned outages as unplanned even if they result in a programmed outage later.
- Measure duration to the nearest whole day.
- Record the start and end time of an outage using scada data.
- Record the end of an outage as when recommissioning is completed and peak week production capacity is fully restored.
- Make no adjustment for over-running planned outages.
- Make no adjustment for unplanned outages which are not responded to immediately.
- Justify use of data sources other than telemetry.

Reduction in Capacity

For each outage the impact of the outage is recorded as the reduction in peak week production capacity. For asset failures or programmed work resulting in the total loss of water production from the site then the impact of the outage is recorded as the total peak week production capacity for the site. Some asset failures or programmed work may result in a reduction of peak week production capacity. For example, a groundwater source with a peak week production capacity of 10Ml/d may have three boreholes on site, all with capacity of 5Ml/d. Under normal circumstances boreholes 1 and 2 may be operated to provide the site output of 10Ml/d. If the pumps in boreholes 1 and 2 fail then borehole 3 is switched on but can only replace half the lost capacity. The lost peak week production capacity in this instance would be 5Ml/d. The replacement of the failed pumps may require the whole output to cease for the period of the works. From the point at which the output is zero the lost capacity would increase to 10Ml/d and would have a separate duration to the initial partial reduction in capacity.

[OUT4] Exclusions

Unplanned outage arising from changes in raw water quality beyond the normal water quality operating band shall be excluded as this is not a measure of asset health. Exclusions must be evidence based including evidence to show what the normal water quality operating band for that production site is. This exclusion applies to transient changes to raw water quality such as turbidity, algae, pollution, spikes in nitrate and pesticide. If a company chooses to manage variable raw water quality by proactively temporarily restricting water production then this should also be classed as an exclusion.

Long-term trend based changes in raw water quality which result in unplanned outages are not permitted as exclusions as a company should have the data to recognise a rising trend and foresee the need to plan for treatment etc.

Extreme weather can result in raw water quality events as described above. In addition to this they may present constraints on ability to resolve the outage e.g. a storm event may increase turbidity and cause a site failure and flooding of the immediate area. It may be difficult for operational staff to attend site to rectify the problem. In an example such as this the health and safety constraint on access should be allowed as a further exclusion. Extreme weather may also include heavy snowfall when access to remote sites can be difficult.

A company is expected to:

- Demonstrate based on evidence normal water quality operating bands for each water production site.
- Record raw water quality events outside of these bands and provide evidence of the exceedance.

- Provide evidence of extreme weather events such as storms and snowfalls which have presented hazards preventing access to sites.

Glossary

PWPC	Peak week production capacity
WRMP	Water Resources Management Plan
Ml/d	Mega litres per day

[OUT6] Annex A: Compliance Checklist

A company is required to complete this checklist for submission with its value of annual outage PC.

The elements of each component to be assessed separately based on the following rules:

Compliance for elements is reported against:

R	Not compliant with the guidance and having a material impact on reporting
A	Not compliant with the guidance and having no material impact on reporting.
G	Fully-compliant with the guidance

An overall RAG to be assigned for each component based on the following rules:

Compliance for overall components is reported against:

R	There are one or more red elements in the component or the combined effect of amber elements is considered to produce a material impact.
A	Half or more of the elements in the component are amber and the combined effect of the amber elements is considered not to produce a material impact.
G	More than half of the elements in the component are green

	Component	Compliant (R/A/G)	Reason for any non-compliant components	Confidence grade
1	**PWPC**			
a	Annual review			
c	PWPC by production site			
d	Water resource zone PWPC			

2	**Asset failure / unplanned outage**			
a	Source data			
3	**Planned outages**			
a	Source data - programme of works			
4	**Duration**			
a	Start time			
b	End time			
c	Rounding			
	Reduction in capacity			
a	Reduced capacity			
b	Total outage			
5	**Exclusions**			
a	Normal water quality operating band			
b	Evidence of WQ events			

For each component on the checklist, and for the overall performance measure, companies will report a confidence grade.

Confidence grades provide a reasoned basis for companies to qualify the reliability and accuracy of the data. Companies should employ a quality-assured approach in the methodology used to assign confidence grades, particularly if sampling techniques are in place.

The confidence grade combines elements of reliability and accuracy, for example:

- A2 Data based on sound records etc. (A, highly reliable) and estimated to be within +/- 5% (accuracy band 2)

Reliability and accuracy bands are shown in the tables below.

Reliability Band	**Description**
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from limited sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Accuracy band	Accuracy to or within +/-	But outside +/-
1	1%	-
2	5%	1%
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Accuracy outside +/- 100 %, small numbers or otherwise incompatible (see table below)	

~~5.5~~5.6 Reporting guidance – Mains repairs per 1,000 km

Objective

The guidance has been developed to enable all companies to report mains bursts per 1,000km of mains for the defined year following good practice and a reasonable level of accuracy and with a common approach. Companies shall apply consistent and robust methods and common assumptions. This will facilitate the comparison of performance across companies by customers, regulator and other companies with reasonable confidence.

Key principles

There are several key assumptions made in the compilation of the guidance:

- Reporting of mains bursts per 1,000km shall be subject to each company's assurance process which is applied to all measures reported annually;
- Companies have a methodology or procedure in place for reporting on mains bursts per 1,000km. The procedure is reviewed as part of their assurance process.

There is an assumption that there will be continued improvement by all companies in the short and medium term through innovation, new technology, data quality improvements and staff training:

- The measure assumes a clear and simple approach that can be understood by customers and regulators;
- The essential reporting requirements for reporting on mains bursts per 1,000km are set out;
- The focus on the guidance is on annual reporting of mains bursts per 1,000km. It is not intended as a definitive guide to managing the risk of mains bursts;
- Exclusions are to be kept to a minimum and shall be consistent with the reasonable expectations of an affected customer.

Exclusions

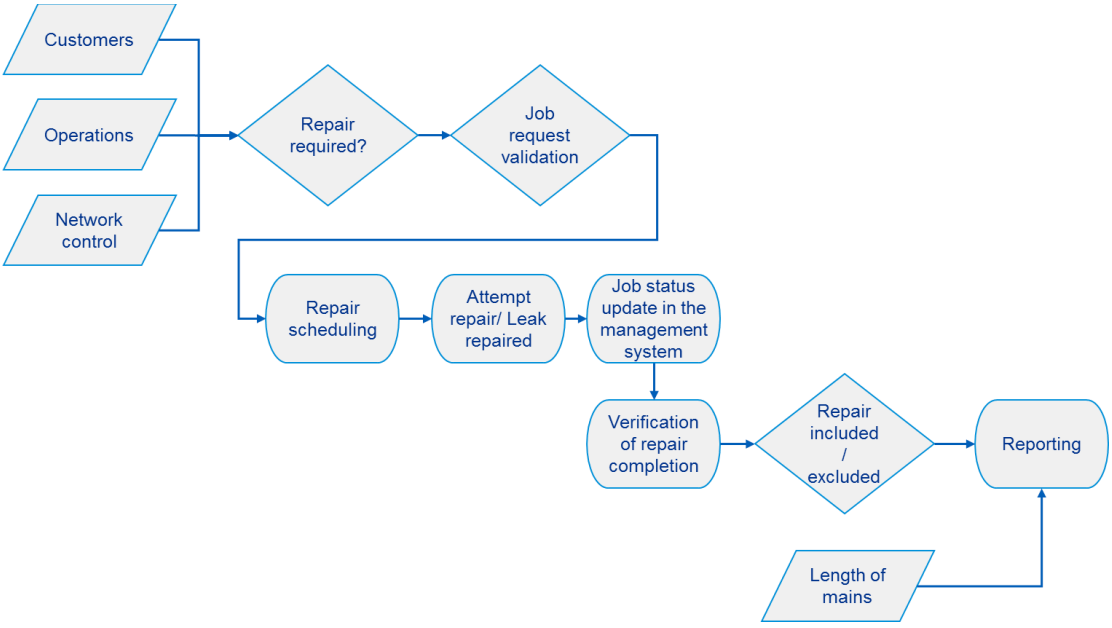
The default position is that the water company manages the risk of mains bursts and there are no exclusions. The cause of the mains burst is not relevant to the calculation of the reported figure, with the following exceptions and points of clarification:

- Any work that is not undertaken on the main e.g. solely on a ferrule, hydrant or valve and clamps associated with these ancillaries, which does not involve a repair on the main shall be excluded. Clamps used to repair the main shall be included. ~~Clamps used to repair the main shall be included.~~

- All third party damage should be excluded where costs are potentially (rather than actually) recovered from a third party.

Measure definition

The diagram below shows a simplified version of the process.



Component definitions

Mains bursts repair work

Number of mains bursts per thousand kilometres of total length of mains. Mains bursts include all physical repair work to mains from which water is lost. This is attributable to pipes, joints or joint material failures or movement, or caused or deemed to be caused by conditions or original pipe laying or subsequent changes in ground conditions (such as changes to a road formation, loading, etc. where the costs of repair cannot be recovered from a third party).

[MRP1] Any repair work undertaken on the water mains (i.e. all pipes conveying treated water around the distribution point but not including communication pipes or supply pipes) shall be included. Any work that is not undertaken on the mains e.g. solely on a ferrule, hydrant, valve and clamp associated with the ancillary which does not involve a repair on the main shall be excluded. Clamps used to repair the main shall be included.

All incidents should be included which involve over-pressure or pressure cycling, and surge failures, etc., which reflect the system operating conditions, even where

these failures are accidental rather than associated with weaknesses in pipe condition.

[MRP2] Once the main is recharged, and customers are back in supply, then if there is a new incident it is counted as a separate repair. If there is a secondary burst not at the point at where the repair took place during the recharge, then it should be captured as a separate reported burst.

[MPR3] Self-laid mains, or other mains adopted should be treated as part of the incumbents' network from the time of adoption. If a developer has a burst on its main prior to adoption this is not included within the metric.

Mains length

The length of main is the length of all pipes conveying treated water around the distribution point but not including communication pipes or supply pipes.

Records

All companies shall maintain verifiable records for all mains bursts irrespective of whether they are included. The aim of the records is to provide an auditable method for identifying the specific incident that are included and excluded from the return.

Methodology statement

Companies shall maintain a methodology statement. It shall be used as a decision support tool to expand on this document as necessary. It should record any changes in approach compared to previous years.

Compliance check list

The compliance check list shall be completed and presented with the reported figure.

[MRP4] Annex A Compliance Checklist

A company is required to complete this checklist for submission with its value of mains bursts per 1,000km.

The elements of each component to be assessed separately based on the following rules:

Compliance for elements is reported against:

R	Not compliant with the guidance and having a material impact on reporting
A	Not compliant with the guidance and having no material impact on reporting.
G	Fully-compliant with the guidance

	Component	Compliant (R/A/G)	Reason for any non-compliant components	Confidence grade
1	Mains bursts repair work			
2	Mains length			
3	Records			
4	Methodology statement			

For each component on the checklist, and for the overall performance measure, companies will report a confidence grade.

Confidence grades provide a reasoned basis for companies to qualify the reliability and accuracy of the data. Companies should employ a quality-assured approach in the methodology used to assign confidence grades, particularly if sampling techniques are in place.

The confidence grade combines elements of reliability and accuracy, for example:

- A2 Data based on sound records etc. (A, highly reliable) and estimated to be within +/- 5% (accuracy band 2)

Reliability and accuracy bands are shown in the tables below.

Reliability Band	Description
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from limited sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Accuracy band	Accuracy to or within +/-	But outside +/-
1	1%	-
2	5%	1%
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Accuracy outside +/- 100 %, small numbers or otherwise incompatible (see table below)	

Certain reliability and accuracy band combinations are considered to be incompatible and these are blocked out in the table below.

Compatible confidence grades				
Accuracy band	Reliability band			
	A	B	C	D
1	A1			
2	A2	B2	C2	
3	A3	B3	C3	D3
4	A4	B4	C4	D4
5			C5	D5
6				D6
X	AX	BX	CX	DX

~~5.6~~5.7 Reporting guidance – Sewer collapses per 1,000km

Objective

This guidance seeks to enable all companies to report on sewer collapses for the defined year with confidence and at a reasonable level of accuracy and with a common approach. Companies shall apply consistent and robust methods and common assumptions. This will facilitate the comparison of performance across companies by customers, regulators and other companies with reasonable confidence.

Key Principles

There are several key assumptions made in the compilation of the guidance:

- Reporting on number of sewer collapses shall be subject to each company's assurance process which is applied to all measures reported annually.
- Companies have a methodology or procedure in place for reporting on sewer collapses

There is an assumption that there will be continued improvement by all companies in the short and medium term through innovation, new technology, data quality improvements and staff training:

- The measure assumes a clear and simple approach that can be understood by customers and regulators;
- The essential reporting requirements for reporting on sewer collapses are set out in the guidance;
- The focus of the guidance is on annual reporting of number of sewer collapses. It is not intended as a definitive guide to managing the risk of sewer collapses;
- Exclusions are to be kept to a minimum and shall be consistent with the reasonable expectations of an affected customer.

Applying this guidance is likely to mean that comparisons of historical performance between companies, and of individual companies' previous performance, may not necessarily be valid. However, it is anticipated that future individual company year on year trends in performance will be possible.

Measure Definition

[SWC1] Number of sewer collapses per thousand kilometres of all sewers causing an ~~reported~~ impact on service to customers or the environment.

This measure seeks to reflect failures, due to structural weakness in the asset ~~set out the table below~~, causing an ~~reported~~ impact on service to customers or the

environment. A sewer collapse is considered to be where a structural failure has occurred to the pipe and any loss of flow has occurred ~~and where this cannot be rectified with jetting, and requires excavation to replace/repair the pipe and then restore flow~~that results in a service impact to a customer or the environment and where action is taken to replace or restore the pipe to reinstate normal service. The measure intentionally does not refer to the magnitude of the collapse. The measure includes rising mains.

Impact on service to customers is the loss of pass forward flow at the location of the collapse. Where there has been no impact on a customer but there has been flooding or pollution ~~one or more of the following~~ there will be deemed to have been an impact on the environment.~~:~~

- ~~Contamination of land other than in the immediate vicinity of the collapse~~
- ~~Contamination of ground water~~
- ~~Contamination of a surface water source~~
- ~~The collapse of the ground above the sewer and where the ground level profile was changed as a result~~

~~**Pipe Condition (structural)**~~	~~**Cross Sectional Loss**~~
~~Structural failure – pipe structural integrity compromised~~	~~>50% loss~~
~~Fully collapsed pipe~~	~~>50% loss~~
~~External backdrops~~	~~>50% loss~~
~~Missing pipe (Covers all modes of failure including chemical attack eg. H2S)~~	~~>25% loss of circumferential area~~
~~Pipe bridges~~	~~>50% loss~~
~~Rising mains (cover all infrastructure assets)~~	~~Burst (or leak causing a reportable service failure) rising main~~

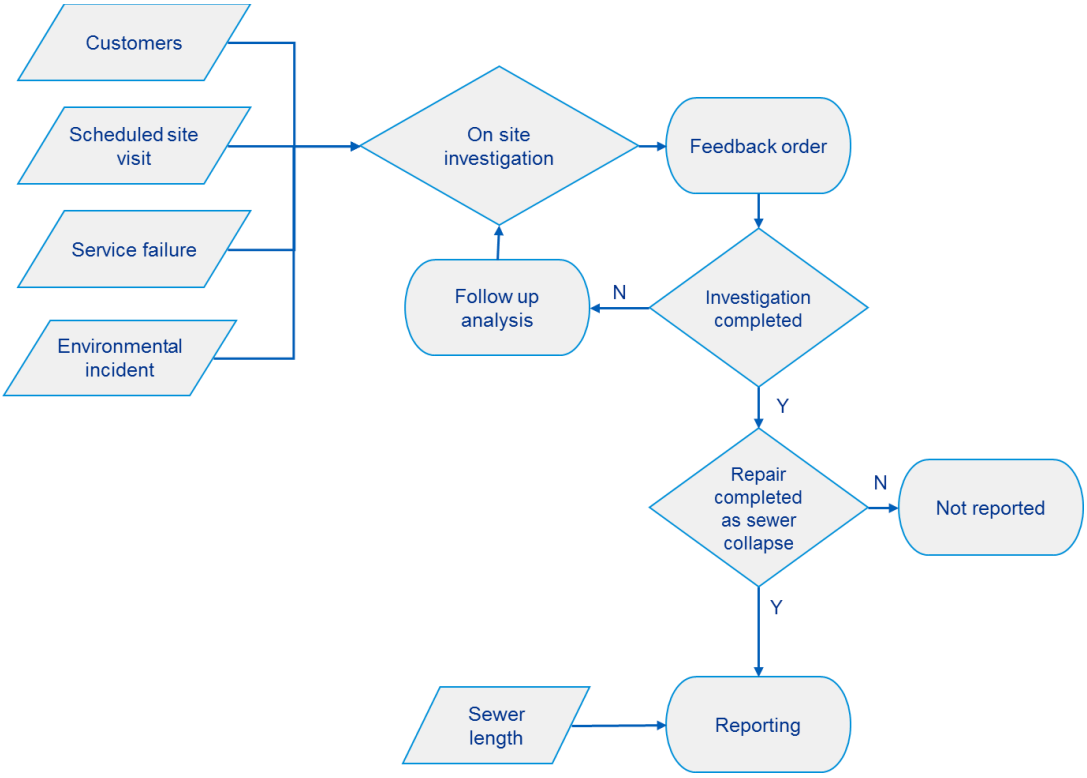
Note this measure should include all public sewer and lateral collapses recorded by the company inclusive of those incidents that have been reported as flooding or pollution failures, if the primary cause of the flooding or pollution was a sewer

collapse.~~Note where the cross sectional failure is <50% and a blockage to normal flow has been observed, this should be reported as a blockage.~~

Note multiple incidents on the same length of sewer (manhole to manhole/ valve to valve) will count as a single incident if all work is carried out as part of the same remedial job. This assumes that the locations are in close proximity. This would not be the case if separate locations were more than 25m apart. ~~Additionally, if there is any doubt to the extent of the cross-sectional loss (i.e. whether it is >50%) then it should be included as a reportable collapse.~~

Reporting Process

The process for deriving the number of sewer collapses is given in the diagram below:



A company is required to report against this definition and:

- Disclose where its methodology does not comply with this guidance using the checklist in Annex A;
- Explain the reasons for any non-compliance;
- Set out its plans and programme to comply with the guidance; and

- Disclose any other factors which have an impact on the methodology for reporting outage.

Components

Sewer Length

Companies should separately record the length of sewer that was transferred to their responsibility under the Transfer of Public Sewers Regs 2011.

Exclusions

The following exclusions could apply to the sewer collapse measure definition:

- Proactively identified collapses – Should a collapse be found as a result of proactive activity (survey or proactive sewer maintenance work) on the network unrelated to the reported reactive activity to restore service then it could be excluded.
- Third party damage – Third party structural damage (including water utility damage) of the sewer is not an indicator of asset health and hence could be excluded.
- Manhole damage and internal backdrops could be excluded
- Displaced joints, cracked or fractured pipes, open joints, intruding connections, minor pipe breaks and hard blockages do not reflect sufficiently significant structural failure hence could be excluded from the measure. ~~Failure of a bridge structure supporting a pipe is not a sewer collapse unless the pipe has failed and caused the bridge failure.~~

[SWC2] Annex A: Compliance Checklist

A company is required to complete this checklist for submission with its reported value for sewer collapses.

The elements of each component to be assessed separately based on the following rules:

Compliance for elements is reported against:

R	Not compliant with the guidance and having a material impact on reporting
A	Not compliant with the guidance and having no material impact on reporting.
G	Fully-compliant with the guidance

An overall RAG to be assigned for each component based on the following rules:

Compliance for overall components is reported against:

R	There are one or more red elements in the component or the combined effect of amber elements is considered to produce a material impact.
A	Half or more of the elements in the component are amber and the combined effect of the amber elements is considered not to produce a material impact.
G	More than half of the elements in the component are green

	Component	Compliant (R/A/G)	Reason for any non-compliant components	Confidence grade
1	Number of collapses			
2	Sewer length			
a	Length excluding transferred sewers			
b	Length of sewers transferred under the Private Sewer Regs 2011			

For each component on the checklist companies will report a confidence grade.

Confidence grades provide a reasoned basis for companies to qualify the reliability and accuracy of the data. Companies should employ a quality-assured approach in the methodology used to assign confidence grades, particularly if sampling techniques are in place.

The confidence grade combines elements of reliability and accuracy, for example:

- A2 Data based on sound records etc. (A, highly reliable) and estimated to be within +/- 5% (accuracy band 2)

Reliability and accuracy bands are shown in the tables below.

Reliability Band	Description
A	Sound textual records, procedures, investigations or analysis properly documented and recognised as the best method of assessment.
B	As A, but with minor shortcomings. Examples include old assessment, some missing documentation, some reliance on unconfirmed reports, some use of extrapolation.
C	Extrapolation from limited sample for which Grade A or B data is available.
D	Unconfirmed verbal reports, cursory inspections or analysis.

Accuracy band	Accuracy to or within +/-	But outside +/-
1	1%	-
2	5%	1%
3	10%	5%
4	25%	10%
5	50%	25%
6	100%	50%
X	Accuracy outside +/- 100 %, small numbers or otherwise incompatible (see table below)	

Certain reliability and accuracy band combinations are considered to be incompatible and these are blocked out in the table below.

Compatible confidence grades				
Accuracy band	**Reliability band**			
	A	B	C	D
1	A1			
2	A2	B2	C2	
3	A3	B3	C3	D3
4	A4	B4	C4	D4
5			C5	D5
6				D6
X	AX	BX	CX	DX

6 Appendix B: Questionnaires

This section compiles the questionnaires sent to companies. The questionnaires were to be completed and returned to us by the 12th of January.

Leakage

a) Overall approach

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q1	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting for this measure, or on the clarity or coverage of the definition for this measure?**

Q2	**Can you summarise the process you used for shadow reporting, and what you consider to be the key assumptions that you use in calculating leakage levels. Specifically, can you set out:** **i. The key assumptions used in your assessment and particularly highlighting any assumptions that could have a material impact upon reported leakage, and how frequently these assumptions are updated** **ii. The key reasons for the difference in reported value in the shadow report as compared to previous reports** **iii. The areas identified as Amber or Red in the RAG assessment, how material you think these factors are in the overall leakage calculation, and where there is more than one element in an area of the RAG assessment, the basis on which you have made an overall RAG assessment for that area.**

Q3	**Implementing the new reporting requirements in line with the new PC shadow definitions.** **Please can you summarise your progress and any challenges associated with implementing reporting against the new PC definitions, specifically:** **i. If you have already implemented the reporting process in line with the new PC definition when did you complete this?** **ii. If you have not yet implemented the reporting process, what is your current best estimate of the timetable for completion of the process of implementation of your reporting processes in line with the new PC definition?** iii. **If parts of the process are likely to be in place sooner than others then please provide details of milestone dates.**

b) Coverage

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q4	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q5	**Can you summarise the extent of your network covered by the process and what you consider to be the key assumptions that you use in calculating leakage levels. Specifically, can you set out:** **i. What percentage of a Company's billed households and non-households are within designated network areas where night flows can be continuously monitored and reported on a regular frequency?** **ii. How, for the purpose of leakage reporting, have you defined a household and a non-household property?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken. Note: for review of definitions of household and non-household property see Q8**

c) Availability

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q6	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**
Add definition of measure from guidance at the top of each section.	

Q7	**Can you summarise how you assess availability, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. What percentage of properties within continuous night flow monitoring networks are available for reporting night flow data through the year?** **ii. What software rules are applied to night flow data to establish whether it is valid for use in the leakage calculation?** **iii. If 90% of data is available is this alone deemed to be sufficient for use in leakage calculations or is the extent of operable data also taken into account?** **iv. What manual checks are completed and at what frequency to determine validity of night flow data?** **v. What reporting level is leakage reported at?** **a. District Meter Area (DMA) using district meters;** **b. water resource zone level using distribution input meters; or**

	c. an intermediate zone level using meters installed on reservoir outlets or trunk mains within the distribution network. **vi. How is DMA meter under-registration assessed and applied?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

d) Properties

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q8	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q9	**Can you summarise how you assess property numbers (for both households and for non-households), highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. Are all properties are mapped to defined zones or DMAs and checked against properties listed on the companies' billing system? What confidence do you have that you know which zone or DMA each billed address is in? If there are properties that are not mapped to defined zones or DMAs, how many are there relative to the size of defined zones or DMAs in the relevant geographic area?** **ii. Do you exclude void properties from night use allowances, and if so, how do you define void properties?** **iii. Do you include an allowance for losses from illegal occupation of voids and if so please outline what assumption is used and on what basis?** **iv. What leakage allowances do you include for properties not within DMAs or monitored zones?**

	v. How frequently is property data that is used in the leakage calculation updated, and how frequently is it cross-checked against other data sets? **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

e) Night flow period and analysis

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q10	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q11	**Can you summarise how you assess night flow, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. What night flow data frequency do you use (i.e. what time interval is logged data averaged over)?** **ii. Do you derive leakage from a fixed period of at least one hour but not longer than two hours during the night?** **iii. Do you vary the fixed period during the year to address significant changes to night use patterns? If yes, why do you vary the period and is the change applied to all DMAs/zones? If no, are you confident that there are no significant changes in night use patterns during the year?** **iv. How frequently do you adjust night use throughout the year to allow for variable customer night use (e.g. seasonal adjustments)?** **v. Do you use weekly leakage estimates with no exclusions for variation during the year?**

	vi.	**Do you use average night use values across all DMAs? If yes, do you include negative leakage values when compiling values of annual average leakage?**
	vii.	**Do you investigate prolonged periods of negative leakage, how is this accounted for?**
	viii.	**With regard to data in filling:** **a. Do you have any DMAs that fall outside the six-month threshold, and if so, how does the number of DMAs in this situation compare with the previous year?** **b. Do you infill data for non-operable periods by interpolating pre- and post-data? If so, over what time period?** **c. Do you use actual flow for the night flow period for NHH properties with continuous monitoring?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

f) Household night use

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q12	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consisting reporting of this measure, or on the clarity or coverage of the measure definition?**

Q13	**Can you summarise how you assess household night use (HHNU), highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **a. Do you assess household night use over the same time period as you use to determine minimum night flow?** **b. How do you determine whether the survey sample is representative of the company as a whole?** **c. How and when do you recruit new customers to the survey?** **d. Whether the sample size is sufficient to capture continuous and intermittent night use with confidence?** **e. How frequently HHNU is derived?** **f. What plumbing loss assumptions are included and what is the basis for these?** **g. What monitoring and maintenance of IHM and SAM monitors is in place?** **h. For companies using SAMs for the estimation of HHNU, to what extent have the recommendations**

	of the recently completed UKWIR report on the application of a fast logging methodology for continuing monitoring been applied? **i. What benefits have been achieved/are expected from the adoption of fast logging?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

g) Non household night use

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q14	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q15	**Can you summarise how you assess non-household night flow, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. Do you assess non-household night use (NHHNU) over the same time period as you use to determine minimum night flow?** **ii. Whether the survey sample is representative of the company as a whole, including customers billed on an assessed basis as well as a metered basis?** **iii. Whether the sample size is sufficient to capture continuous and intermittent night use with confidence?** **iv. How frequently NHHNU is derived?** **v. What plumbing loss assumptions are included and what is the basis for these?** **vi. How is meter under-registration taken into account when assessing NHHNU?**

	vii. Do you have a reliable and representative average billed volume (ABV) model and how frequently is it used to update average billed volumes? **viii. Do you comply with the target threshold for continuous monitoring? If not what is the extent of non-compliance?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

h) Hour to day conversion

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q16	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q17	**Can you summarise how you undertake hour to day conversion, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. Do you have hour-to-day factors for each DMA derived from pressure logging and how often are they updated? If you do not have DMAs for all or part of your area how do you undertake hour to day conversion?** **ii. What N1 factor do you use and why?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

i) Annual distribution leakage

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q18	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q19	**Can you summarise how you assess annual distribution leakage, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. Is annual distribution leakage calculated as an average of 52 weeks without any exclusions?**

j) Trunk main leakage

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q20	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q21	**Can you summarise how you assess trunk main leakage, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. How do you define 'trunk main'?** **ii. Is company specific data used to assess the value of trunk main leakage?** **iii. Does the company have sufficient meters installed to allow flow balances to be calculated over 95% by volume of the trunk main network?** **iv. How frequently are trunk main losses refreshed?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

k) Service reservoir losses

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q22	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q23	**Can you summarise how you assess service reservoir leakage, highlighting any key systems and assumptions used in the process. Specifically can you set out:** **i. Is company specific data used to assess the value of service reservoir leakage?** **ii. Do you use mass balance across reservoirs, if so how do you eliminate trunk main leakage from the calculation? If you survey, what methods are used and how frequently are surveys undertaken.** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

l) Distribution input

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q24	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q25	**Can you summarise how you assess distribution input, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. Is distribution input metered with at least daily readings at all defined locations?** **ii. Do you exclude treatment works take offs downstream of a meter from DI calculations?** **iii. How frequently are data validity checks completed?** **iv. Is missing data infilled?** **v. How do you check and validate the data transfer systems from meter output to central database?** **vi. Are flow checks on DI meters consistent with the principles of the 'EA Abstraction Good Metering Guide' specifically the frequency of checks?** **vii. Is average weekly data derived from representative daily values? Over what timescale?** **viii. How is meter under-registration assessed and applied?**

	Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.

m) Water delivered - measured

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q26	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q27	**Can you summarise how you assess measured water delivered, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. What assumptions do you use in terms of meter under registration?** **ii. If a meter under-registration greater than 3% is used what is the reason for this?** **iii. What approach do you take to supply pipe leakage?** **iv. What is your accruals process, and how do you use CMOS data in this?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

n) Water delivered – unmeasured

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q28	**Do you have any observations on how effective the current methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q29	**Can you summarise how you assess water delivered un measured, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. Do you account for Meter Under Registration in the calculation of unmeasured HH and NHH consumption from a survey of properties?** **ii. Can you provide evidence that the survey to determine unmeasured HH and NHH consumption is representative of the company as a whole?** **iii. What percentage of monitors are included in the survey (to determine unmeasured HH and NHH consumption) as an average annual measure?** **iv. Quantify the uncertainty allocated to unmeasured household consumption and the justification for this assumption?**

		Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.

o) Company own use

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q30	**Do you have any observations on how effective the current methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q31	**Can you summarise how you assess company own use, highlighting any key systems and assumptions used in the process. Specifically, can you:** **i. Quantify the uncertainty allocated to company own use and the justification for this assumption?** **ii. Set out what proportion of company own use is metered or logged?** **iii. Set out what your estimation is of distribution operational use as a percentage of distribution input, and can you explain the basis for this estimate?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

p) Other water use

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q32	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q33	**Can you summarise how you calculate other water use, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. What estimate of water delivered unbilled (legally and illegally) is used? What proportion of DI is this, and what is the basis of this estimate?** **ii. What estimate of operational system use is used? What proportion of DI is this, and what is the basis of this assessment?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

q) Water balance and MLE

These questions will help us to understand how you approach and calculate reported leakage values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q34	**Do you have any observations on how effective the current shadow reporting methodology is at achieving consistent reporting of this measure, or on the clarity or coverage of the measure definition?**

Q35	**Can you summarise any issues you have or assumptions you make in applying the MLE methodology. Specifically, can you:** **i. Describe the components making up the MLE calculation** **ii. Set out how you assess the confidence in your components to MLE?** **iii. Set out the size of the water balance gap in 2016/17 and the key reasons for this gap (if >3%)** **iv. Set out what the magnitude of the impact of comparing bottom up and top down approaches in Ml/d and as a % of pre-MLE Distribution input?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

Per Capita Consumption (PCC)

These questions will help us to understand how you approach and calculate reported PCC values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Evidence to be available in the interview should be the basis of the calculation used and checks that have been undertaken.

r) Overall approach

Q1	**Do you have any observations on how effective the current methodology (i.e. the one companies use for their Water Resource Management Plans) is at achieving consistent reporting for this measure, or on the clarity or coverage of the definition for this measure?**

Q2	**Can you summarise the processes and what you consider to be the key assumptions that you use in calculating PCC levels. Specifically, please set out:** **i. The key assumptions used in your assessment and particularly highlighting any assumptions that could have a material impact upon reported PCC** **ii. If and how you normalise PCC estimates compared to base year?** a. For the effects of weather year to year b. For the effects of restrictions on supply c. Any other effects?

	iii. How does the change to leakage reporting affect your calculation of PCC?

s) Definition

These questions will help us to understand how you approach and calculate reported PCC values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q3	**Do you have any observations on how effective the current methodology is at achieving consistent reporting for this measure, or on the clarity or coverage of the measure definition?**

Q4	**Can you summarise the extent of your network covered by process and what you consider to be the key assumptions that you use in calculating PCC levels. Specifically, please set out:** **a. Would you be able to back-cast your PCC values to 2014/15** i. What factors could prevent you being able to back-cast? ii. How far back could you back-cast? iii. How would you assess your confidence in your back-cast assessments? **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

t) Population

These questions will help us to understand how you approach and calculate reported PCC values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q5	**Do you have any observations on how effective the current methodology for population is at achieving consistent reporting for this measure, or on the clarity or coverage of the measure definition?**

Q6	**Can you summarise how you assess population served, highlighting any key systems and assumptions used in the process. Specifically, please set out:** **a. How you assessed base year population and forecasts?** i. Top down or bottom up estimates? ii. What representation or stratification do you use for samples? **b. How current year population is related to base year population?** **c. How you divide population into measured and unmeasured households and non-household properties?** i. Surveys used and how are frequently are they updated? ii. How you assess confidence in population figures used in subsequent calculations? iii. What factors may affect the accuracy of your assessments? **d. How often do you update your population assumptions? Are there any assumptions you consider could be improved? What impact has**

	updating population estimates had on reported PCC figures in the past, and can you describe the extent of the change? **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

u) Properties

These questions will help us to understand how you approach and calculate reported PCC values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q7	**Do you have any observations on how effective the current methodology for properties is at achieving consistent reporting for this measure, or on the clarity or coverage of the measure definition?**

Q8	**Can you summarise how you assess property numbers, highlighting any key systems and assumptions used in the process. Specifically, please set out:** **a. How you calculate property numbers?** i. How do your calculations relate to properties in your billing system? **b. How retail non-household separation has affected the assessment of property numbers?** **c. How you are able to measure properties on a consistent basis going forward after non-household separation?** **d. Do you exclude void/empty properties from property numbers?** i. How do you assess void numbers? ii. How do you assess the confidence of estimates? **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

v) Occupancy rate

These questions will help us to understand how you approach and calculate reported PCC values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q9	**Do you have any observations on how effective the current methodology for assessing occupancy rates is at achieving consistent reporting for this measure, or on the clarity or coverage of the measure definition?**

Q10	**Can you summarise how you assess occupancy rate, highlighting any key systems and assumptions used in the process. Specifically, please set out:** **a. How you assess the occupancy rate of measured and unmeasured properties and non-household properties** i. Surveys used ii. Sample size, stratification, frequency updated, confidence **b. How do you assess the accuracy of occupancy rates?** i. What factors may affect the accuracy of occupancy rates? ii. Do you make any adjustments for children/adults, unemployed or retired vs. working, daily attendance at school or college, seasonal absence, changes due to holidays, hidden population, farms, non-households?

w) Measured Consumption

These questions will help us to understand how you approach and calculate reported PCC values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q11	**Do you have any observations on how effective the current methodology for assessing measured consumption is at achieving consistent reporting for this measure, or on the clarity or coverage of the measure definition?**

Q12	**a) Per Household Measured Consumption** **Summarise how you assess measured household consumption, highlighting any key systems and assumptions used in the process. Specifically, please set out:** **i. Do you base your assessment on billed volumes or meter readings?** **ii. If you use meter readings to assess consumption?** a. How do you account for zero, missed or erroneous reads? b. Do you make any exclusions to meter reads? **iii. If you use billed volumes to assess consumption** a. Do you assess and adjust for void properties? b. How do you adjust for leak allowances? c. How do you adjust for internally or externally measured properties?

	iv. How do you adjust water delivered volumes for supply pipe leakage to derive consumption volumes? a. How do you assess supply pipe leakage for internally and externally measured properties? b. How do you assess the accuracy of supply pipe leakage? **v. How do you assess meter read/billed read volume accruals?** **vi. What assumptions do you use in terms of meter under registration?** **vii. If a meter under-registration greater than 3% is used what is the reason for this?** **b) Per Capita Consumption for measured households** **Summarise how you assess measured per capita consumption, highlighting any key systems and assumptions used in the process. Specifically, can you set out:** **i. How you derive and apply occupancy rate estimates to calculate PCC from PHC or vice versa?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

x) Unmeasured consumption

These questions will help us to understand how you approach and calculate reported PCC values and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q13	**Do you have any observations on how effective the current methodology for assessing unmeasured consumption is at achieving consistent reporting for this measure, or on the clarity or coverage of the measure definition?**

Q14	**a) Per household unmeasured consumption: Individual Household Monitor (IHM)** **If you use an IHM summarise how you measure water delivered unmeasured, highlighting any key systems and assumptions used in the process. Specifically, please set out:** **i. How the IHM is structured?** **a.** Sample size, selection method and stratification, representation (age, demographic, property type, garden size, swimming pool) b. What evidence can you provide that the survey to determine PHC is representative of the company as a whole? c. How do you demonstrate the statistical significance of the IHM? **ii. What procedures and systems are used to assess PHC from an IHM?** **iii. How you maintain the sample year to year?** **iv. How often do you read the non-household meters?**

a. Metered or logged properties?
b. Type of meter or logger?

v. How you deal with zero, missed and erroneous reads?

vi. How do you deal with accruals and matching the sample data to the required annual assessment period?

vii. How you assess and apply SPL in your calculation?

viii. How you assess and apply plumbing losses in your calculation?

ix. How you address high or low outliers in the calculation of PHC?

x. How you extrapolate the sample outcome to zonal and company estimates of PHC?

xi. How you account for MUR in the calculation of unmeasured PHC?

xii. How do you deal with detected SPL in the sample?

xiii. Quantify the uncertainty allocated to unmeasured household consumption and the justification for this assumption?

b) Per household unmeasured consumption: Small Area Monitor (SAM)

If you use an SAM summarise how you assess water delivered unmeasured, highlighting any key systems and assumptions used in the process. Specifically, can you set out:

i. How many SAM's are included in the assessment (to determine PHC) as an average annual measure? How the SAM is structured?

a. Sample size, selection method and stratification, representation (mix of property and occupant age, demography, property type, garden size, swimming pool etc)

b. What evidence can you provide that the survey to determine PHC is representative of the company as a whole?

Q14	**ii. What procedures and systems are used to assess PHC from SAM's?** **iii. How do you assess the number of household properties?** a. Billed properties, separation of NHH properties? b. How do you assess and deal with void properties? **iv. How you extrapolate the sample outcome to zonal and company estimates of PHC?** **v. How you ensure operability and identify and deal with any zonal breaches data gaps or errors in the SAM input meters?** **vi. What adjustments do you apply for pressure controlled SAM's e.g. Hour to Day factors? How are they calculated?** **vii. How often you read the SAM meters?** a. Metered or logged, continuous integrated or intermittent? b. Type of meter or logger **viii. How you assess and apply leakage in your calculation?** a. Distribution losses and supply pipe losses b. Explain any differences from the application of consistent measurement of leakage **ix. How you assess and adjust for non-household water delivered in each SAM?** a. Sampled, logged, frequency, modelled, measured or unmeasured, allowances? **x. How you account for MUR in the calculation of unmeasured PHC?** **xi. How you quantify the uncertainty allocated to unmeasured PHC and the justification for this assumption?** **c) Per capita unmeasured consumption** **Can you summarise how you calculate water delivered unmeasured, highlighting any key systems and**

	assumptions used in the process. Specifically, please set out: **i. How you derive and apply occupancy rate estimates to calculate PCC from PHC or vice versa?** **Evidence which should be available in the interview should be the basis of the calculation used and checks that have been undertaken.**

Supply interruptions

Q1	**Do you have any observations on how effective the consistent shadow reporting methodology (the consistent methodology) is at meeting the defined objective and key principles of this measure, or on the clarity or coverage of the measure definition?**

a) Overall approach

These questions will help us to understand how you approach the capture and reporting of supply interruption information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q2	**Can you provide a methodology of the process that you adopt to identify and capture supply interruptions data and highlight any inconsistencies with the consistent methodology and set out the key assumptions that you make in developing your return? Please provide examples of deviations from the methodology**

Q3	**Implementing the new reporting requirements in line with the new PC shadow definitions.** **Please can you summarise your progress and any challenges associated with implementing reporting against the new PC definitions, specifically:** **iv. If you have already implemented the reporting process in line with the new PC definition when did you complete this?** **v. If you have not yet implemented the reporting process, what is your current best estimate of the timetable for completion of the process of implementation of your reporting processes in line with the new PC definition?** vi. **If parts of the process are likely to be in place sooner than others then please provide details of milestone dates.**

b) Property count

These questions will help us to understand how you approach the capture and reporting of supply interruption information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q4	Do you have any observations on the clarity or coverage of this aspect of the consistent definition?

Q5	**Can you summarise the process that you adopt to identify and capture the properties which are affected by supply interruptions? Specifically, can you set out:** **i. Whether you include all connected properties including those that are not occupied?** **ii. Whether you count properties supplied by a common supply pipe individually?** **iii. Whether you count properties covered by a single bill as one property?** **iv. How do you report non household customers?** **v. How you seek to account for the incremental nature of supply loss, and how effective this is in determining an individual impacted time for individual properties?** **a. Evidence, which would be expected to be available in the interview should be copies of processes and work instructions used to allow staff to appropriately identify and classify affected properties, and evidence of checks and controls that are put in place to ensure compliance with these processes** **vi. Give examples of when the precautionary principle has been applied in assessing whether a property has been affected by a supply interruption** **vii. Detail any property exclusions** **viii. Provide details of systems used to identify property details and elevation** **ix. How frequently is property data updated within corporate systems**

c) Start time

These questions will help us to understand how you approach the capture and reporting of supply interruption information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q6	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q7	**Can you summarise the process that you adopt to identify and capture the time at which properties are assumed to start being affected by supply interruptions? Specifically, can you set out:** **i. What percentage of start times (as a percentage of customer minutes lost) are based on:** **a. Customer contact** **b. Pressure & Flow data** **c. Modelled data** **d. Valve operation** **ii. What percentage of reported interruptions are validated/reviewed** **iii. Whether you only consider supply is lost to the first cold water tap when the pressure in the adjacent main is <=3m pressure or do you consider it lost at higher pressures for example if the property is supplied from a long service pipe or available if property is at a different elevation?** **iv. How you determine the start time of an interruption for a block of flats, and whether the same time is assumed or incremental start times are applied?** **Evidence, which would be expected to be available in the interview should be copies of processes and work instructions used to allow contract staff to appropriately identify start times, and evidence of checks and controls that are put in place to ensure compliance with these processes and a breakdown and evidence of the numbers of properties where start times are addressed through different approaches, including those set out above.**

d) Stop time

These questions will help us to understand how you approach the capture and reporting of supply interruption information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q8	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q9	**Can you summarise the process that you adopt to identify and capture the time at which properties are assumed to stop being affected by supply interruptions? Specifically, can you set out:How do you determine the stop time of an interruption?** **i. What percentage (of customer minutes lost) of stop times are based on** **a. Customer contact** **b. Pressure & Flow data** **c. Modelled data** **d. Valve operation** **e. This should be reported as a percentage of Customer Minutes Lost** **ii. What percentage of reported interruptions are validated/reviewed** **iii. Do you consider supply is restored to the first cold water tap when the pressure in the adjacent main is >3m pressure or do you consider it restored at higher pressures for example if the property is supplied from a long service or available if at a different elevation?** **iv. Do you validate stop times for all interruptions using pressure and flow information, if no what percentage of interruptions are validated?** **v. How do you determine the stop time of an interruption for a block of flats?** **Evidence, which would be expected to be available in the interview should be copies of processes and work instructions used to allow contract staff to appropriately identify start times. Evidence of checks and controls that are put in place to ensure compliance with these processes. A breakdown and evidence of the numbers of properties where start times are addressed through different approaches, including those set out above.**

e) Properties affected by more than one interruption

These questions will help us to understand how you approach the capture and reporting of supply interruption information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q10	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q11	**Can you summarise the process that you adopt to identify and capture properties that are affected by more than one interruption in a report year? Specifically, can you set out whether the interruptions at properties affected by more than one interruption during the reporting year are counted separately?** **Evidence, which would be expected to be available in the interview should be a breakdown and evidence of the numbers of properties affected by more than one interruptions.**

f) Short term restoration of supply

These questions will help us to understand how you approach the capture and reporting of supply interruption information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q12	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q13	**Can you summarise the process that you adopt to include/exclude properties from the report, where supply has been restored for a minimum period of 1 hour? Specifically, can you set out:** **i. How you identify short term restorations and validate the time and properties for which supply has been restored?** **Evidence, which would be expected to be available in the interview should be copies of processes and work instructions used to allow staff to appropriately identify stop times and re-start times.** **Evidence of checks and controls that are put in place to ensure compliance with these processes.** **A breakdown and evidence of the numbers of properties where supply interruptions are excluded from the reported value due to short term restoration of supply to properties.**

g) Records

These questions will help us to understand how you approach the capture and reporting of supply interruption information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q14	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q15	**Can you summarise the process that you adopt to validate your company's asset health data against the company's customer service data? Specifically, can you set out:** **i. Whether and how the full data set (specified within the methodology) is being stored for all reportable incidents of supply interruptions?** **ii. Whether and what evidence of challenge is being stored?** **iii. Evidence, of the recorded information used to support the FY17 shadow report** **iv. Evidence of checks and controls that are put in place to ensure the data is reliable accurate and complete,**

Q16	**Do you have any changes in your methodology since the Shadow Reporting that impact on the reported RAG status for FY17?**

Sewer flooding

a) Overall approach

These questions will help us to understand how you approach the capture and reporting of sewer flooding information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q1	**Do you have any observations on how effective the current shadow reporting methodology (the methodology) is at meeting the defined objective and key principles of this measure, or on the clarity or coverage of the measure definition?**

Q2	**Can you summarise the process that you adopt to identify and capture sewer flooding incidents and highlight any inconsistencies with the process used within the methodology and/or key assumptions that you make? Specifically, can you set out:** **i. How contacts are screened to determine if the responsibility lies with the company or with others?** iv. Evidence, which would be expected to be available in the interview should include scripts from the call centre and a breakdown and evidence of the numbers of incidents that become excluded at this point. Where changes are expected to be made to scripts as a result of the new reporting arrangements these should be provided or described. **ii. How further incidents might be excluded as the flooding investigations progress?**

	v. Evidence might include the reasons for additional exclusions and the numbers excluded at each stage of assessment. **iii. How do companies deal with calls during extreme events and excess call volumes? What checks are taken on whether the number of abandoned calls might have a material impact on reported figures?**

Q3	**Implementing the new reporting requirements in line with the new PC shadow definitions.** **Please can you summarise your progress and any challenges associated with implementing reporting against the new PC definitions, specifically:** **vii. If you have already implemented the reporting process in line with the new PC definition when did you complete this?** **viii. If you have not yet implemented the reporting process, what is your current best estimate of the timetable for completion of the process of implementation of your reporting processes in line with the new PC definition?** **ix. If parts of the process are likely to be in place sooner than others then please provide details of milestone dates.**

b) Assets causing flooding

The purpose of these questions is to better understand the data and systems used to record flooding from assets.

Q4	**Do you have any observations on the clarity or coverage of this aspect of the consistent shadow reporting definition (the consistent definition)?**

Q5	**Provide evidence to demonstrate that flooding from transferred private pumping stations has been applied appropriately. Show reasoning where exclusions have been applied** **Evidence, which would be expected to be available in the interview is a breakdown and evidence of the numbers of incidents that are identified from private pumping stations and the numbers that are subsequently excluded.**

c) Severe weather

The purpose of these questions is to better understand the data and systems used to record flooding from assets.

Q6	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q7	**Can you summarise the process undertaken to determine whether incidents should be classified as severe weather and on any differences in the process that is adopted for severe weather incidents? Specifically, can you:** **i. Clarify that severe weather exclusion is applicable only to hydraulic events and does not apply to flooding other causes** **ii. Set out how severe weather is assessed? E.g. radar data vs rain gauge or other approach? If you use more than one approach, does this have a material impact?** **iii. Set out how the starting point for severe weather assessment is determined e.g. time/date stamp of call / discovery, an assessment of when the flooding commenced, assessment of when the rainfall commenced etc.** **iv. Do you already use FEH 13 or intend to use it in the future?** **v. How effective and complete are the company's processes for accessing river level return information and what impact does the company think there may be upon reported severe weather incidents. Where river levels are not being used outline the company approach** **vi. How effective and complete are the company's processes for assessing tidal influences in their approach for establishing weather outfall locking.**

	Where river levels are not being used outline the company approach vii. Whether the company has excluded incidents on the basis of "multiple rainfall events" viii. What methodology the company applies to determine if multiple rainfall events and / or 1 in 100-year river level events materially affected the ability to freely discharge and cause sewer flooding as a result for any given incident Evidence, which would be expected to be available in the interview should include a breakdown and evidence of the numbers of incidents that are identified as being severe weather events in total and through each relevant sub bullet

d) Internal or external flooding

The purpose of these questions is to better understand the data and systems used to record flooding from assets.

Q8	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q9	**Can you summarise the process undertaken to categorise flooding incidents between internal and external? Specifically, can you demonstrate with evidence how you apply the guidance on section 3 (categorise flooding incidents between internal and external). Ensure your explanation covers compliance against points listed below.** **i. Car parks and specially underground car parks** **ii. Shower tray** **iii. Damp patches or standing water:** **iv. Third party damage or abuse** **v. Overland flow** **vi. Jetting and blockage clearance activities** **vii. Flooding of property next to highway** **viii. Building type compliance on internal flooding** **ix. Any other exclusions**

e) Repeat incidents

The purpose of these questions is to better understand the data and systems used to record flooding from assets.

Q10	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q11	**Demonstrate with evidence how you apply the guidance on repeats. Evidence any circumstance where repeat incident has been excluded**

f) Neighbouring properties

The purpose of these questions is to better understand the extent to which companies proactively investigate neighbouring properties and the impact that this investigation has upon reported incident numbers.

Q12	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q13	**Demonstrate with evidence how you apply guidance on neighbouring properties. Outline the process used to ensure a reasonable approach has been applied in assessing flooded properties.** **Describe any other sources of evidence other than customer contacts that are either used to identify incidents or corroborate incidents and how they are used.**

g) Records and methodology statement

The purpose of these questions is to better understand the robustness of the records and processes used to develop the reported information.

Q14	**Do you have any observations on the clarity or coverage of this aspect of the consistent definition?**

Q15	**Demonstrate and evidence how you apply section 7 (records) of the guidelines**

Sewer collapses - review approach

There is currently little consistency in the approaches companies use to report sewer collapses. An industry practitioner group has developed a potential consistent definition, set out below. No company currently reports fully in line with this definition.

The overall approach for the review for this measure is to:

1. Validate (or challenge) whether the proposed definition is an appropriate basis for consistent reporting
2. Assess for each company the degree to which the company currently reports in line with this definition and the materiality of any variance
3. Assess the gap for each company between their current method of reporting and the proposed consistent definition
4. Assess the timeline for each company within which this gap could be closed

Sewer collapses – questions for companies

Q1	**Do you have any observations on how effective the proposed definition would be as a basis for consistent reporting, or on the clarity or coverage of the measure definition?**

Q2	**How does your current basis of reporting sewer collapses compare with the proposed definition?** iv. Outline any variances in approach

Q3	**What changes would you need to make to bring your current basis of reporting in line with the proposed definition, and over what timescale could this be achieved?**

Q4	**Regarding the potential exclusions set out in section 4 of the proposed definition:** **a) What is your view of the rationale for excluding each of these potential exclusions?** **b) If proactively identified collapses were included in the definition as well as reactively reported collapses, could they be reported separately and what changes (if any) would be needed to your reporting processes?**

Proposed basis for consistent reporting for sewer collapses

1. Objective:

This guidance seeks to enable all companies to report on sewer collapses for the defined year with confidence and at a reasonable level of accuracy and with a common approach. Companies shall apply consistent and robust methods and common assumptions. This will facilitate the comparison of performance across companies by customers, regulators and other companies with reasonable confidence.

2. Key principles

There are several key assumptions made in the compilation of the guidance:

- Reporting on number of sewer collapses shall be subject to each company's assurance process which is applied to all measures reported annually;
- Companies have a methodology or procedure in place for reporting on sewer collapses

There is an assumption that there will be continued improvement by all companies in the short and medium term through innovation, new technology, data quality improvements and staff training;

- The measure assumes a clear and simple approach that can be understood by customers and regulators;
- The essential reporting requirements for reporting on sewer collapses are set out in the guidance;
- The focus of the guidance is on annual reporting of number of sewer collapses. It is not intended as a definitive guide to managing the risk of sewer collapses;
- Exclusions are to be kept to a minimum and shall be consistent with the reasonable expectations of an affected customer

Applying this guidance is likely to mean that comparisons of historical performance between companies, and of individual companies' previous performance, may not necessarily be valid. However, it is anticipated that future individual company year on year trends in performance will be possible.

The adoption of this metric across the industry does not preclude any company electing to have other sewer collapse measure with company specific definitions.

3. Measure definition

Number of sewer collapses per thousand kilometres of all sewers causing a reported impact on service to customers or the environment. This measure seeks to reflect failures, due to structural weakness in the asset set out the table below, causing a reported impact on service to customers or the environment.

Pipe Condition (structural)	Cross Sectional Loss
Structural failure – pipe structural integrity compromised	>50% loss
Fully collapsed pipe	>50% loss
External backdrops	>50% loss
Missing pipe (Covers all modes of failure including chemical attack eg. H2S)	>25% loss of circumferential area
Pipe bridges	>50% loss
Rising mains (cover all infrastructure assets)	Burst (or leak causing a reportable service failure) rising main

Note this measure should include all public sewer and lateral collapses recorded by the company inclusive of those incidents that have been reported as flooding or pollution failures, if the primary cause of the flooding or pollution was a sewer collapse.

Note where the cross sectional failure is <50% and a blockage to normal flow has been observed, this should be reported as a blockage.

Note multiple incidents on the same length of sewer (manhole to manhole/ valve to valve) will count as a single incident if all work is carried out as part of the same remedial job.

Additionally, if there is any doubt to the extent of the cross-sectional loss (i.e. whether it is >50%) then it should be included as a reportable collapse.

4. Exclusions

The following exclusions could apply to the sewer collapse measure definition:

- Proactively identified collapses – Should a collapse be found as a result of proactive activity (survey or proactive sewer maintenance work) on the network unrelated to the reported reactive activity to restore service then it could be excluded.

- Third party damage – Third party structural damage (including water utility damage) of the sewer is not an indicator of asset health and hence could be excluded.

- Manhole damage and internal backdrops could be excluded

- Displaced joints, cracked or fractured pipes, open joints, intruding connections, minor pipe breaks and hard blockages do not reflect sufficiently significant structural failure hence could be excluded from the measure.

- Failure of a bridge structure supporting a pipe is not a sewer collapse unless the pipe has failed and caused the bridge failure.

- Minor circumferential area loss confined to the area immediately around a joint does not reflect sufficiently significant structural failure hence could be excluded from the measure

Mains Repairs

Note on terminology: the phrases 'mains bursts' and 'mains repairs' tend to be used interchangeably but can be misinterpreted. This document uses 'mains repairs' and equivalent phrases throughout, and the measure is for **completed** mains repairs.

This document also uses the phrase 'detected mains repair' to denote a mains where the need for a repair was identified by the company (previously described as 'proactive'). The phrase 'reported mains repair is used to denote what would previously have been descried as a 'reactive' mains repair/burst, i.e. reported to the company by a customer or third party. There would be benefits in separately reporting 'detected' and 'reported' repairs.

Q1	**Does your current methodology apply the OFWAT definition of a main repair from JR11 in full?** **i. Outline any deviations or amendments from the JR11 definition**

h) Overall approach

These questions will help us to understand how you approach the capture and reporting of mains repairs information and, when we compare responses across all the companies, to understand the diversity that exists and how this is influencing company specific approaches and reported values.

Q2	**How do you monitor and record Detected and Reported repairs needing repairing?** **i. Provide method for reporting Detected and Reported mains needed repairing and explain whether the same method is used for all mains (i.e. does the method vary according the location and size of the mains)** **ii. Provide definition of Detected and Reported mains repairs** **a. How would you report a mains needing repairing identified by a field technician?** **b. How would you report a mains needing repairing reported by an employee directly?** **c. How would you report a mains needing repairing reported by third party e.g. Police?** **d. How would you report a mains needing repairing identified via telemetry flow or pressure alarm?** **e. How would you report a non-household mains needing repairing?** **f. How would you report a mains needing repairing on private mains?**

Q3	**Provide the methodology to identify and capture mains repair data.** **i. Include approach taken to identify and confirmation detected vs report** **ii. Indicate what year historically this data is available from** **iii. Provide details of any exclusions**

Q4	**How do you report third party repairs?**
Q5	**Can you summarise the process that you adopt to validate your company's mains repair data** **i. Whether and how the full data set (specified within the methodology) is being stored for all reportable incidents** **ii. Whether and what evidence of challenge is being stored?** **iii. Evidence of checks and controls that are put in place to ensure the data is reliable and accurate and complete**

Q6	**Do you have any additional exclusions?** **i. Provide definitions of all exclusions in reporting for example workmanship/ repeat failures**

Unplanned outage

The questions below are intended to facilitate the development of a new, asset health focussed, definition for unplanned outage. Comments are provided for questions where appropriate, to aid understanding. Ofwat's draft definition of unplanned outage for PR19 can be found here.

Q1	**i. How do you define the maximum sustainable production capacity? Can you demonstrate the process taken to derive this number and any assumptions? (e.g. licence constrictions, treatment capacity, abstraction capacity, seasonal variation).** **ii. If this number differs from those quoted in the water resources management plan, can you account for these differences?** **iii. What is the process followed to make changes to the maximum sustainable production capacity? What are the criteria for making this change?** **Comment: Maximum sustainable production capacity is currently open to some interpretation. This question is intended to identify how the term is being interpreted, to aid in identifying a consistent approach.**

Q2	**i. The 1995 UKWIR outage guidance defines planned and unplanned outage. Are you satisfied with this definition and is it consistent with how you currently report outage in WRMP annual reporting?**

	ii. Where outage was planned what evidence do you have to substantiate this? iii. Are there occasions when you would move an outage from unplanned to planned? If yes, can you summarise the process of doing this and the criteria that are required. Comment: It is critical that there is consistency on how companies define planned and unplanned outage for this measure. There would be value in reporting outage in its entirety (unplanned, planned, and exclusions) to encourage consistency across the industry.

Q3	i. Can you demonstrate the process that is currently followed in reporting WRMP annual outage against DO? ii. What assumptions are made (e.g. telemetry, operational input)? iii. How do you calculate the max flow reduction from an outage? iv. What is the minimum period of outage that is captured for current outage reporting or proposed to be captured against MSPC? v. What is the process used to assess the accuracy of this data? vi. Can you provide historical data, or back-cast this data, and to what extent? a. Does the outage data currently/historically reported for WRMP annual returns also allow you to calculate the outage against MSPC? b. How much of your company is represented by this data? c. How robust is this data? d. Would you be able to provide data for FY17/18? Comment: The data used for this measure is not necessarily recorded in order to report it in terms of maximum production capacity, or audited, across the industry. There likely to be significant variations in data capture.

Q4	i. **If an asset failure does not impact the maximum production capacity, is this data captured? For example, if an abstraction pump fails, but there is sufficient flow from other sources, or through use of a standby, there is no impact on the maximum flow from the works.** ii. **Is this data reported and would you include this in the unplanned outage number?**

Q5	**If an asset failure occurred at a time when max production capacity was already limited by 'planned' works, how would you account for this in reporting?**

Q6	**Do you have any observations on the clarity or coverage of the definition?**

Q7	i. **At which point do you start and stop recording the time of failure?**

	ii. Can you summarise the process taken to identify and verify the time of failure and the time of return to service? iii. What is the minimum 'returned to service' time period, after which a failure is classified as a new failure, and not a continuation of the previous failure? iv. Can you summarise the process that you adopt for reporting multiple asset failures occurring at the same time, at the same treatment works, or overlapping time periods? Comment: Where there is no service impact there are instances where an instant repair is not the most efficient course of action, particularly at non-critical sites. There is a question on whether time weighting of this measure drives the right kind of behaviour, for example: health and safety considerations, working at night, cost impact and nuisance to customers (e.g. noise).

Q8	i. A reduction in maximum production capacity caused by deteriorating water quality should not be included in this measure if deterioration of water quality exceeds the normal operating range of the treatment works, to ensure that the focus of the measure is on asset health, not water input quality. Which water quality parameters would you anticipate limiting the max production capacity? ii. How do you define the 'normal operating range' of water quality, which the works is capable of treating? iii. To apply an exclusion for being outside of this range, how would you demonstrate that the raw water quality exceeds the specified limits?

Q9	**How do you differentiate between deteriorating raw water quality caused by external factors, or by management of raw water assets?**

Q10	**Currently, extreme weather is not proposed to be included as an exclusion. Are there any examples of times when it would be appropriate to exclude such events? (e.g. a health and safety risk)**