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Trust in water

Delivering Water 2020: consultation on PR19 methodology
Appendix 3: Outcomes technical definitions

Appendix to chapter 4: Delivering outcomes to customers

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Appendix 3: Outcomes technical definitions

Purpose of this appendix

In this appendix we provide more detail on definitions for:

- the 14 common performance commitments we are proposing for PR19; and
- the long list of asset health metrics we are proposing companies should choose from if they are selecting asset health performance commitments that are very similar to ones on the list.

We are seeking feedback on all the definitions below. Further information on our proposed approach to the common performance commitments and the long list of asset health metrics is in the Delivering outcomes for customers chapter of the main consultation document and Appendix 2 on Outcomes.

Context

As explained in the main consultation document we have taken these definitions from a number of sources. We want to emphasis a few points of context.

In relation to the consistent definitions for leakage, supply interruptions and sewer flooding we have supported companies working together, co-ordinated by Water UK, and working with UKWIR to review the consistency of reporting for three key measures. They have assessed whether the consistency of reporting for these metrics could be improved, including reviewing previous reporting guidance for clarity and completeness in the light of improvements in the technology and techniques available for reporting. UKWIR is publishing the new definitions and an accompanying report today.

We have included a definition from the DWI on its new measure for water quality compliance, the Compliance Risk Index (CRI). The DWI is continuing to work with its stakeholders on the full definition of the CRI.

We have also used some of the work of the Water and Wastewater Resilience Action Group (WWRAG) Task & Finish sub-group and UKWIR and companies to propose some options for resilience metrics.

1. Definitions for the common performance commitments

1.1 Customer measure of experience (C-MeX)

C-MeX is an incentive mechanism to encourage water companies in England and Wales to provide an excellent service experience to residential water customers. We are currently consulting on the design of C-MeX. Our preferred option combines financial and reputational incentives and measures the following aspects of service delivery:

> **Customer service:** A customer's satisfaction with the water company's handling and resolution of a matter. This is measured by surveying customers who have contacted their water company with a recent matter.
>
> **Customer Experience:** A customer's satisfaction with the overall service provided by their water company. This is measured by surveying bill payers who have not directly contacted their company.

C-MeX replaces SIM. **WaterworCX** is the umbrella term for the C-MeX and D-MeX incentives.

We provide more details on our preferred option and the other options for C-MeX in Appendix 2 on Outcomes.

1.2 Developer measure of experience (D-MeX)

D-MeX is the incentive mechanism to encourage water companies in England and Wales to provide an excellent service experience to developer services customers. It combines financial and reputational incentives and measures the satisfaction of developer services customers with the customer service and experience provided by their water company.

D-MeX is a new measure we will introduced for PR19. **WaterworCX** is the umbrella term for the C-MeX and D-MeX incentives.

As explained in Appendix 2 on Outcomes our preferred approach is to set up a D-MeX Task and Finish Group of developer services customers and water companies to explore how best to develop and implement a six-monthly satisfaction survey that could be compared across companies.

1.3 Water quality compliance – Compliance risk index

Compliance risk index (CRI) is a new measure being developed by the drinking water inspectorate (DWI) in consultation with water companies. CRI will replace the current Mean Zonal Compliance (MZC) index to accommodate upcoming drinking water quality regulations amendments, and to adopt a risk-based monitoring methodology to assess compliance. Broadly speaking, CRI will be calculated by taking into account the significance of the parameter failing the standards in the Regulations, the cause of the failure, the company's handling and managing of the failure, and the location of the failure within the supply system taking into account the proportion of the company's consumers who are affected.

Definition

The Compliance Risk Index (CRI) is a measure designed to illustrate the risk arising from treated water compliance failures, and it aligns with the current risk based approach to regulation of water supplies used by the Drinking Water Inspectorate (DWI).

This is a new measure developed in consultation with water companies. Some details are still to be finalised by DWI, but the following outlines the broad principles of the measure.

CRI includes elements relating to:

- the significance of the parameter failing the standards in the Regulations (the Parameter score);
- the cause of the failure; the manner of the investigation of the failure by the company; and any mitigation put in place by the company (the Assessment score); and
- the location of the failure within the supply system taking into account the proportion of the company's consumers affected.

The formula for the calculation of the index is as follows:

For compliance failures in water supply zones; for compliance failures at water treatment works or designated supply points; for compliance failures at service reservoirs:

$$CRI = \frac{\sum SCP}{\text{Total company population served}} + \frac{\sum SCV}{\text{Total volume of water supplied daily by the company (m3/day)}} + \frac{\sum SCR}{\text{Total Service Reservoir capacity of the company (m3)}}$$

Where: S = Parameter score (see (i) below)

C = Assessment score (see (ii) below)

P = Population affected - for compliance failures in water supply zones

V = Volume affected - for compliance failures at treatment works or designated supply point

R = Service Reservoir capacity affected - for compliance failures at service reservoirs

i. Parameter score

Compliance failures for different parameters do not pose equal risk to consumers. The standards in the Regulations are based on different criteria: whilst some are set on a human health basis, others are based on aesthetic concerns, as indicators or for other reasons. This means that the risk posed from non-compliance with a parameter standard varies depending on the reason for the standard.

The CRI Parameter score reflects this difference and scores are as follows

Basis for standard	Score
Health Risk	5
Health Risk Indicator	4
Aesthetic	3
Regulatory Impact	2
Non Health Risk Indicator	1

ii. Assessment score

All compliance failures are assessed by DWI to ensure that the wellbeing and interests of consumers were protected by best practice in management of compliance failures. Obviously, a well-managed compliance failure with appropriate and speedy mitigation action poses a lower risk to consumers. The DWI also considers the root cause of the failure and whether the company's actions led to or increased the likelihood of the failure, and whether further remedial action is necessary.

Therefore the DWI Inspector's assessment has been assigned a score for CRI shown below:

DWI Inspector assessment	Score
Enforce	5
Covered by legal instrument	4
Enforcement considered	4
Recommendations made	3
Suggestions made	2
Satisfactory investigation did not identify cause	1
Trivial	1
Unlikely to recur	1
Incorrect data	0
Outside operational limits	0

1.4 Water supply interruptions

The definition of supply interruptions which follows is identical to the one published on UKWIR's website.

Reporting Guidance - Supply Interruptions

1. 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.

2. 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.

3. Exclusions

The default position is that the water company manages the risk of supply interruptions and there are no exclusions. 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.

4. Measure Definition

- **Calculation of the Performance**

$$\sum \frac{((properties\ with\ interrupted\ supply \geq 180\ minutes) x\ (full\ duration\ of\ interruption))}{Total\ number\ of\ properties\ supplied\ (year\ end)}$$

- **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.

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.

5. 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.

6. 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.

7. 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.

8. 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.

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 rewards.

9. Compliance Check List

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

10. 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.

1.5 Leakage

The definition of leakage which follows is identical to the one published on UKWIR's website.

Reporting Guidance – Leakage

1. 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.

2. Key Principles

There are several key principles applied in the compilation of the guidance, which we set out below.

- Reporting of annual average leakage 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 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[1].

3. Measure Definition

[1] Consistency of Performance Reporting Measures, UKWIR 2017

Annual average leakage is defined as the sum of distribution system leakage, including 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).

A company is required to report against this definition and:

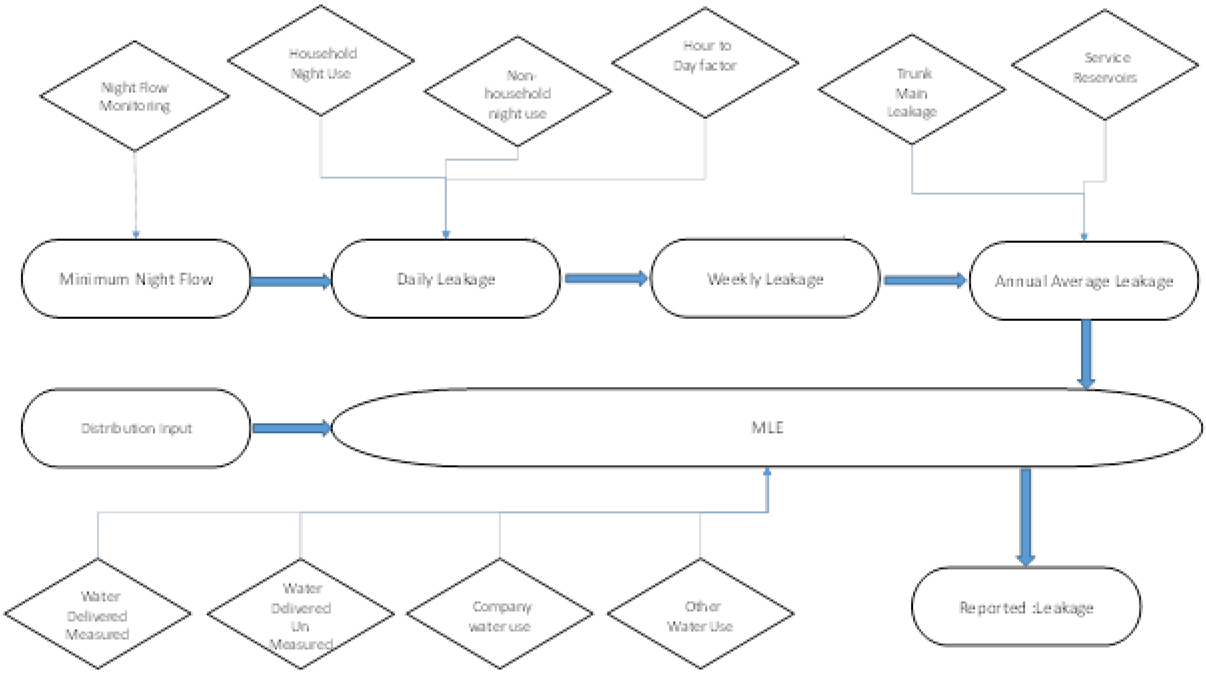
- report a post-MLE average leakage value expressed as Ml/d to one decimal places;
- disclose where its methodology does not comply with this guidance using the checklist in Annex A;
- explain the reasons for any non-compliance;
- set out its plans and programme to comply with the guidance; and
- disclose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

4. Reporting Process

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

- 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.

The process is shown in the following diagram.



5. Components of Leakage Estimation

5.1 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. '

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.

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.'

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.

5.2 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.

5.3 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 there is no 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.

5.4 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'[2] 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[3]. A company may extend this period to two hours.

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

- Night flow data frequency shall be at least every 15 minutes.

[2] Managing Leakage 2011, 10/WM/08/42: UKWIR 2011

[3] Improved Household Night Use Allowances; 14/WM/08/53: UKWIR 2014

- 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.

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.
- 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 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.

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.

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

The IHMs were originally designed to derive estimates of per capita consumption and 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 PCC 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*[4] 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 impact on night use; for example the impact of season 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.

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

- 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.

5.6 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[5] 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 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.

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

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.
- 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.

5.7 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[6] 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.
- 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[7] unless a company is able to demonstrate a higher or lower value would be more appropriate using its own data.

5.8 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 valid daily values of leakage using data points which are representative of the week. Where valid data is

[6] Assessment of Key Parameter for Leakage Analysis, 17/WM/08/59, UKWIR 2017
[7] 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.

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.
- The annual value of leakage expressed as Ml/d shall be derived from an average of the 52 week data.

5.9 Trunk Main and Service Reservoir Losses

Trunk Mains

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[8]', 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 disadvantage of this method is that

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

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.

A company is expected to estimate service 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.
- 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.

5.10 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.

6. Water Balance Components

6.1 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'[9] and in particular the frequency of flow checking defined in Table 6.2 of the EA guide.

6.2 Water Delivered Measured

Water delivered measured shall include for household and non-household volumes. Include estimates of under-registration and supply pipe leakage for internally metered properties. Measured data shall be derived from the meter readings within the company's billing system including estimated reads.

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. To ensure that estimates of water delivered measured are not unduly biased by indicative assumptions of meter under-registration, a company should not assume a value greater than an average of 3% unless it can demonstrate a higher value.

New guidance on the estimation of unmeasured household consumption[10] proposes a measured household monitor to enable the nature of consumption patterns to be better understood.

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 report water delivered measured using the following criteria.

- Metered data as derived from a company's own billing system or from CMOS for non-households.
- An estimate of supply pipe losses shall be included for internally metered properties consistent with the company's current assumption of supply pipe losses.
- Inclusion of any leakage allowance can be included where a rebate has been applied to a customer's bill.

[9] EA Abstraction Good Metering Guideline, EA February 2002
[10] 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. A company shall assume a meter under-registration not exceeding an average 3% unless it can evidence a higher value.
- Meter replacement consistent with a company's replacement programme.

6.3 Water Delivered Unmeasured

Water delivered unmeasured has historically been derived from a combination of population, properties, occupancy and per capita consumption. The relationships are not linear in that as occupancy increases, per capita consumption reduces. Supply pipe losses are included. This is a significant component of the water balance and therefore needs continual focus to maintain and improve this estimate.

Population and Occupancy

Guidance on population and occupancy should be derived using the guidance in the Water Resources Management Plan Guidelines[11].

Unmeasured Per-capita Consumption (PCC)

Unmeasured household per capita 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) established by companies.

Recent good practice is that IHMs shall be based on a representative sample of at least 1000 unmeasured properties across a company's area of supply. Representation may be by demographic group, property type or other recognised statistical group. Individual monitors 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 on a weekly basis. Data on household occupancy is updated at least once per year. The IHM needs continual monitoring to limit the level of any supply pipe losses or other continuous flows. Any other

[11] Final Water Resources Management Plan Guidelines, EA/ Natural Resources Wales, May 2016

continuous flows are attributable to customer use or plumbing losses and should be included in estimates for PCC or PHC.

While an allowance is made for meter under-registration it is expected that meters will have an enhanced specification compared with normal domestic meters and are continually monitored. Meters are expected to be selected and maintained to minimise meter under-registration. A phased meter replacement programme should be in place.

SAMs are also be based 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 exclude non-households; the total sample size is dependent on the acceptable uncertainty applied to PCC estimates and assumptions on SAM outage. The number of properties in SAMs for night use are greater than required for IHM because of the variability in intermittent night use. There are limitations to the SAMs where the proportion of metered properties increases above 50%. The best practice guide[11] provides further guidance. The IHM monitoring requirements for household occupancy, continual monitoring and meter under-registration shall be equally applied.

Estimates of plumbing losses not fully represented in the sample shall be based on a company's own data either through a separate assessment or with the IHM or SAMs surveys.

New guidance on the estimation of unmeasured household consumption[12] 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.

A company is expected to report per capita consumption for unmeasured households using the following criteria.

- The PCC surveys shall follow the principles set out in the UKWIR Report 'Best Practice for unmeasured per-capita consumption monitors 1999[10] and the more recent report Future Estimation of Unmeasured Household Consumption, UKWIR 2017[11].
- An estimate of PCC shall be derived from a company's own individual household monitor or small area surveys.

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

- 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 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 survey as defined in the 2017 UKWIR Report.
- A SAM shall also comprise a representative sample of customer' characteristics. The sample size shall be 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 shall be applied.
- Quantify the uncertainty allocated to unmeasured household consumption and provide evidence to justify the uncertainty value used.
- Continual monitoring and maintenance of IHMs and SAM monitors.
- 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.
- Estimate of plumbing losses shall be based on the company's own data.

Unmeasured non-households

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

A company is expected to report water delivered to unmeasured non-households using the following criteria.

- Where this 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.

6.4 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. 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.

6.5 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.
- 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.

7. 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[13] 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

[13] Demand Forecasting Methodology, NERA for UKWIR 1995: 95/WR/01/1

excess of the +5% gap, expressed as Ml/d, shall be added to the leakage 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:

- 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; and
- Revisit all material components of the water balance where the water balance gap is >5% or < -5%.

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.

A company is expected to apply confidence intervals 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%.

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.

8. 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
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

1.6 Per capita consumption (PCC)

Per capita consumption is defined as the average amount of water used by each customer that lives in a household property. We are using the same definition as that used for water resources management plans (WRMPs).

This is calculated as total consumption (both metered and unmetered households) divided by the total population. All estimates of per capita consumption (PCC) should be expressed in units of litres per head per day (l/h/d) and exclude underground supply pipe losses.

Companies should report the same forecast data as used in WRMP tables for the “Average Household – PCC” reported in the final plan table (Row 31FP) and the outturn should be consistent with the WRMP annual review returns.

The WRMP tables auto-calculate the PCC from consumption divided by population (i.e. top down), not directly from the sum of demand micro-components. This is because company calculations of PCC may include Maximum Likelihood Estimation (MLE) adjustments.

The reporting for the PCC outcome should be consistent with this approach.

In detail the Average Household – PCC is calculated for WRMP19 as follows:

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

Each consumption component is made up of:

- water delivered minus underground supply pipe leakage; and
- where water delivered is the average volume of water entering the distribution network at point of production and then delivered to households. This measure of water delivered excludes water lost on the distribution network (distribution losses) and any water taken unbilled, but this does include supply pipe leakage.

1.7 Internal sewer flooding

The definition of internal sewer flooding which follows is identical to the one published on UKWIR’s website. The UKWIR definition includes external sewer flooding, but it is only internal sewer flooding that we are proposing to be a common performance commitment for PR19. However, external sewer flooding is part of our long list of asset health metrics and uses the definition that follows (see section 2.2.4).

Reporting Guidance – Sewer Flooding

1. 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.

2. 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.

3. 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; and

2. the number of external flooding incidents per year.

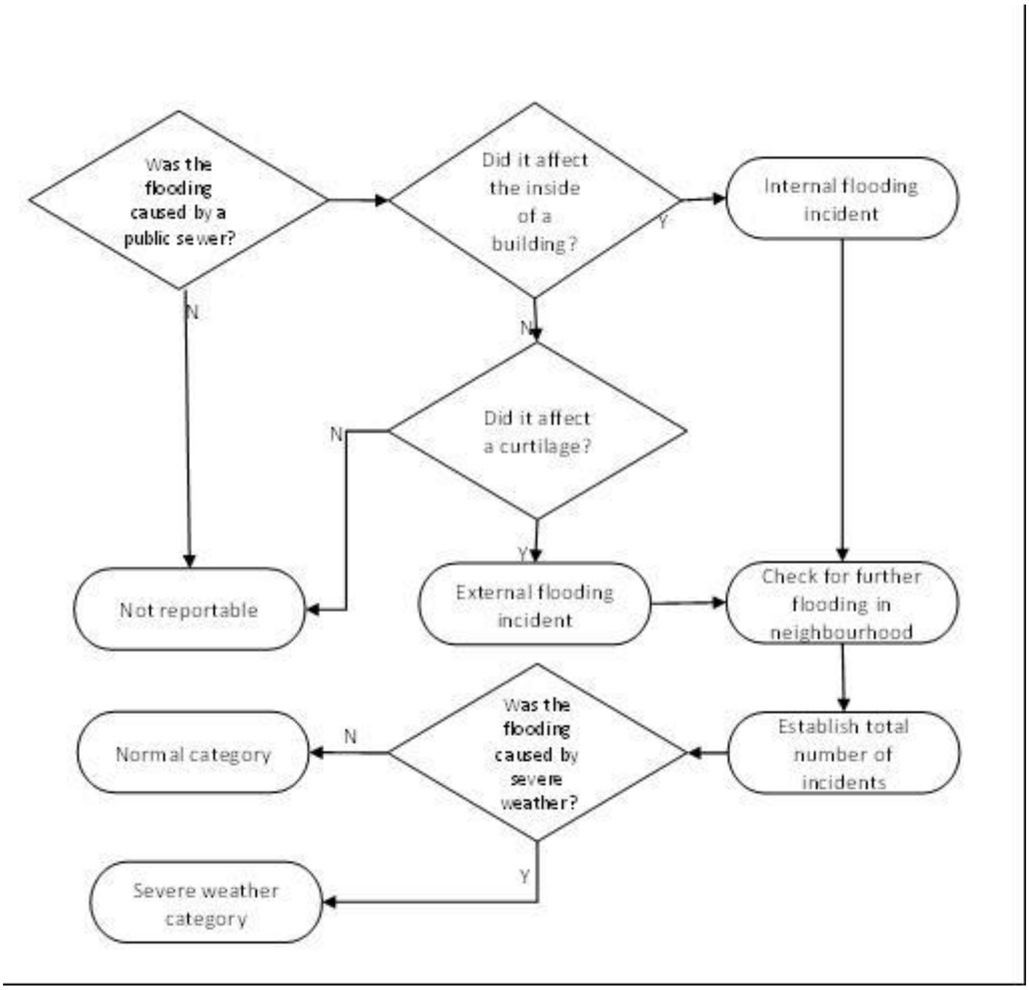
For both measures, companies will report the number of incidents a) including and b) excluding the impact of severe weather, as defined in section 6.

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.

4. Process diagram

The diagram below shows a simplified version of the process.



1. 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 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 and private assets. 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.

2. 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.

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 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.

3. 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); and
- summer houses.

In the case of farms, golf clubs etc.; flooding of the immediate curtilage of the main buildings (gardens, patios etc.) shall be included.

In the case of a flooding event affecting an area in the same ownership, such as an industrial park, retail park, hospital site, university site etc., it shall be counted as one incident.

The following areas shall be excluded from the reported numbers:

- ‘highways’ – including footpaths; and
- ‘public’ open space; agricultural land; car parks.

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

4. 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 investigation or follow on work is complete.

5. 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.

6. 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. 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 necessary.

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.

7. 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.

8. Risk

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

9. 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.

10. Compliance Check List

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

11. References

1. The Water UK "Guide to Transfer of Private Sewers Regulations 2011", published on 30th September 2011

2. The Flood Estimaton Handbook (FEH), published by the Centre for Ecology and Hydrology.

1.8 Pollution incidents (Category 3)

We are proposing to use Category 3 pollution incidents for the PR19 common performance commitment. We are using the Environment Agency's (EA's) definition, including its classification of pollution incidents according to their impact on the environment and people and the level of response needed.

1.8.1 Definition of a pollution incident

An incident is:

- a specific event or occurrence;
- brought to the EA's attention;
- within its areas of responsibility; and
- which may have an environmental and/or operational impact[14].

An incident can either happen in a single location or in multiple locations at the same time or sequentially (such as flooding).

Events are brought to the EA's attention through reports from members of the public, emergency services, local authorities, other regulators, industry, EA staff and other parties.

Incidents within the EA's area of responsibility, that have a potential or actual environmental impact, include reports of:

- environmental harm/pollution of surface waters or groundwater;
- environmental harm to land, air and water from a site, substance or process we regulate;
- impacts on human health or nuisance to the local community from a site, substance or process we regulate;
- major air pollution incidents where we co-ordinate the monitoring and modelling;
- fish kills and illegal fishing;
- damage to nature conservation sites and species from activities we regulate;
- illegal abstraction and low river flows;
- speeding vessels and closure of a navigation fairway;
- flooding or potential causes of flooding; and
- environmental harm from land drainage works.

[14] This is outlined in the EA document, available from the EA on request,: "Incidents and their classification: The Common Incident Classification Scheme"

Environmental harm includes damage to nature conservation sites and species, physical habitats, and fish and the fisheries they support.

The incident does not actually need to result in an environmental impact, as the EA's actions may prevent damage occurring.

Alarms from EA telemetry / automated equipment

An event leading to the generation of an alarm, from EA telemetry or other automatic equipment, is as an incident if the EA needs to deploy non-routine resources to investigate or respond.

This includes automated recordings of high flows and low dissolved oxygen, and operational telemetry alarms indicating flooding or an imminent potential for flooding.

Analytical failures

A retrospective analytical failure is an incident where the investigation reveals an ongoing polluting problem, or there is evidence of an environmental impact. This includes both results from EA sampling and self-reporting from the industry.

For example, bathing water sample exceedances are incidents if the subsequent investigation reveals evidence of an event at an identified source, such as a combined sewer overflow (CSO).

Failing a mandatory directive doesn't automatically mean a Category 1 or 2 incident, but is likely to. The EA will also consider the actual impact on water quality, the status of the water body, and other impact criteria.

Operator ('self') recorded / reported events

A permit, consent, or local agreement, may require an operator to notify the EA of alarms and emissions. Operators may also be required to keep records of any emissions and actions taken to comply with the permit, and submit them to us or make them available for inspection.

These are classified as incidents where the investigation reveals an ongoing polluting problem, or there is evidence of an environmental impact.

Works undertaken to address minor nuisance issues which have not resulted in environmental impact will not normally be incidents. For example, a record of litter outside a site which has been collected or mud on the road which has been cleaned up.

The majority of notifications of emission limit values being exceeded from installations do not have any environmental impact as the permit is based on best available techniques (BAT) or appropriate measures / cost-benefit. Historically, self-notification of breaches of emission limit values by operators results in few incidents.

Breaches of legislation, permit limits, and illegal activity

A permit breach and illegal activity is an incident if it is a specific event that is having, or about to have an environmental impact if some form of immediate preventative action is not taken. For example:

- an unbunded oil tank on a permitted site would not be an incident unless it was leaking and causing or likely to cause pollution; and
- a breach of a flood defence consent would not be an incident unless an environmental impact was actually taking place, or action was required to prevent an imminent impact (see consent infringements).

This applies however observed, whether by EA staff during routine visits, or reports from the public or operator.

Inspections

For non-flood related work, an event observed during a routine visit or inspection is an incident if it is a specific event that is having, or about to have an environmental impact if some form of immediate preventative action is not taken.

Soil damage observed during a farm cross compliance visit is not an incident unless it is having, or immediately about to have, an environmental impact which is within the EA's area of business (such as actual or potential pollution of surface waters or groundwater).

For flood-related work, an event observed during a routine visit or inspection is an incident if it is causing flooding, or non-routine maintenance is required to prevent imminent flooding.

Amenity issues

All complaints about permitted sites are incidents, with each type of amenity issue (such as noise, odour, flies or dust) being a separate incident.

For ongoing incidents of the same type, the first incident will be recorded as normal, and all subsequent incidents will be recorded as duplicates.

Issues with fundamentally different causes will be classified as separate incidents.

Ongoing events

Flooding from severe weather, causing multiple events throughout the duration of the high water, are separate incidents by river catchment. Record by field team area where this involves several small catchments.

Intermittent discharges

Ongoing complaints about intermittent discharges are separate incidents if each one relates to a discrete event. Even if the source is exactly the same, each discrete event will usually constitute a separate incident unless the operator is taking agreed action to resolve a known problem. For example: intermittent discharges from a broken pumping station or sewer when it rains and where the water company has a timely program in place to address are considered as the same incident.

Complaints about an ongoing event of which the EA is already aware (and where the operator is taking action) are separate incidents if the report suggests that the impact may have increased and an inspection is needed.

Bathing Waters Directive: short-term pollution events

The EA’s forecasts of 'short term pollution' (STP) for some bathing waters, in line with the revised bathing waters directive, are not pollution incidents. However, it is possible that a pollution incident could occur and coincide with a forecast of STP. If this happens, the incident will be recorded in the normal manner.

Complaints regarding permitted sites, discharges or emissions

Where an event constitutes an incident (based on the conditions set out in the paragraphs above), the EA will presume any emission or discharge to have an environmental impact. It is responsibility of the operator to prove otherwise.

Reports regarding the EA’s role as competent or responsible authority

All reports about a site or asset where the EA is the competent or responsible authority are incidents if they have the potential to, or are, impacting on people, property or the environment.

1.8.2 Specific information about this metric

Reporting for this metric will be the total number of category 3 (minor or minimal impact) pollution incidents in a calendar year emanating from a discharge or escape of a containment from a sewerage company asset.

Performance will be reported as the number of incidents per 10,000km of sewer.

Category 3 - minimal impact

Pollutants that have entered the water course so have caused an impact but that impact is limited.

Other factors to consider will be downstream receptors, such as sites of special scientific interest (SSSIs), abstractors, how far they are away from the discharge, and the number of reports about the same incident. For spills to land, factors to consider are the presence of a source protection zone (SPZ) or if the water course is being used for amenity (i.e., people in the water, swimming, boating, etc.). The presence of one of these factors may increase the potential impact score. For example:

- discharge of grey water (probably sewage) from a pipe in to a water course. The pollution can be seen a few metres downstream but there is no other impact observed;
- road traffic collision that has released a few 10s of litres of vehicle fluids (fuel, oil, coolant water, etc.) on to the road and into a surface water drain;
- spill of a few litres of oil that has gone in to a surface water drain;
- a thin sheen of oil on a water course. The thin sheen (rainbow effect) may extend a few hundred metres: a small amount of oil will spread out a long way but is still only a small amount; and
- discoloured, soapy, foaming or ‘dirty’ discharge from a pipe. The pollution can only be seen for a few 10s of metres downstream and no other impacts are observed.

1.9 Risk of severe restrictions in a drought

The overall measure will be presented as the percentage of the population the company serves that would experience severe supply restrictions (e.g., standpipes or rota cuts) in a 1 in 200 year drought.

This would be, on a company basis, the number and percentage of population at risk of experiencing severe restrictions (such as standpipes or rota cuts) in a 1 in 200 year drought. The population is considered to be ‘at risk’ if the supply-demand balance for the 1 in 200 year drought event results in a deficit. This will occur when the theoretical deployable output minus outage allowance (available supply) is less than the dry year demand plus base year target headroom (uncertainty).

The data used for this metric should be consistent with that forecast and reported for the water resources management plans (WRMPs) which have their own technical guidance issued by the Environment Agency, Natural Resources Wales and others. The 1 in 200 year drought used as part of this metric should be the same design event as used to provide cost information for the reference level of service (0.5% or 1 in 200) as required by the water resources planning guidelines (in section 3.6 - Reference level of service).

Companies’ forecasts should include the impacts of less severe restrictions (temporary use bans, non-essential use bans) on the supply-demand balance components at a frequency as stated in their WRMP, when calculating this measure.

Companies should report the forecast population at risk (numbers and proportion) for the next 25 years (minimum planning period used in water resources planning) based on the supply demand balance for the 1 in 200 year drought event. If a water resource zone is in a deficit in any year the number of customers in that zone are reported as at risk. All the companies’ zones are then summed together to give a total number of customers at risk in any given interval. The annual proportion of customers at risk is calculated by dividing this by the total number of customers served by the company. The overall measure will use the annual average (over 25 year forecast) proportion of customers at risk.

This will be the total number of customers at risk over the 25 years, divided by the 25 years as a proportion of total customers served.

$$\frac{\sum \text{total customers at risk over 25 years / 25}}{\sum \text{total customers over 25 years / 25}} \times 100$$

It is expected that this initial forecast will show a stable or improving trend over the 25-year period.

Companies will update the 25-year forecast at the end of the 2020-21 to 2024-25 period, to cover the new 25-year period (2025-26 to 2049-50) and report the revised annual average proportion of customers at risk. The difference between the two 25-year forecasts’ performances indicates how well the company has performed. The reward and penalty can then be based on the change in the forecasts of customers at risk.

The revised forecasts should be consistent with data submitted as part of WRMP annual reviews and those being incorporated into WRMP24. The revised forecasts should utilise updated outturn data for deployable output (delivered schemes), outage allowance, demand data components, and target headroom. The assumptions and tools to calculate the supply-demand balance forecasts should remain consistent with the start of AMP forecasts.

A company should be able to improve performance on this metric by reducing its actual outage, reducing its actual demand (e.g., leakage, water efficiency) and increasing its available supplies in a drought (deployable output) that will be of benefit in the 1 in 200 year event, which covers three of the four resilience aspects (redundancy, reliability and resistance). These changes in outturn will feed into the revised forecasts at the end of period allowing the metric performance to be reported.

For target headroom companies should use 95% uncertainty (or equivalent for complex methods) for the first five years of the planning period forecasts and for performance reporting.

Example calculation of risk of severe restrictions in a drought metric

A water resource zone has 100,000 customers

For each year interval in the 25 year planning period the supply-demand balance for the 1 in 200 year drought is as follows:

Deployable output – Outage allowance – Demand – Target headroom

For the example water resources zone this equates to

100 – 10 – 85 – 10 = -5 (5Ml/d deficit in supply-demand balance calculation)

Therefore, for this year, all customers (100,000) in this zone are at risk of severe restrictions in a 1 in 200 year drought.

If the company has two water resource zones and the second WRZ (also with a population of 100,000) has a forecast surplus for this interval year in the planning period, then the number of customers at risk would be 100,000 and the proportion of customers at risk would be 50%.

	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	…	2044-45	Forecast annual average

PR19 forecast customers at risk (nr 000s)	100	100	100	100	100	100	…	100	100
PR19 forecast proportion customers at risk (%)	50	50	50	50	50	50	…	50	50
PR24 forecast customers at risk (nr 000s)	-	-	-	-	-	0	…	0	0
PR24 proportion of customers at risk (%)	-	-	-	-	-	0	…	0	0

In this example the company initially forecasts stable risk for the 25 year period. However, they deliver outperformance in this measure by improving their supply demand balance for a 1 in 200 year drought meaning that less customers are at risk (none) for the next 25 year forecast period.

The data feeding this metric is expected to be consistent with the company's WRMP, which has associated guidance and is reviewed by the EA. We expect the company to provide their own data assurance on the components that contribute to this metric on the basis that it is the company's responsibility to own and assure their own data.

1.10 Wastewater flooding risk

This metric aims to capture the risk of a wastewater company's population experiencing wastewater system flooding. As outlined in the outcomes appendix 2 there are four options (1a, 1b, 2 and 3) for this metric:

1.10.1 Risk of flooding of wastewater systems

There are two options within option 1, both of which have the same first step. However, for ease of presentation we will show the two options separately.

<u>Option 1a</u>

Flooding Metric for wastewater drainage systems		Step 1: Initial Catchment assessment (whole catchment populations)		Step 2: Find residual risk in catchment by assessing resilience activities that have been applied beyond the design / standard operation of the asset, to reduce the impact of flooding	
Impact	**Surface water and sewer flooding**				
Hazard	**Extreme rainfall in excess of 1:30**				
Risk Grade	Catchment characteristics	Population	% Region	Population	% Region
5	The sewer network is the only drainage network in the catchment and the catchment is low lying disharging to a terminal pumping station. The capacity and capability of the pumping station is critical in extreme weather and can be overrun as all flows have to be pumped AND/OR there is a lack of capacity in the trunk sewer network and the pumping station within extreme weather events.	623839	12.83%	50000	1.03%
4	This catchment has a rapid response resulting in high flow routing through the sewer and drainage network AND/OR through one point in the network (such as a terminal pumping station) AND/OR there is a lack of capacity within the sewer network to handle these high peak flows resulting in sewer and surface water flooding and overland flow - there are other drainage pathways through the catchment.	1959000	40.29%	130000	2.67%
3	The catchment is at risk of fluvial or sea inundation with the sewerage assets being overrun by flood waters. The sewer network can no longer operate effectively due to the presence of flood waters. AND/OR Consequence of asset failure as a result of other critical infrastructure AND/OR Risk of asset failure due to transport dependency (access roads). AND/OR catchments that are dependant on HIGH RISK assets such as sewers and rising mains under/over rivers, railways and motorways or catchments with complicated drainage arrangements such as multiple flow	1859409	38.24%	180000	3.70%
2	Large complex networks with many dependencies and high urban density. HIGH RISK for urban creep and legacy misconnections of surface water resulting in a storm response. High urban growth. Assets may be in vulnerable areas(under railways) and HIGH risk of vandalism/theft. Catchment may also be subject of HIGH RISK of ground water ingress through proximity to water table. HIGH RISK of illegal (or out of consent) trade discharge of a substance/material that could affect sewage system/treatment operation.	144887	2.98%	40000	0.82%
1	Small simple networks with low urban density. Low potential for urban creep and legacy misconnections of surface water. Low growth levels.AND/OR Catchment has slow response and may be flat (risks of septicity).	275706	5.67%	20000	0.41%
Total population		4862841		420000	

Step 1: Assign a level of risk (1 to 5) to the catchment in question using the table. In some ways this is a measure of vulnerability of the catchment as well as likelihood of the flood since it takes into account capacity in peak flows and geographical location. The population size gives a measure of the consequence of failure.

Step 2: Calculate the residual population at risk in each catchment to rainfall with a return period of 1 in 50 years.

Factors such as new development, impermeable paving of land and population growth would act to increase risk. Companies' actions to remove surface water/ground water ingress from sewers or to increase sewer capacity would act to reduce risk. We would expect companies to show a stable or improving trend over the five year period.

Please note that Option 1a is not a fully completed metric. Guidelines are needed to ensure companies complete the spreadsheet and steps consistently. In particular some more work is needed to:

- characterise catchments - this should include clarity on definitions and risk assessment methodologies; and
- standardise the approach to calculating residual population at risk.

Option 1b

Example flooding metric catchment consequence table

Flooding Metric for wastewater drainage systems		Step 1: Initial Catchment assessment - what rainfall return period to apply to drainage capacity model
Impact	**Surface water and sewer flooding**	
Hazard	**Extreme rainfall**	
Risk Grade	Catchment characteristics	Design storm to use
5	The sewer network is the only drainage network in the catchment and the catchment is low lying disharging to a terminal pumping station. The capacity and capability of the pumping station is critical in extreme weather and can be overrun as all flows have to be pumped AND/OR there is a lack of capacity in the trunk sewer network and the pumping station within extreme weather events.	1 in 50
4	This catchment has a rapid response resulting in high flow routing through the sewer and drainage network AND/OR through one point in the network (such as a terminal pumping station) AND/OR there is a lack of capacity within the sewer network to handle these high peak flows resulting in sewer and surface water flooding and overland flow - there are other drainage pathways through the catchment.	1 in 30
3	The catchment is at risk of fluvial or sea inundation with the sewerage assets being overrun by flood waters. The sewer network can no longer operate effectively due to the presence of flood waters. AND/OR Consequence of asset failure as a result of other critical infrastructure AND/OR Risk of asset failure due to transport dependency (access roads). AND/OR catchments that are dependant on HIGH RISK assets such as sewers and rising mains under/over rivers, railways and motorways or catchments with complicated drainage arrangements such as multiple flow	1 in 20
2	Large complex networks with many dependencies and high urban density. HIGH RISK for urban creep and legacy misconnections of surface water resulting in a storm response. High urban growth. Assets may be in vulnerable areas(under railways) and HIGH risk of vandalism/theft. Catchment may also be subject of HIGH RISK of ground water ingress through proximity to water table. HIGH RISK of illegal (or out of consent) trade discharge of a substance/material that could affect sewage system/treatment operation.	1 in 20
1	Small simple networks with low urban density. Low potential for urban creep and legacy misconnections of surface water. Low growth levels.AND/OR Catchment has slow response and may be flat (risks of septicity).	1 in 10 if applicable

Step 1: Assign a risk grade (1 to 5) to the catchment in question using the table (the same table as for Option 1a).

Step 2: Use the risk grade from the table to dictate the rainfall return period that should be used as an input into the drainage capacity model for the assets in the catchment. Companies can include catchments in the lowest risk category, but this is not mandatory for practical reasons due to lower need to prioritise getting data for low risk catchments. It should either include all level 1 catchments or exclude all level 1 catchments for all years.

The risk categorisation is a high level way to consider the potential consequences of flooding in a catchment. The methodology proposed does not consider flooding at a property level, but that sewers may discharge in heavy rainfall. In a high risk catchment, such as that in which the city of Hull resides, the consequences of flooding are severe. It is proportionate that the system has a high level of flood protection. For rural catchments, while flooding is undesirable, if flooding does not impact properties either internally or externally, it is proportionate for these catchments to have a lower level of flood protection.

Step 3: This step is an adaptation of the drainage capacity model[15] [16] enhanced method outlined in workstream 2 (WS2) of the 21st Century Drainage programme (21st CDP).

For each catchment follow the methodology described, but only use the design storm for the catchment determined in step 1. A variety of durations must be used to determine the critical storm. For each catchment determine the pipes that surcharge in the critical storm. For all pipes in a catchment that surcharge weight results using population equivalent.

$$\frac{\text{Population equivalent upstream of all pipes that surcharge x 100}}{\text{Population equivalent upstream of all pipes}}$$

Where there is no data, and the risk grade of the catchment is 2 to 5, the pipes in that catchment should be assumed to surcharge. This will highlight where companies do not have good models or data.

We would expect assurance to be provided by the companies, including of forecasts, if we use the future performance model.

[15] http://www.water.org.uk/policy/improving-resilience/21st-century-drainage in particular guidance document in https://dl.dropboxusercontent.com/u/299993612/Policy/21CD/WS2/WS2-RT006-Guidance-R2.0.pdf

[16] Chartered institute of water and environment management (CIWEM) urban drainage group has a code of practice for sewer hydraulic modelling Code of Practice for the Hydraulic Modelling of Sewer Systems. We would expect all companies to follow this code of practice. This is currently being updated.

There are further options. We could dispense with step 1 and only complete step 2 using the rainfall return period of 1 in 50 years, a storm only likely to occur once in 50 years. However, this would not differentiate the consequences that lack of capacity in the sewerage system can have on different catchments and the implications for operational resilience.

We could also use the methodology proposed by work stream 2 of the 21st Century Drainage Programme and consider the proportion of pipes that this methodology highlights as “red” using enhanced models, weighted by the population equivalent upstream of each pipe. Again this methodology does not take into account the potential consequences of flooding in different catchments and uses a relatively low standard to determine the red rating – a surcharge return period of 2 years or less.

1.10.2 Option 2: vulnerability of combined sewer overflows (CSOs) to rainfall

This metric would measure the frequency of combined sewer overflows.

There will be event duration monitors on the vast majority of CSOs by 2020. Depending on the sensitivity of the water course it spills into, the CSO will be monitored either every 2 or 15 minutes. Currently the expectation is for companies to report annually on spill frequency and duration to the Environment Agency.

Spill frequency and duration can give an indication of the performance of assets, for example, increases in spill frequency could indicate the catchment needs to be managed better by using more sustainable drainage, or building additional capacity in the system.

This metric would require companies to monitor their overflow frequency[17] in separate categories for the 2 / 15 minute measurements. This would be for all CSOs in place and returning data by April 2020.

The CSOs would then be categorised into High, Medium or Low spill frequency:

Vulnerability of CSO / Frequency spill / year	Number of CSOs
High (>40)	X
Medium (>20 but <40)	Y
Low (<20)	Z

[17] At this early stage the measure would not use duration as well as frequency to calculate a volume.

$$\frac{\text{Number of high frequency spilling CSOs} \times 100}{\text{Number of all measured CSOs}}$$

The proposal here is for a metric of high frequency spills. The metric could use catchment area or the upstream population equivalent.

CSO event duration monitoring is in early stages of development. Performance on the metric would be assessed as performance in 2025 relative to that on the same CSOs in 2020.

There would be no exceptions to excluding data from this metric. However, companies could set their performance commitment levels taking into account the storm overflow assessment which all companies must do for each CSO that has over 40 spills. The storm overflow assessment looks at the costs and benefits[18] of interventions to reduce spills. If an overflow passes through this process and is found to be non-cost beneficial to reduce spill frequency then it is removed from that, and the next, reporting round.

This metric is a lagging indicator but can assess vulnerability of the wastewater system as high frequency of overflows would likely indicate reduced resilience of systems to rainfall. As the 21st CDP Workstream 2 process further develops modelling for CSOs, a leading indicator similar to how the model for pipes in Option 1b works could be developed looking at future spilling risk and flood / surcharge return periods.

1.10.3 Option 3: reduction in surface water in combined sewers, by looking at the size of the area disconnected from combined sewers by retrofitting sustainable drainage

This metric looks at the size of the area disconnected from combined sewers by retrofitting sustainable drainage systems. The size (measured in hectares, for example) of a local impermeable area that would normally contribute to surface water run-off into a combined sewer that is disconnected from the combined sewers by fitting sustainable drainage measures. These measures are, for example, water butts, permeable paving, rain gardens and green rooves. Thames Water's performance commitment SB5 from PR14 is an example of a metric of this type.

[18] best technical knowledge not entailing excessive costs (BTKNEEC)

1.11 Common asset health measure 1: mains bursts per 1,000 km

Our definition for mains bursts per 1,000km comes from JR11 Reporting requirements Issue 1.1 - March 2011, June Returns 2011, chapter 11 line 12.

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). Include ferrule failures that are attributable to mains material condition or local ground movements, but not incidents of ferrule failure due to ferrule materials or poor workmanship, or associated with the communication pipe connection.

Exclude maintenance work on valve packings, hydrant seals, air valves etc. For the avoidance of doubt, all leakage occurring at locations or through joint or material failures which would have been designed for the life of the main (irrespective of whether earlier failure occurs) should be regarded as mains bursts. Failure of consumable or maintainable items (valve packings, etc.) should be excluded. Exclude valve, hydrant, washout and air valve replacements.

Include incidents of 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.

All third party damage should be excluded where costs are potentially (rather than actually) recovered from a third party.

1.12 Common asset health measure 2: unplanned outage

This is a measure of asset outage (primarily non-infrastructure – above ground assets), for water abstraction and water treatment activities, in terms of the average unavailable flow (based on 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.

Unplanned outage for this measure is a temporary loss of maximum 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 closely matches 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 maximum production capacity. We prefer the use of maximum production capacity rather than deployable output due to it being a fixed value that should be more readily known within company operations (rather than the variable and specialist use of deployable output). It also captures more asset health type events without any further threshold trigger requirements (e.g. impact on zonal deployable output) and will be easier to explain to customers. This definition of unplanned outage makes use of UKWIR outage allowance for water resource planning, 1995.

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 of first abstraction and 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
- 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).

Water resource availability based on quantity is not included in unplanned outage reporting. Supply availability due to overall quantity (dry weather) is related to baseline deployable output which is considered elsewhere as part of water resource planning. The assumption here for outage reporting is that there is enough water available (in terms of quantity) when it is required (which is likely the case under normal weather conditions). However, this does not apply to production capacity (quantity) being unavailable due to unplanned reservoir works such as unplanned drawdowns for maintenance. As shown in the above list this also does not apply to water quality – where poor raw water quality limits the maximum production capacity this should be reported in the outage calculation.

An unplanned outage may or may not have an actual impact on the resource zone or its customers. If an outage occurs during a period of low demand and resources are relatively plentiful it is unlikely that the individual outage will cause a supply-shortfall. It does increase the risk of a customer interruption (by reducing redundancy) and highlights asset health concerns. This would still be recorded as an unplanned outage.

An unplanned outage is considered to be temporary as it is the loss in maximum production capacity that can be recovered (e.g., repairing a failed asset). This temporary loss in production capacity may be for a few hours or up to three months. In general any longer than three months then the loss should be reflected in baseline maximum production capacity (thus contributing to the deployable output assessment for water resources planning). If there is a temporary loss which has taken over three months then its inclusion should be justified appropriately and included in the unplanned outage measure and WRMP (deployable output) outage reporting for consistency. For this measure the minimum length of an outage that should be reported is one day. Some companies report outages at a more granular sub-daily level and can continue to do so. Where sub-daily outages are reported in WRMP data this should be consistent with this measure.

The maximum production capacity is a fixed value and therefore does not vary based on planning assumptions (such as weather). The maximum production capacity may not be what the works output is on the day of the outage or what it is required to produce that day. Whether or not the capacity is needed, the reduction from maximum capacity should be recorded and reported as unplanned 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).

Unplanned outage – calculation example

For a single source works:

- A source works has a maximum 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 maximum capacity of 15 Ml/d for 15 days
- The weighted outage for this source = 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 maximum 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 maximum production capacity = 120 Ml/d
- Unplanned outage proportion = 12.4%

Although this unplanned outage definition is different to that reported for the annual WRMP review, in many cases the outage as measured in terms of lost deployable output will be the same or very close to that of production capacity. It will be expected that actual outage trends reported for the WRMP review should closely match those for this measure using maximum production capacity.

1.13 Common asset health measure 3: sewer collapses per 1,000 km

Our definition for sewer collapses comes from JR11 Reporting requirements Issue 1.1 - March 2011, June Returns 2011, chapter 16, line 12.

Number of sewer collapses per thousand kilometres of all sewers. Include bursts to rising mains, even where failures are accidental rather than due to weakness in pipe condition. All third party damage should be excluded where costs are potentially (rather than actually) recovered from a third party.

1.14 Common asset health measure 4: pollution incidents caused by non-infrastructure (above ground) assets

The number of pollution incidents (categories 3 and 4 as classified by the Environment Agency) should be filtered by their cause following any root-cause analysis undertaken for lessons learned and reporting purposes. Those incidents (3 and 4) that were caused by non-infrastructure assets, namely those associated with sewage treatment works, storm tanks and sewage pumping stations (including rising mains) should be included in this asset health measure.

The asset cause of pollution incidents could include, asset failure, functional deterioration, being inoperable at the time they are required, and telemetry/meter failure. It is the responsibility of companies to categorise these events clearly and consistently. The data assurance should be consistent with that for reporting other measures with company ownership of data and processes but should also show data consistency with any EA data reporting.

This will be reported as a number of pollution incidents per volume of wastewater discharge permits (number/m^3/day).

2. Definitions for asset health long list

2.1 Water indicators

The following indicators are historic serviceability indicators proposed for the asset health long list from which companies can select and report on.

2.1.1 Properties at risk of receiving low pressure

This measure is the same as the former DG2 serviceability indicator. Any reference to DG2 in this definition is to aid familiarity and to reinforce that the indicator has not changed from that used in the former June Returns for DG2.

The aim of this indicator is to identify the number of properties that have received, and are likely to continue to receive, pressure below the reference level when demand is not abnormal.

The total number of properties in the undertaker's area of water supply which, at the end of the year, have received, and are likely to continue to receive, a pressure or flow below the reference level.

To ensure consistency of information reported by companies the following regularly used terms are defined below:

Reference level: The reference level of service is a flow of 9l/min at a pressure of 10m head on the customer's side of the main stop tap (mst). The reference level applies to a single property.

The reference level of service must be applied on the customer's side of a meter or any other company fittings that are on the customer's side of the main stop tap.

Where a common service pipe serves more than one property, the flow assumed in the reference level must be appropriately increased to take account of the total number of properties served.

For two properties, a flow of 18l/min at a pressure of 10m head on the customers' side of the mst is appropriate. For three or more properties the appropriate flow should be calculated from the standard loadings provided in BS6700 or Institute of Plumbing handbook. See below for a tabulation of minimum mains pressures for the reporting of low pressures on common services.

Surrogate for the reference level: Because of the difficulty in measuring pressure and flow at the mst, companies may measure against a surrogate reference level. Companies should use a surrogate of 15m head in the adjacent distribution main unless a different level can be shown to be suitable. In some circumstances companies may need to use a surrogate pressure greater than 15m to ensure that the reference level is supplied at the customer's side of the mst (for example in areas with small diameter or shared communication pipes).

Common supplies: Common supplies are where a communication pipe supplies more than one property. The required pressure in the adjacent water main used to estimate properties affected should exceed those given in the table in the guidance section. This table is intended to be a guide to the absolute minimum service acceptable over an hour (i.e. it is not based on an instantaneous peak flow). The calculations assume delivery of 9 l/minute upstairs to a combination tank (not in the loft) in the end property on a common service of half-inch bore. The calculations use the BS 6700 loading units (LU) basis, but at 3 LUs per property (9 l/minute). The LU calculations on larger groups of properties (i.e. more than 100) give instantaneous flows of between 4 and 8 times the peak hour flow rates actually observed on local distribution systems, subject to leakage and hose pipe assumptions. Accordingly, the use of 3 LUs per property is taken as an acceptable minimum.

Allowable exclusions: There are a number of circumstances under which properties identified as receiving low pressure should be excluded from the reported figure. The aim of these exclusions is to exclude properties which receive a low pressure as a result of a one-off event and which, under normal circumstances (including normal peaks in demand), will not receive pressure or flow below the reference level. For exclusions see the guidance section.

Guidance

Surrogate for the reference level: Where companies choose to report against a surrogate pressure of less than 15m, evidence must be provided that this is sufficient to provide the reference level of service for all properties taking into account the length and condition of communication pipes and head loss through any meters or other company fittings. We expect all assumptions to be in the methodology. A surrogate pressure which will only provide the reference level for average properties (i.e. for average length communication pipes in good condition with no meter fitted) is not appropriate because some properties will have communication pipes longer than average; others will be in a poor condition or have meters fitted. Allowance must be made in such instances.

If a higher surrogate is used, the assumptions should be clearly stated in the methodology.

Headline figure: This is an estimate of the total number of properties in the company's area that are below the reference level. Therefore, if the reported figure is likely to represent an underestimate (or overestimate), this must be reflected in the assessment of the reliability and accuracy of the reported information.

In practice, companies will report the number of properties served by a main in which the measured pressure falls below the surrogate for the reference level (usually 15m head in the adjacent distribution main) subject to the allowable exclusions.

Estimated figures: Companies may include in their reported figures estimates for the number of properties which are below the reference level but which have not yet been specifically identified. The basis for the estimate must be explained in the methodology.

Allowable exclusions: Companies must maintain verifiable, auditable records of all the exclusions that they apply in order to confirm the accuracy and validity of their information.

All properties identified as having received pressure or flow below the reference level must be reported, unless it can be confirmed that they are covered by one of the following exclusions.

Abnormal demand

This exclusion is intended to cover abnormal peaks in demand and not the daily, weekly or monthly peaks in demand which are normally expected.

Some companies are more affected by low pressures caused by occasional prolonged peaks in demand than by a few abnormal peak days each year. In such cases, instead of excluding up to five days each year, companies may choose to apply the abnormal demand exclusion over a five-year period. This will allow companies to exclude from their figures properties affected by low pressures that occur on any 25 days in a rolling five-year period.

The 'excluded day' may be applied to the company as a whole or at the level of individual zones. However, in either case, once a property has suffered low pressures on either more than five days in one year or 25 days in five years, it must be added to the reported figures.

Option 1 - During the report year, companies may exclude for each property a maximum of 25 days of low pressure caused by abnormal demand in a rolling five-year period. Companies should exclude from the reported figures properties that are affected by low pressure only on the days identified as "high demand" in the report year. In years where demand is normal (i.e. the exclusion is not being used), properties affected by relevant low pressure incidents should be reported as receiving low pressure (unless covered by one of the other exclusions).

Option 2 - Where extensive pressure logging covering the majority of properties in the supply area is used, the company may exclude properties where logger records verify that up to five incidents of low pressure lasting more than one hour have occurred. Under this option, it is not necessary to match the low pressure incidents with high demands. Companies that choose this method must include the number of properties that suffer more than five incidents of low pressure lasting more than one hour in the reported figure without necessarily identifying the specific occasions and reasons for abnormal demand. If this method is used, no other allowance may be made for abnormal demand but the other exclusions still apply.

Companies must clearly state in their methodologies which approach they have adopted in applying this exclusion, list the distribution or supply zones they have chosen and the number of days excluded. If the exclusion is applied at the level of individual zones, rather than to the company as a whole, the company must maintain verifiable records which list the number of 'excluded days' used for each distribution zone each year.

Planned maintenance

Companies should not report low pressures caused by planned maintenance. It is not intended that companies identify the number of properties affected in each instance. However, companies must maintain sufficiently accurate records to verify that low pressure incidents that are excluded because of planned maintenance are actually caused by maintenance.

One-off incidents

This exclusion covers a number of causes of low pressure:

- mains bursts;
- failures of company equipment (such as Pressure Reducing Valves or booster pumps);
- firefighting; and
- action by a third party.

If problems of this type affect a property frequently, they cannot be classed as one-off events and further investigation will be required before they can be excluded.

Low pressure incidents of short duration

Properties affected by low pressures which only occur for a short period, and for which there is evidence that incidents of a longer duration would not occur during the course of the year, may be excluded from the reported figures.

- In locations where companies carry out continuous pressure logging year round, low pressure incidents of less than one hour may be excluded.
- Where short term or intermittent logging is used, if all low pressure incidents lasting less than one hour are excluded then there is a danger that properties which are actually below the reference level will be missed from the figures. In this case a suitable minimum duration depends on the exact methodology used but may be 30 or even 15 minutes. If logging is carried out at times when low pressures are unlikely to be detected because demand is low, the results cannot be used to confirm zero returns.

Common services

Companies should establish the numbers of properties supplied via common services from sample investigation of the distribution system. Many instances of low pressure in these situations are presently unreported. Not all of these properties have either loft tank storage or any water supply upstairs.

Companies are required to record the numbers of properties on common services that have received and continue to receive pressures below the reference level, and include these in the reported numbers.

Companies may use their own calculations, but the required pressure in the adjacent water main used to estimate properties affected should exceed those given in the table below. This table is intended to be a guide to the absolute minimum service acceptable over an hour (i.e. it is not based on an instantaneous peak flow). The calculations assume delivery of 9 l/minute upstairs to a combination tank (not in the loft) in the end property on a common service of half-inch bore. The calculations use the BS 6700 loading units (LU) basis, but at 3LUs per property (9 l/minute). The LU calculations on larger groups of properties (i.e. more than 100) give instantaneous flows of between 4 and 8 times the peak hour flow rates actually observed on local distribution systems, subject to leakage and hose pipe assumptions. Accordingly, the use of 3LUs per property is taken as an acceptable minimum.

Number of properties fed from one direction on common service	Pressure (in head) required in adjacent main			
	Half-inch communication pipe		Three quarter-inch communication pipe	
	Short side[19]	Long side	Short side	Long side
2*	10	11	10	11
3	12	14	11	13
4	15	18	13	16
5	19	23	16	20
6	25	29	21	24
7	30	35	25	28
8	37	42	31	33
9	45	51	38	40
10	54	61	46	48

Note: if delivery to a loft tank is taken to be the minimum acceptable service, not less than 3 m pressure should be added to the above tabulated values.

The values calculated for two properties are theoretical: for delivery to a loft, the usual surrogate of 15 m head to a single property should be taken as a minimum reference level.

The section on the reference level refers to the need for companies to use a higher flow rate in the reference level for common services and sets out the criteria for determining appropriate flows in these circumstances.

These criteria are not intended to extend the company's responsibility to solving problems caused by deficiencies in customers' pipes. Its aim is to ensure that there is a proper recognition of pressure and flow problems which affect properties sharing common services, where there is a deficiency in the part of the apparatus which is the company's responsibility (e.g. an undersized communication pipe which is unable to provide sufficient flow).

Properties with the common service pipes can be split into four categories:

- company’s and customer’s apparatus are adequate:
    - no problems with pressure or flow, nothing to report;
- company’s apparatus adequate, but customer’s pipework is deficient:

[19] Short side and long side refer to the length of supply pipes from properties to water mains which are usually not laid down the middle of a road.

  - pressure and/or flow problems are not reportable because company pipes are able to provide sufficient pressure and flow to the limit of company responsibility;
- company's apparatus is inadequate but customer's pipework is adequate:
  - pressure and/or flow problems which are reportable because there is a deficiency in the company's apparatus;
- both the company's and the customer's apparatus are inadequate:
  - pressure and/or flow problems are reportable.

Of these four categories, only the last two fall within the definition of properties at risk of receiving low pressure.

Ofwat recognises that in cases covered by the final category it may not always be sensible for the company to take unilateral action to solve the problem unless the customer takes some action to improve their own pipework. Nevertheless, these problems must be included in the reported figure. If significant, companies should note the number of properties which are below the reference level but the company cannot solve because there are also defects in the customer's part of the system.

Company methodologies should discuss how common service problems are identified and assessed and include reference to standard loadings.

2.1.2 Customer contacts per 1,000 population supplied – discolouration (orange/brown/black)

Customer contact rate per 1,000 population supplied for discolouration (orange/brown/black) as reported in the Chief Inspector's Report on Drinking Water on a calendar year basis. This is the same measure as reported for the former serviceability matrix, however, the continuity of this indicator depends on the DWI's policy on keeping this indicator for future reporting.

2.1.3 Distribution index TIM

The arithmetic mean of the mean zonal compliance values for the three parameters turbidity, iron and manganese. Item 9, 3 and 4 of Part II in Table B of Schedule 1 of the Water Supply (Water Quality) Regulations 2016. This is the same measure as reported in the Chief Inspector's Report on Drinking Water on a calendar year basis.

This is also the same measure as reported for the former serviceability matrix, however, the continuity of this indicator depends on the DWI's policy on keeping this indicator for future reporting.

2.1.4 Water treatment works coliform non-compliance (% samples failing for coliforms leaving WTW)

The number of water treatment works with determinations containing coliforms as a percentage of the number of determinations of water leaving treatment works taken at frequencies required by regulation 13 (Schedule 3, table 3, item 2), as specified in regulation 4 (schedule 1, table A, part II, item 1) of the 'Water Supply (Water Quality) Regulations 2016' (and its equivalent in Wales). This is the same measure reported in the Chief Inspector's Report on Drinking Water on a calendar year basis.

2.1.5 Service reservoir coliform non-compliance (% service reservoirs having more than 5% of coliform samples failing)

The number of service reservoirs where more than 5% of the samples taken exceeded the maximum concentration required for coliform bacteria as a percentage of the number of service reservoirs tested for microbiological parameters. As stated for Item 1 of Part II in Table A of Schedule 1 of the Water Supply (Water Quality) Regulations 2016. This is the same measure reported in the Chief Inspector's Report on Drinking Water on a calendar year basis.

2.1.6 Number of water treatment works where turbidity 95th percentile is greater than or equal to 0.5 NTU

The number of operational potable water treatment works and sources (where measured) whose turbidity 95th percentile equals or exceeds a 0.5 NTU (Nephelometric Turbidity Units) threshold. Calculate 95th percentile value using all data from regular routine sampling of final water from sources for the calendar year.

2.1.7 Enforcement actions considered for microbiological standards

The number of enforcement actions considered by the DWI for a breach of microbiological standards during the calendar year.

2.1.8 Unplanned non-infrastructure maintenance (water)

Unplanned maintenance required as a result of equipment failure or reduced asset performance.

Unplanned maintenance is a company specific indicator and should closely align with the metrics used by the company to measure the ongoing state of its mechanical, electrical and instrumentation and control equipment.

The counting procedures should focus on capturing relevant data from the company's maintenance systems at a level of granularity and materiality for this purpose. A rising trend in the indicator will indicate deterioration, a reducing trend will indicate improvement, and a stable trend will indicate stability, for an unchanging size of asset base. The data should be held at one or more levels of aggregation, to inform the distribution of numbers among different asset types, e.g., pumping and treatment.

The data collected should be a count of all the unplanned jobs completed (with a completed work order). It should not be a count of investigations where nothing was done, or minor jobs carried out as a result of an inspection which are not recorded as a work order.

The data should include all water non-infrastructure assets, including: water treatment works, pumping stations (on the network), and any other non-infrastructure asset. The data must also include all planned-reactive jobs, that is, anything strategically planned for reactive maintenance, i.e., 'run to fail' assets, etc.

Unplanned maintenance on all assets should be included in the data regardless of asset criticality, this ensures the entire asset base is captured. Reported as total unplanned non-infrastructure maintenance jobs as a proportion of all non-infrastructure assets

2.2 Wastewater indicators

2.2.1 Pollution incidents categories 1 and 2

This is the Environment Agency's measure of Category 1 and 2 pollution incidents. We have set out the definition of a pollution incident under section 1.8 above. This section look at the definition of Category 1 and 2.

The Environment Agency's categorisation of pollution incidents describes incidents of major, persistent, extensive or serious impact or damage to air, land, water, people, property, ecosystems, habitats and / or amenity as category 1, and pollution incidents of significant impact or effect on environment, people or property as category 2. It should be noted that this includes pollution incidents from all asset types.

Category 1 - major effect on water quality

Pollutants that have a visible or measureable effect for a longer distance downstream (several kilometres) and that will have an impact on the quality or use of that water.

Other factors to consider will be downstream receptors and how far they are away from the discharge, the number of reports about the same incident, the presence of an abstraction point or conservation designation (e.g., sites of special scientific interest, SSSIs), for spills to land the presence of a source protection zone (SPZ), or if the water course is being used for amenity (i.e., people in the water, swimming, boating, etc.). The presence of one of these factors may increase the potential impact score.

Category 1 incidents will very likely cause impacts on wildlife, and may be associated with dead or dying fish. For example:

- a thick film of oil extending several kilometres downstream and possibly covering the whole water course width;
- a discharge of discoloured, soapy, foaming or 'dirty' water from a pipe. The pollution can be seen for 600 plus metres downstream and will be visible across the whole width of the watercourse;
- a failure of a large rising main sewer that is discharging directly into a watercourse or surface water drain and cannot be shut down;
- a road traffic collision that has released thousands of litres of vehicle fluids (fuel, oil, coolant water, etc.) on to the road and into a surface water drain;
- a road traffic collision involving a HGV that has lost containment of its load (liquid) resulting in a few hundreds of litres entering the surface water drainage;
- a highly discoloured watercourse, where the effect is observable over the full width of the watercourse and for over 800 metres;
- firefighting activities resulting in large amounts of runoff entering a watercourse or surface water drainage. This will normally be a fire with more than 10 fire engines (pumps, tenders or appliances) in use. This includes waste fires;
- any report of a Control of Major Accident Hazards (COMAH) incident should be a potential category 1 incident; and
- large volume spills (more than 1,000 litres) of food stuffs, such as milk, fruit juices, beer, sugar/syrup, etc.

Category 2 - significant effect on water quality

Pollutants that have a visible effect or a measureable effect (this would be identified by field measurements for substances like ammonia, dissolved oxygen, pH, etc.) for a longer distance downstream (several hundred metres or a few kilometres) and that will have an impact on the quality or use of that water.

Other factors to consider will be downstream receptors and how far they are away from the discharge, the number of reports about the same incident, for spills to land the presence of an SPZ, or if the water course is being used for amenity (i.e., people in the water, swimming, boating, etc.). The presence of one of these factors may increase the potential impact score.

Category 2 incidents will often cause impacts on wildlife, and may be associated with dead or dying fish. For example:

- a thick film of oil extending several hundred metres downstream and possibly covering the whole water course width;
- a discharge of discoloured, soapy, foaming or 'dirty' water from a pipe. The pollution can be seen for at least 100 to 600 metres downstream and may visible across the whole width of the watercourse;
- a failure of a rising main sewer that is discharging directly into a watercourse or surface water drain;
- a road traffic collision that has released a few 100s of litres of vehicle fluids (fuel, oil, coolant water, etc.) on to the road and into a surface water drain;
- a road traffic collision involving an LGV that has lost containment of its load (liquid) resulting in 200 to 600 litres entering the surface water drainage system;
- a highly discoloured watercourse, where the effect is observable over the full width of the watercourse and for 400 to 800 metres;
- firefighting activities resulting in large amounts of runoff entering a watercourse or surface water drainage. This will normally be a fire with more than five fire engines (pumps, tenders or appliances) or a high volume pump; this includes waste fires; and
- large volume spills (more than 205 litre standard barrel size) of food stuffs, such as milk, fruit juices, beer, sugar/syrup, etc.

2.2.2 Pollution incidents category 4

This measure is to highlight the number of pollution incidents with little or no impact on the environment and people (category 4) caused by the company-owned assets or operations during the calendar year. It should be noted that this includes pollution incidents from all asset types.

Category 4 - no impact

Incidents that fall within the definition of an incident but do not have an impact on the environment. For example:

- a spill on a site that is contained within the boundary of the site by designed infrastructure like bunding or sealable site drainage, or it may be simply that the land around the site contains the spill or it is contained by spill kits;
- a farmer who has spilt some slurry but digs a containment ditch or bank to contain the spill; and
- a fire where the runoff water is going into only the foul water drain (the local water company should be notified).

2.2.3 Sewer blockages

Number of sewer blockage events that required clearing. A blockage is an obstruction in a sewer which causes a reportable problem (not caused by hydraulic overload), such as flooding or discharge to a watercourse, unusable sanitation, surcharged sewers or odour.

2.2.4 External sewer flooding

The definition of external sewer flooding we are proposing is identical to the one published on UKWIR's website. The UKWIR definition is set out in section 1.7 as it combines internal and external sewer flooding.

2.2.5 Percentage of sewage treatment works discharges failing numeric consents

The percentage of sewage treatment works discharges with numerical discharge consents found to be non-compliant with sanitary or non-sanitary consent conditions in the calendar year. Include both those failing Water Resources Act 1991 (WRA91) consents and Urban Waste Water Treatment Directive (UWWTD) self-monitored consents. This compliance assessment is undertaken by the Environment Agency on a calendar year basis.

2.2.6 Percentage of total population equivalent served by sewage treatment works in breach of WRA or UWWTD consent (LUT)

The percentage of population equivalent served by sewage treatment works discharges which were sampled during the calendar year and found to be non-compliant with look-up table consents conditions in the Water Resource Act look-up table consent conditions, or non-compliant with Urban Wastewater Treatment Directive look-up table consents for biochemical oxygen demand (BOD) and / or phosphorus (P). This compliance assessment is undertaken by the Environment Agency on a calendar year basis.

2.2.7 Unplanned non-infrastructure maintenance (wastewater)

Unplanned maintenance required as a result of equipment failure or reduced asset performance.

Unplanned maintenance is a company-specific indicator and should closely align with the metrics used by the company to measure the ongoing state of its mechanical, electrical, and instrumentation and control equipment.

The counting procedures should focus on capturing relevant data from the company's maintenance systems at a level of granularity and materiality for this purpose. A rising trend in the indicator will indicate deterioration, a reducing trend will indicate improvement, and a stable trend will indicate stability, for a constant size of asset base. The data should be held at one or more levels of aggregation, to inform the distribution of numbers among different asset types, e.g., pumping and treatment.

The data collected should be a count of all the unplanned jobs completed (a completed work order). It should not be a count of investigations where nothing was done, or minor jobs carried out as a result of an inspection which are not recorded as a work order.

The data should include all wastewater non-infrastructure assets, including sewage treatment works, pumping stations (on the network), and any other non-infrastructure asset. The data must also include all planned-reactive jobs, that is, anything strategically planned for reactive maintenance, i.e., 'run to fail' assets, etc.

Unplanned maintenance on all assets should be included in the data regardless of asset criticality as this ensures the entire asset base is captured.