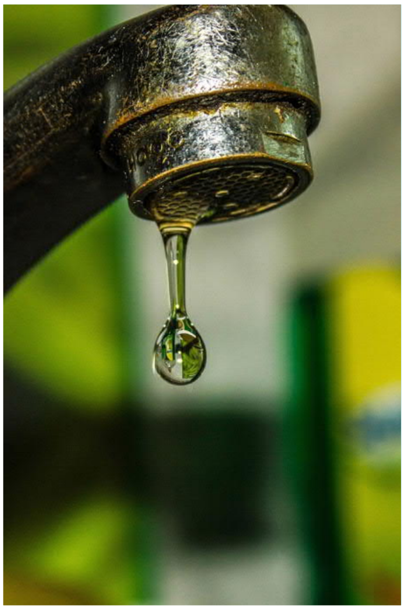

Method Statement: Outage

Version 2

July 2021

Title	Method Statement: Outage
Last updated	21/04/2021
Version	Version 2
History of Changes made to this version	Version 1 updated to include new regionally consistent methodology.
Summary of areas where substantive changes have been made as a result of consultation feedback	Further clarity on how nitrates/water quality issues are considered as outage included within the Abnormal Water Quality section on page 14. Clearer definition of what is 'material' to the supply demand balance when discussing sensitivity testing included within Sensitivity Testing section on page 24 and Materiality Considerations section on page 26.
Summary of areas where substantive changes have been made as a result of the revised Water Resource Planning Guidelines	Version 2 of the Method Statement has been prepared using and in alignment with the WRPG supplementary guidance – outage.
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Approved by	Meyrick Gough
WRSE Director Approval	Meyrick Gough

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For the full library of WRSE Method Statements, please visit wrse.org.uk/library.

A consultation on the WRSE Method Statements was undertaken in Autumn 2020 – the consultation details can be viewed on the WRSE engagement hq platform at https://wrse.uk.engagementhq.com/method-statements.

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Executive Summary

Water Resources South East (WRSE) is developing a multi-sector, regional resilience plan to secure water supplies for the South East until 2100.

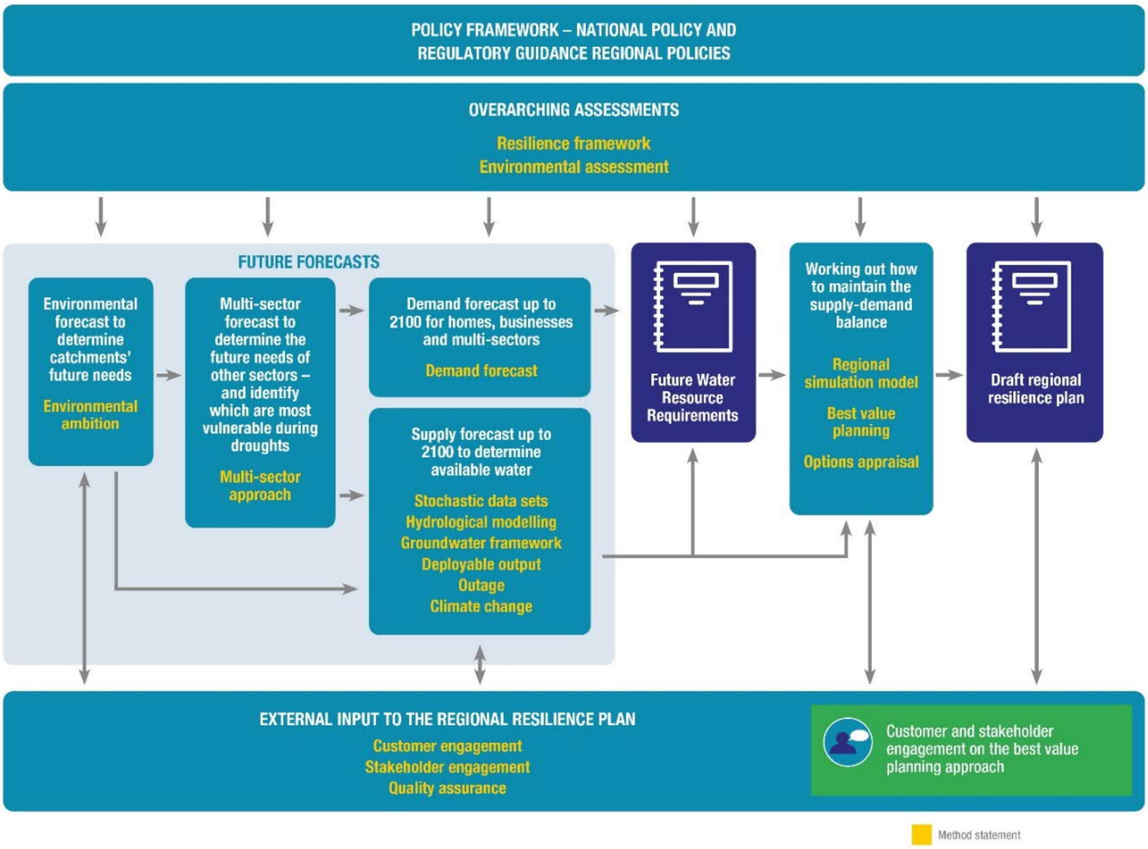
We have prepared Method Statements setting out the processes and procedures we will follow when preparing all the technical elements for our regional resilience plan. We consulted on these early in the plan preparation process to ensure that our methods are transparent and, as far as possible, reflect the views and requirements of customers and stakeholders.

Figure ES1 illustrates how this outage Method Statement will contribute to the preparation process for the regional resilience plan.

We need to provide a regionally consistent and improved approach for assessing outage, which is the temporary loss of reliable water due to planned or unplanned events and determine how much of a `planning buffer' we need to factor into our regional resilience plan.

Water resources and supplies are not guaranteed – the temporary loss of reliable water can be due to planned events, such as needing to carry out maintenance at water treatment works, or unplanned events such as power cuts. We need to take account of this upfront and build it into our plan, so we don't face temporary disruption to supplies.

Figure ES1: Overview of the Method Statements and their role in the development of the WRSE regional resilience plan



1 Background

In order to align with the ambitions of the regional planning objectives, WRSE has carried out work to develop a new outage methodology to provide a regionally consistent and improved approach for assessing outage and calculating a suitable planning allowance.

This work is now complete. In this Method Statement we outline the approach we took to developing the new methodology and provide details of the methodology itself.

2 Approach to develop the methodology

Task 1

We completed a review and gap analysis to understand the current interpretations and methods for each company's:

1. reporting of outage against regulatory requirements and
2. forecasting of outage allowance for both the water resources management plans and regional plans.

A report was prepared on the interpretations, noting where there is alignment, inconsistency and their potential significance for water resource management planning. This was colour coded, using the criteria in Figure 1, below for each question across all companies.

Figure 1: Gap analysis criteria

Red	Amber	Green	Blue
Material inconsistency or departure from guidance or good practice and/or hindrance to robust outage assessment	Minor inconsistency or departure from guidance or good practice and/or hindrance to robust outage assessment	Consistent with guidance or good practice with few hindrances to robust outage assessment	Inconsistent with guidance in a positive way, offering learning opportunities for WRSE

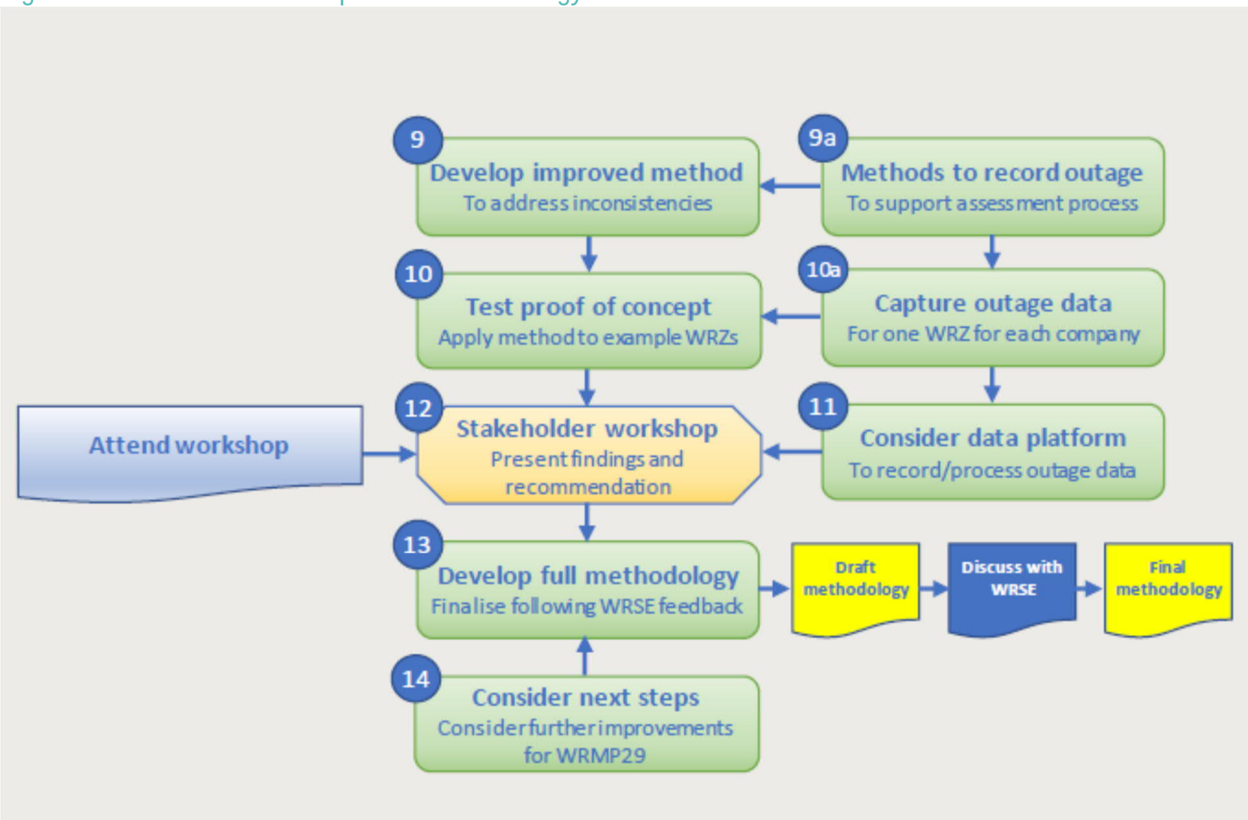
This identified areas of alignment across companies, and consistency with guidance. It also identified the inconsistencies and their potential materiality.

Task 2

Next , we considered how we could provide consistency, promote best practice and ensure adherence to latest guidelines. We developed and tested a consistent methodology for the recording and calculation of outage and forecasting outage allowance. We also put forward the proposal for a group approved data platform to consistently record and process the data required – highlighting what this could look like and where gaps would arise.

Figure 2 below sets out the approach that was taken to move from the findings of Task 1 and develop the full methodology.

Figure 2 – Process to develop final methodology



A workshop took place on 5th August 2020 with companies, stakeholders and regulators to present the WRSE proposals for the new methodology.

The programme that was followed to develop the full methodology form June to August 2020 can be found in Appendix 1.

Roles and responsibilities

The following key individuals and consultants were involved in the development of the new outage methodology:

- WRSE workstream lead – Andrew Halliday (South East Water)
- Consultant Appointed to develop the methodology – Mott MacDonald

Maintenance of Method Statement

This Method Statement was updated in July 2021 to provide details of the new full methodology for outage in Section 4 below.

3 Methodology

This methodology specifies a means to provide consistency, best practice and adherence to the latest guidelines for the recording and calculation of outage for annual reporting and for dry year or critical period water resource management planning.

Methodology overview

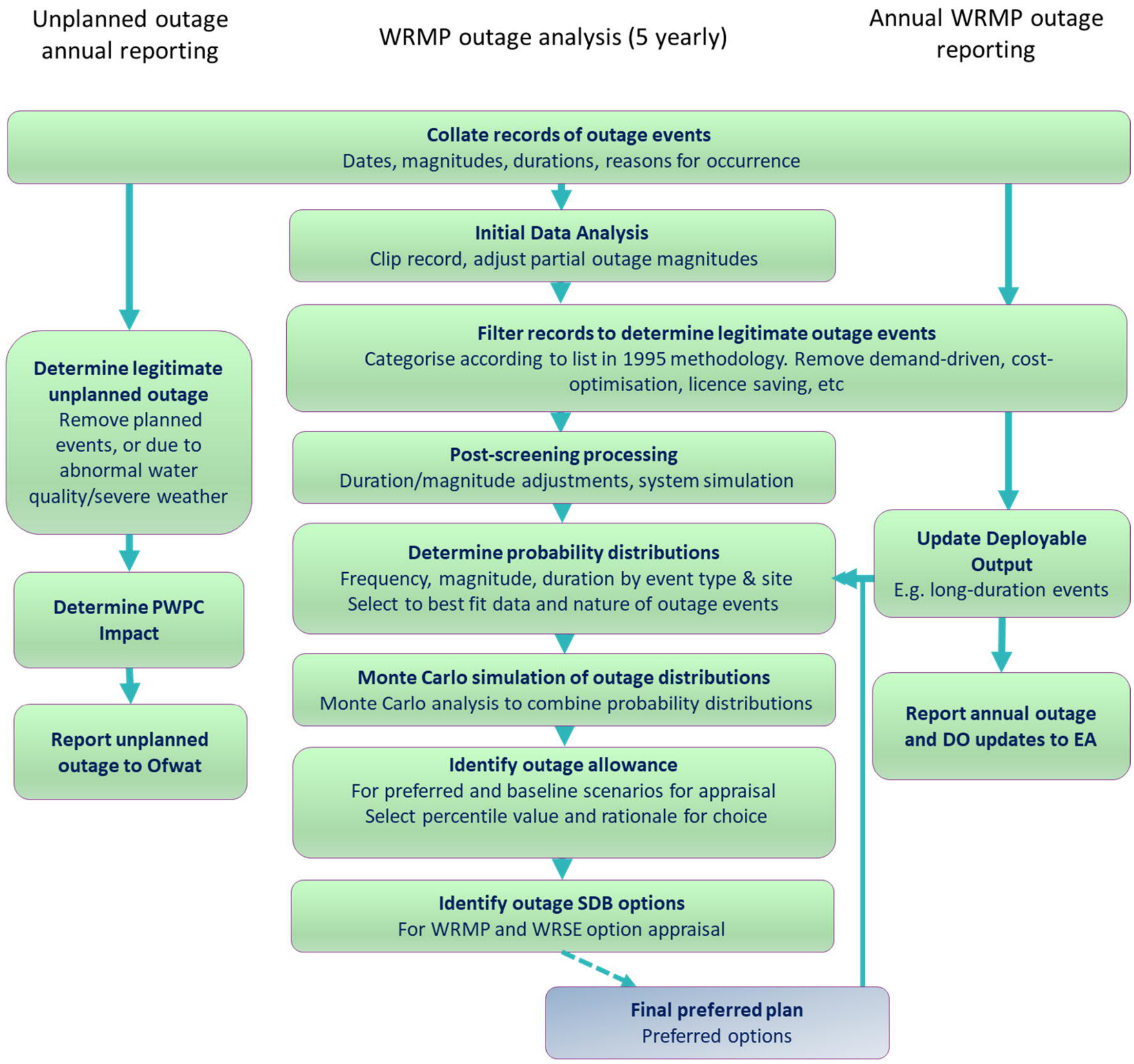
This methodology provides consistent guidance on recording, processing, analysing and modelling outage event data for annual reporting, outage allowance determination and outage option identification, for companies of the WRSE group. It is accompanied by a common outage modelling platform (see Appendix 1) to assist companies in processing and modelling the outage event data on a consistent basis. It also provides some further guidance on the unplanned outage performance commitment, to support the detailed guidance provided by Ofwat for PR19.

All potential outages may be recorded in the outage modelling tool (OMT), with screening for legitimacy carried out within this tool. This will ensure a clear and transparent audit trail for the company's outage allowance, with explanation for any variation between annual returns and outage allowances. It will show how capital investment has been accounted for, and explain any other adjustments to outage. It also provides a clear explanation for the scope of and limitations for any WRMP options to reduce outage.

An overview summary of the approach to outage across the three elements of outage is shown Figure 3 below. Figure 5 to Figure 9 provide a more detailed summary of the approach in flow-chart form – see Appendix 2.

A detailed description of each aspect of outage compilation and analysis is then presented in the subsequent sections.

Figure 3: Summary of overall approach



Accounting for new options

For WRSE investment modelling, one specific area of complexity is how to account for the outage of supply options. The final sub-section of the methodology, Identifying and accounting for WRMP options, describes how an outage allowance should be made for options, but not specifically in the context of WRSE investment modelling.

There are two ways companies may account for the outage of new options for WRSE investment modelling at WRMP24:

1. Include an outage allowance in the baseline supply/demand forecast to account for new options
2. Include an allowance for outage in the DO benefit of options.

Where a significant WRZ deficit is expected in all scenarios (relative to total WRZ DI), such that making no allowance for the outage of options could significantly under-estimate the need for options, companies should apply alternative 1 prior to regional investment modelling. The simplest way of including this outage allowance may be for companies to not adjust outage allowance for losses of DO in the baseline supply forecast: i.e. use actual historical outage despite the write-down in DO.

Where deficits are expected to be relatively small (relative to WRZ DI), or vary considerably between regional investment scenarios, companies may make an allowance for new options in the baseline supply/demand forecast, but only based on the smallest expected deficit.

During post-modelling programme appraisal, companies should then review their outage allowances, given the options selected for each scenario. For small deficits, no adjustment to outage may be necessary. For more significant deficits, companies should determine an additional outage allowance to include in the next round of investment modelling. They should choose between alternatives 1 and 2 as follows:

- Alternative 1 (baseline supply/demand forecast outage adjustment) would be most appropriate where the deficit is relatively similar between scenarios and/or the outage allowance of an option varies considerably between scenarios
- Alternative 2 (option DO adjusted for outage) would be most appropriate where the deficit varies considerably between investment scenarios, and the outage allowance of any given option does not vary too much between scenarios.

Where there is significant variation in deficits between scenarios, and the outage allowance for a given option varies considerably between scenarios (for example, due to local outage recovery for certain scenarios but not others), then scenario-specific outage allowances may be required. This is considered unlikely for most WRZs.

Companies should take account of the supply of water from a given option to different WRZs and/or companies across all scenarios, when deciding on the most appropriate adjustment, and to avoid double-counting outage allowances.[1]

[1] For example, if a new reservoir is picked to supply different WRZs under different scenarios (via different transfers), and the outage allowance associate with that reservoir does not vary much between scenarios/WRZs, then adjusting its DO for an outage allowance may be most appropriate, in which case, no company should allow outage for the option in its baseline outage allowance. Conversely, if the outage associated with the option varies considerably between scenarios (through outage recovery potential for some WRZs but not others), and the deficits for all associated WRZs are similar in all scenarios, then baseline outage allowance adjustment for each WRZ may be most appropriate.

A summary of the alternatives is shown in the table below.

Scale of Deficit (relative to WRZ DI)	Variation in deficits between scenarios (relative to WRZ DI)	Variation in outage allowance of an option between scenarios	Proposed Adjustment
Small	Minor	Any	No adjustment needed
Medium/large	Minor	Minor	Either update baseline outage or adjust option DO
Medium/large	Minor	Significant	Update baseline outage
Any	Significant	Minor	Adjust option DO or scenario-specific outage allowances
Any	Significant	Significant	Scenario-specific outage allowances

Data capture

WRMP and UOPC data consistency

Where possible, companies should compile one set of data for both UOPC and WRMP/AR. This should then be processed in order to determine legitimacy, magnitude and duration for both reporting measures.

- Some companies record outage for WRMP planning at a different spatial resolution to that for the unplanned outage performance commitment: for example, WRMP outage at a source level and UOPC outage at a treatment works level. Companies should aim to specify outage at a single spatial resolution for both metrics for consistency. The Ofwat UOPC guidance states, "A company should define its peak week production capacity (PWPC) for each water production site or source works included in its water resources management plan." In comparison, deployable output is typically specified at a resolution based on the key constraint on output in a dry year.
- Differences may therefore arise when, for example, two sources are constrained by individual abstraction licences in a dry year but their PWPC is constrained by the treatment capacity of a shared treatment works. In

this case, it may be necessary to specify different durations and magnitudes of outage for UOPC and WRMP, and/or outage may be excluded for one but included in the other, where it impacts PWPC but not DO, for example. It may occasionally be appropriate to specify two separate events in the outage modelling tool, with clear notes to explain why the event impacts are different for UOPC and WRMP.

Durations should be recorded through a start date of when the asset or source failure first impacted either DO or PWPC, and an end date of when the source could have re-entered supply at its normal capacity.

For determining magnitude, especially for partial outage, data should be recorded in terms of actual output put into supply, rather than as a % loss of output against a benchmark (DO, UOPC, etc). Actual output is more likely to be recorded accurately than losses, which may require understanding of WRMP or UOPC, and require additional information of the measure they are recorded against. Percentage loss is also non-comparable if companies measure it against different benchmarks.

Data captured should include the volume of losses associated with a non-outage lack of demand or operating philosophy decision, i.e. reduction in site output due to factors other than asset or source failure. This should be specified in Ml/d and determined as the difference between the actual site output and what the site could have produced, had unlimited demand been placed on the sourceworks.

Companies may opt instead to specify only the "potential sourceworks output" for each day of the outage, the output which would have been achievable under unlimited demand on the sourceworks.
Actual outage is determined as either [total outage recorded less demand/operational-based reductions] or [DO or PWPC less potential sourceworks output].

> Example: a source with a peak week production capacity (and PDO) of 10 Ml/d and ADO of 8 Ml/d is running at reduced output of 6 Ml/d because of low demand and operationally lower cost sources elsewhere in the supply system, when it is hit by a system failure that reduces output to 2 Ml/d. In fact, it could have been run at 5 Ml/d during the event if needed, but 2 Ml/d was the optimal output when accounting for demand and other costs.
>
> The company should record:
>
> - the actual event output of 2 Ml/d <u>and</u>
> - the potential sourceworks output of 5 Ml/d <u>or</u>
> - the demand-related loss of output of 3 Ml/d
>
> The outage magnitude for DYAA WRMP modelling would be (8 – 5) = 3 Ml/d
>
> The outage magnitude for PWPC UOPC and DYCP WRMP modelling would be (10 – 5) = 5 Ml/d

Outage event categories

Companies should specify events against at least one of the following categories, whichever is most appropriate: power failure; system failure; turbidity failure; pollution of source; nitrate failure; cryptosporidium failure; algae failure; other failure. Other sub-categories can be used in addition to those above.

- If a recorded event is found not to have been caused by any form of legitimate outage type in subsequent analysis, then it should be removed from the record. For example, an event recorded as a system failure, which turns out to have simply been an operational decision not to run the source into supply.
- If one asset/source failure causes another, then only the primary cause failure should be specified as the failure type.

> Example: if a source is shut down due to turbidity failure, but water quality sampling subsequently finds cryptosporidium in the raw water, and this extends the duration of the event by several weeks, the event should be classified as a cryptosporidium event, rather than turbidity.

- If two failure types occur simultaneously that are 100% related, but one does not cause the other, then the event type should be classified according to which type causes the greater magnitude and duration.
  - This may require a change in classification at the initial data analysis stage, but data capture processes should be established to provide enough information to make these decisions.
- If two failures happen simultaneously by coincidence, then both should be specified as separate rows in the data capture sheet. If possible, the potential sourceworks output should be specified separately for each failure type for each day of the outage. The duration of each event type may differ and should be specified according to the date at which normal supply could have resumed, in the absence of all other failures.

> Example: a source fails due to a system failure event and nitrate event happening simultaneously, completely unrelated to one another; under the system failure only, potential output would have been 3 Ml/d and duration is only 5 days (the time taken to repair the system); under the nitrate event only, potential output would have been 1 Ml/d (the maximum blended output possible during the event), and duration is four weeks (the time taken for water quality to have returned to a sufficiently good state for blend to operate as normal).
>
> These values should be specified as two separate events in the log, each with its own magnitude and duration.

Recording duration and magnitude

Where outage is recorded only to the nearest day, rather than nearest hour, companies should test the sensitivity of their outage allowance to this time recording resolution, by adjusting all events up/down by half a day and noting the change in outage allowance. If the changes are material to the supply demand balance, event duration should be recorded to the nearest hour if possible.

Where failure magnitude changes significantly during the event, companies should generally average out the magnitude across the event. Companies may specify new events with a different magnitude, but only where the change in magnitude is due to a clearly defined step-change in the outage cause, whose probability of occurrence is notably distinct from the original event.

WRSE common platform

It is not considered practical to record outage events directly into a common platform for WRSE companies at this point. Sharing data would be useful to improve the accuracy of outage allowances where individual companies have limited data records for outages of a particular type at a certain sourceworks, for example for relatively new sources or for options of a new type for the company. In these cases, we recommend bespoke sharing of data in response to specific cases.

- A company finding itself in this position should send out a request to all WRSE companies, and any other relevant companies, for outage event data for sources of the relevant type, stating key source attributes. Companies should respond where possible with data for any sources that may be relevant, along with the relevant source attributes.
- Source attributes might include: source water type (groundwater, surface water, reservoir, effluent reuse, desalination, etc); aquifer type (confined, unconfined, etc); water quality type (typical iron, manganese, nitrate levels); catchment type (arable, pasture, any industries relevant to water quality/pollution etc); high level treatment processes; any other information relevant to outage types, magnitudes, durations and frequencies.

Source names and locations should be anonymised as necessary to mitigate any security risks or commercial risks for companies.

Initial data processing

Data record

For Outage Allowance calculations, companies should select a period of historical outage data which is broadly representative of current conditions and resource configuration, but which also provides sufficient quantity and range of events to enable accurate magnitude, duration and likelihood distributions of event types to be determined for each sourceworks. Ideally this duration should be at least 5 to 10 years. Consideration should be given to the following:

- If historical investment activities have affected the duration or magnitude of outage events of a certain type at a given source, then events prior to the investment should be left in the record, but magnitude and/or duration adjusted to reflect the changes at the point of screening/processing (see subsequent sections for more information)
- If historical investment activities have affected the likelihood of outage events of a certain type at a given source.

Companies then have three options:

1. Clip the record of analysis to the point at which investment occurred;
2. Adjust the likelihood probability distribution manually to reflect the change in likelihood;
3. Adjust the historical record of events to account for changes in likelihood, for example by excluding certain events, in order to derive an appropriate frequency distribution.

If data before a certain date is considered unreliable, e.g. due to insufficient data recording, or unreliable recording, companies should clip their historical record back to that date only. Any adjustments should be clearly justified with evidence where possible, for example with data from other similar source works showing how investment has affected outage risks.

If there is uncertainty over the reliability of data prior to a certain date, companies should test the sensitivity of including this data in their outage allowance. If insensitive, then a best judgement decision should be made as to whether it is included or not. If highly sensitive, companies should undertake a more detailed study into the historical record for that event type and sourceworks to decide whether adjustments to the historical record should be made.

Example: treatment at a groundwater source was upgraded five years ago to mitigate turbidity failures associated with dewatering a fissure, which occurs when the source is operated at high rates under low groundwater levels. This reduces the likelihood of failure, but the treatment has a design capacity which does not mitigate all events. It does also reduce the risk of crypto failures, and system upgrades made at the same time also reduced the risk of system failures. The company has various options:

- Clip the record of events to five years ago. This would ensure that the capital investment is fully accounted for in the outage allowance, but risks limiting the record of events of other types (e.g. power failures or non-turbidity pollution), which might still be relevant, especially infrequent events.
- Look back through the record of events and exclude ones which would not have happened after capital investment. This increases the length of data record for other failure types, but requires sufficient information on the historical events to be able to say which would no longer have occurred
- Leave all events in place but manually adjust the probability distributions for each relevant event type to account for the investment. For example, reduce likelihood of turbidity failures by 80% and duration by 50%, and reduce likelihood of system failures by 50%. This ensures the full data record is utilised, but requires quantification of the impacts of asset investment on outage that may be subjective.

The choice of approach would depend on quality of recorded information, nature of risks for each event type, and how confident the company feels about making adjustments to PDFs directly. A hybrid of all three options could be applied.

A key consideration is the materiality of changes to the outage allowance. If turbidity/system outage at the source makes a minimal contribution to the overall allowance, as determined from the Monte Carlo analysis and tornado plots for the WRZ (see Section 3.10, Section 5 and Appendix 1 for more information), then it may be unnecessary to make any adjustments. A starting point might be to try end-member adjustments to the PDFs and re-run the allowance calculation to test sensitivity; then decide on the level of evaluation required.

Partial outage

Companies should aim for a position where all outages, full and partial, are recorded to the same level of accuracy and can all be included in one pdf for outage magnitude. Once this standard of recording has been achieved for a number of years, the record should be clipped to the start of this period, and all events prior to this date excluded from analysis. A minimum of 5 years of data is likely to be required for this.

Where partial outage has not been recorded accurately for a long enough period (either no record of partial events, or no record of magnitudes during those events), companies have various options.

1. If an accurate partial outage record is available, but very short, companies should use the shorter period of high-quality partial outage data to determine probability distributions for magnitude, and perhaps duration. They should use the longer period of data to determine likelihood distribution (and potentially duration). Comparing duration and likelihood distributions for both periods of record would be worthwhile, potentially with sensitivity testing to confirm the final distributions used. The impact of any decisions/assumptions should be determined and reported.

2. If all partial outage data is currently unreliable, companies should search for systematic errors in the data, which can be corrected systematically. For example, was partial outage magnitude always recorded against an incorrect baseline output rather than deployable output, which can be corrected? Did partial outages of a certain type not correctly account for operational philosophies, such that actual outage is less than reported, which again can be corrected once the philosophy is considered?

3. If all partial outage data is randomly incorrect, or totally unrecorded at one or more sources, companies should update their outage distributions to account for partial outage using data from other similar sources, in the WRZ or elsewhere. This can be done within the WRSE outage data tool by basing distributions on all data within a zone or of a certain sourceworks type, for example. This should only be done where the alternative data can be shown to be representative, where outage risks are known to be similar.

4. If partial outage data is insufficient to apply any of the methods above, companies should update their distributions using information from other companies' most equivalent sourcework types. This needs a transparent audit trail to identify where and how much infill has taken place and therefore what impact it has on overall outage allowance. Sensitivity testing could also be undertaken to evaluate the materiality of the infilling.

In deciding what adjustments are required, and by what means, companies should start by testing the sensitivity of their outage allowance to partial outage magnitudes at each source and event type. A proportionate approach should be taken, starting with sourceworks and event types which are most material to the outage allowance.

UOPC legitimate outage screening

Planned events

> *Where assets are taken out of supply or made unavailable for supply to enable planned maintenance or capital works to be completed then these should be recorded as planned outages. The same principles for work on standby assets apply here as for unplanned outages.*
>
> *It is expected that a company will have a process whereby planned works on production assets are approved and scheduled. This may be the basis of evidence to demonstrate that the outage is planned.*
>
> *Where planned work results from an asset failure any resulting outage should also be recorded as unplanned.*

Source: Ofwat PR19 Reporting Guidance: Unplanned Outage

Generally speaking, a planned event would be specified on a planned works calendar or schedule, before the event occurred. If there is no evidence the event was planned in advance of the first impact on supply, then it is likely to be an unplanned event. Where an unplanned event is followed immediately by planned maintenance that is only partly related to the unplanned event, because this is better asset management than to delay the maintenance, we recommend that the “planned maintenance brought forward” not be included in the unplanned outage event recorded. To include this planned maintenance would create a perverse incentive for companies to delay important maintenance to avoid penalty, when the right thing is to carry out the maintenance immediately.

The onus would be on companies to clearly demonstrate that the planned element of maintenance was already planned in some way, before the unplanned outage event occurred.

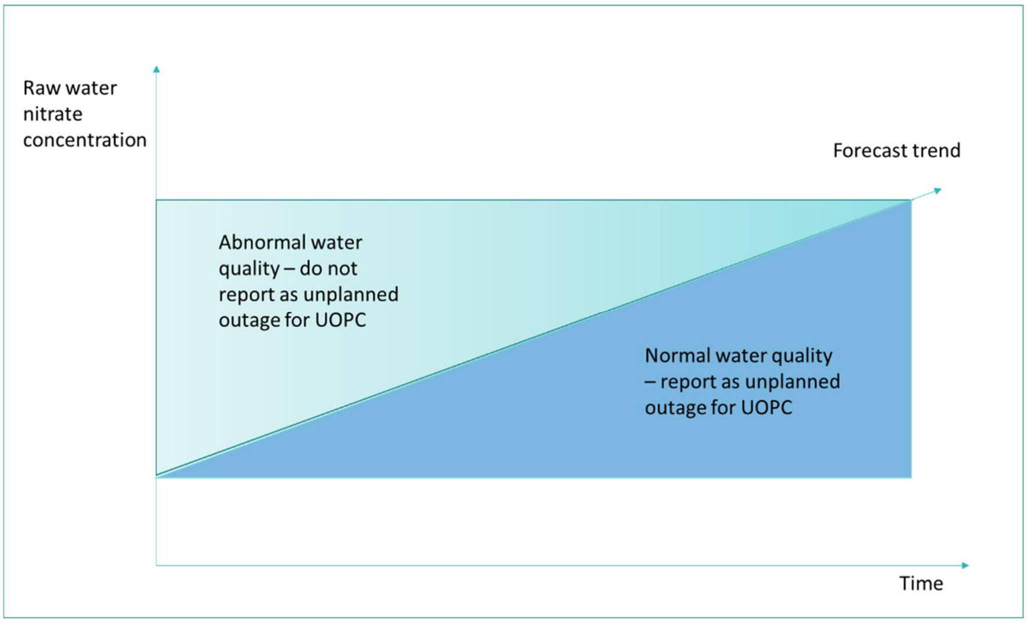
Abnormal water quality

> *Unplanned outage arising from changes in raw water quality beyond the normal water quality operating band shall be excluded as this is not a measure of asset health. Exclusions must be evidence based including evidence to show what the normal water quality operating band for that production site is. This exclusion applies to transient changes to raw water quality such as turbidity, algae, pollution, spikes in nitrate and pesticide. If a company chooses to manage variable raw water quality by proactively temporarily restricting water production, then this should also be classed as an exclusion.*
>
> *Long-term trend-based changes in raw water quality which result in unplanned outages are not permitted as exclusions as a company should have the data to recognise a rising trend and foresee the need to plan for treatment etc.*

Source: Ofwat PR19 Reporting Guidance: Unplanned Outage

Target headroom analysis forecasting may be used to specify normal water quality operating bands for relevant water quality parameters, such as nitrate. Where nitrate concentrations rising in line with the baseline forecast cause an outage event, that event should be included in the unplanned outage performance reporting (companies should have planned around this forecast). Where outage is caused by nitrate concentrations exceeding the forecast, exclude these events from UOPC reporting. This is illustrated in Figure 4 below.

Figure 4: Use of nitrate forecast to identify abnormal water quality for UOPC reporting



WRMP legitimate outage screening

Boundary with deployable output

The Environment Agency, Ofwat and Natural Resources Wales have specified supplementary guidance regarding the boundary between outage and a loss of deployable output, for both planned and unplanned events, as shown in the box below.

Unplanned outages

Where an unplanned outage extends beyond 90 days, you should present an action plan to regulators to show how you are rectifying and managing the outage. Unplanned outages longer than six months should be classed as deployable output reductions unless agreed with regulators. The table below provides a summary.

Duration of loss of supply	*Action*
0-3 Months	*Record as outage*
3-6 Months	*Notify regulators and prepare action plan to reduce outage. Still classified as outage.*
>6 Months	*Record as loss of deployable output until rectified unless agreed otherwise by regulators. You should inform regulators of the quantity of deployable output loss.*

Planned outages

Planned outages are an important part of ensuring you have a resilient and well-maintained network. If you are planning a long-term outage for one of your sources i.e. longer than 12 months, you should adjust deployable output in your WRMP accordingly.

Where a recurrent and predictable water quality issue exists, you should consider whether it is appropriate to reduce deployable output. For example, metaldehyde causing outage at a source multiple times in a year.

Source: WRMP24 Draft Supplementary Guidance: Outage

If a source already has DO = 0 in the planning table, the company should identify whether it is due to re-enter supply at any point in the period. If not, and it is not due to be replaced by a very similar source, then all historical outage from that source should be excluded.

If it is likely to be reinstated, then the date of reinstatement should be specified, and an outage allowance made to account for the source from that date forward. This allowance should be based on historical outage events at the source, but only those which remain a risk in light of any capital investment at the source, and with magnitude and duration of the events updated accordingly if necessary, e.g. based on the reinstated source DO, etc.

If the source is due to be replaced by a similar source (from an asset/source failure point of view), then historical events may be deemed legitimate, although with magnitude updated considering the replacement DO. Events at this source should be included in the outage allowance from the date of replacement.

All unplanned outages up to three months in duration should be recorded as outage with no write-down in DO.

Unplanned outages of greater than three months should be recorded as outage, with an accompanying notification to regulators and an action plan to reduce future outages of this type at the sourceworks.

Unplanned outages greater than six months duration should be recorded in the outage record according to their actual duration. However, for annual reporting of that year, the outage event should be reported with an accompanying reduction in source DO equal to the magnitude of the outage, unless agreed otherwise with the Environment Agency.

For outage allowance calculations, unless agreed otherwise with the Environment Agency, a sourceworks at which an unplanned outage event of greater than six months has occurred should have its DO written down by the outage magnitude, and all outage events of that type at that source excluded from the outage allowance.

When deciding on where the boundary lies, companies should consider what would happen during a planning scenario period (DYAA, DYCP etc), and the impact of the outage as a proportion of total WRZ DO. The six month limit is specified because if a high magnitude (relative to WRZ DO) event of six months really were to occur during a dry year period, albeit with low likelihood, the Monte Carlo averaging process might be inappropriate.

If during a planning scenario period, the event duration could in fact be reduced through emergency dry year actions, then the likely duration should be determined and put to the EA for discussion regarding treating the event as outage, and not writing down DO. Where a shorter duration is agreed as being feasible in the planning scenario, this duration should be used in the outage allowance calculation.

If the outage magnitude is small relative to the total WRZ DO, then it may also be acceptable not to write down DO and to continue to treat the event as outage. In this case, the outage allowance Monte Carlo averaging process would continue to work well. See "Boundary with System Resilience" for further guidance on this.

If the likelihood of the long duration event is very low, particularly for it to coincide with a dry year, for example flooding-related outage, it may be more appropriate not to write down DO, but instead to undertake system resilience scenario testing of the event during normal year conditions, and mitigate the event through resilience investment. In this case the event should still be excluded from the outage allowance (see "Boundary with System Resilience").

The 12-month cut-off for planned outages recognises the fact that companies have more control over planned outages and therefore can avoid DO impacts more easily in a dry year than for unplanned events. The same process as for unplanned outage should be followed to establish whether or not a long-duration event should result in DO write-down or not.

There may be situations where long-term planned outages would not be planned for in a dry year, and so could be excluded from outage allowance, but the actual outage might unavoidably extend into a dry year. In this case, the duration of the outage for WRMP allowance should be specified as that which impacts DO in the dry year. If this duration exceeds 12 months, source DO should be written down, as per the EA supplementary guidance. If this duration is less than 12 months, but the impact of the outage on dry year DO is significant compared to total WRZ DO, then the event should be considered for resilience scenario planning (see section on Boundary with system resilience below).

Examples:

A pollution event causes a complete outage at a 1 Ml/d source from September 2020 to May 2021. The total DO for the zone is 4 Ml/d. The annual report for 2020 would specify the outage of 1 Ml/d and DO is not yet written down. At end of 2021, the duration of the outage (9 months) is known. Because the magnitude is significant relative to the WRZ total DO, source ADO is written down to zero, the total WRZ DO is now 3 Ml/d and all outage events at this source are excluded from the DYAA outage allowance. Reviewing the outage cause, it is decided that the risk of occurrence during critical period is very low, so DYCP DO remains in place, this outage event is not included in the DYCP outage allowance, but other legitimate DYCP outage events at this source remain included in the DYCP outage allowance for the WRZ.

A planned outage results in a 5 Ml/d source being completely removed from supply for 15 months in a zone with 50 Ml/d total DO. In a dry year it is decided the source could have been returned to supply within 9 months. In this case, the DO is relatively small compared to the WRZ and the dry year duration is less than 12 months, so the company proposes to the EA to leave the event as outage. Because the event is planned, it does not feature in DYCP outage allowance. A duration of 9 months is specified for DYAA outage allowance.

Supply system mitigation

Where the supply system storage or balancing of sources mitigates any outage impacts on deployable output from the source, these events will be excluded.

If the event would clearly have no impact on DO in all dry year scenarios (DYAA, DYCP or DYMDO), it should be excluded from the legitimate set of events. This can be determined by considering whether the event impact (duration x magnitude) is small enough that [alternative supply + storage] is sufficient to avoid any DO impact under all scenarios. If so, then it should be excluded from WRMP outage.

Capital investment

Where capital investment (enhancement or maintenance) has eliminated the risk of an outage event type occurring at a given sourceworks, all historical events of this type at the sourceworks should be excluded from the outage allowance calculation. Where capital investment has reduced but not eliminated the risk, relevant historical events should be included but with adjustments made to their calculated magnitude/duration/likelihood probability distributions (see WRMP processing of calculated distributions).

Where the risk of pollution outage events has been mitigated completely by 3rd party activities (e.g. catchment management, factory closure, industrial waste processing improvements, etc) relevant historical outage events should be excluded from the analysis.

DYAA DO recovery

If the altered operation of sources on the same individual or group licence, or conjunctive use tactics with other source types in the local supply system could fully mitigate the outage event, then these events should be excluded from WRMP outage.

This can be done by considering licences and potential for conjunctive use first. If PDO, MDO and ADO are equal, and the source is not on a group licence, then there is unlikely to be room for any DYAA recovery, unless an option for conjunctive use (e.g. groundwater/surface water) is available.

If PDO is greater than ADO, and/or the source is part of a group licence, then consideration should be given as to whether other sources can be run at above ADO flow rates during the outage event, and the outage source then run above ADO to make up for its loss later in the year, resting the other sources, resulting in no net loss of ADO.

If there is some capacity for recovery, but not enough to recover all outage loss, then the event should be included, but its duration and/or magnitude adjusted as part of post-legitimacy processing.

This should take account of the month in which the event occurs relative to the licensing period. An autumn event may provide little scope for recovery if the annual licence period runs January to December; although consideration should be given to negotiating a two-year licence period if this would be material to the supply demand balance. This could enable reduced output from the source at the end of one year to be made up by increasing abstraction from alternative sources nearby above their annual licence in that year, with reduced abstraction in the following (made up by increased abstraction at the outage-loss source).

For complex water resource systems, full system simulation of some outage events at certain sourceworks may be required to determine whether events would have any impact or should be excluded.

Boundary with headroom

If the event is captured adequately by target headroom, then it should be excluded from WRMP outage allowance (see post-screening data processing). This includes:

- When outages are short-term and temporary, driven by random, largely unpredictable and uncontrollable events. A metaldehyde spike in a river resulting in temporary shutdown of an intake is a typical outage event.
- Where headroom is an allowance for uncertainty in the SDB caused by long-term, often gradually occurring, uncertain and permanent occurrences. A pollution event with long-term consequences, such as a contamination plume in an aquifer from an industrial spill which might but hasn’t happened, which renders a sourceworks unusable without investment in treatment is a typical headroom component.
- Typical outage events with a risk of overlap with target headroom are nitrate failures, and other long-term pollution failures. Outages caused by these types of event should be reviewed and screened in/out based on whether the impact on DO is within any Ml/d uncertainty range allowed for under target headroom. See section 0 for more explanation.

- Where nitrate trends are predictable and impact available source outputs owing to changes in blending, then this should be allowed for by writing down future DO. If there is uncertainty in the nitrate trend impacting changes in DO, then this should be allowed for in target headroom.
- Should the company address the nitrate problem through installing treatment facilities, then this may restore or protect DO and reduce headroom, but such facilities will be subject to equipment failures, which should be included in the outage allowance.

Boundary with system resilience

Some failure events are not appropriate for inclusion in the outage allowance, because Monte Carlo averaging is likely to understate their impact and therefore not provide a meaningful way of accounting for their risk. These events should be assessed separately through system resilience or scenario planning. In this case, they should not then be included in the outage allowance, as this would artificially inflate the allowance.

In order to decide whether an event should be evaluated separately under resilience, it is necessary to consider its impact relative to total DO of the supply system at a WRZ level. Outage allowance is effective for events whose total impact (product of magnitude and duration) is small relative to the total WRZ DO of the planning scenario period. In this case Monte Carlo averaging works well at smoothing out random failure events over the planning scenario.

Companies should decide upon a % threshold for the boundary between outage allowance and resilience assessments. We recommend that all events with a magnitude-duration product less than between 5% and 10% of the product of planning scenario duration and total WRZ DO, can be adequately assessed as outage. Companies may assess an event type at a given sourceworks through both outage and a resilience scenario, and then decide how best to account for it. If resilience mitigation is planned, this should be taken account of in the outage allowance.

> <u>Examples</u>:
>
> An event with magnitude 50% of WRZ DYAA DO lasting 1 month can always be assessed under outage under the DYAA scenario (50% ×1/12 = 4%<10%).
>
> Similarly, an event with magnitude 20% of total WRZ DO lasting 5 months could be left in outage for DYAA (20% ×5/12 = 8%<10%).
>
> But for a DYCP lasting only 2 weeks, a 20% WRZ DO event lasting longer than 7 days could be considered for resilience scenarios rather than outage (7/14 × 20% = 10%).

This relies on there being good connectivity between sources in the WRZ. Where connectivity is more limited, an appropriate sub-zonal area should be considered instead to determine the DO magnitude against which event magnitude should be measured.

Higher impact events should be included in annual reporting, but may be excluded from outage allowances and assessed under system resilience scenario testing instead, if considered appropriate. This resilience testing should take account of the likelihood of the event and its seasonality. Many low-likelihood events are unlikely to coincide with 1 in 200-year (or less frequent) drought, so it may be more appropriate to test them against normal year water availability and demand; however some events, such as algal blooms, may credibly coincide with drought events and should be tested against drought scenarios.

The impacts of future climate change should be taken into account when considering likelihoods of both outage events and drought conditions occurring simultaneously. Where outage events are likely to be appraised and mitigated in resilience planning, commentary could be added to the annual report to explain this, and/or commentary added to the WRMP outage report and business plan resilience sections to explain why the outage allowance is lower than that reported in the year the high impact event occurred. As for all other elements of outage allowance, sensitivity testing should be used to decide whether an event is material to the outage allowance and therefore whether it requires detailed consideration of resilience exclusion or not.

Seasonality

The season of occurrence of an event should be accounted for when specifying events for DYCP or DYMDO planning scenarios. For example: winter flooding and freeze-thaw events should be excluded from peak summer DYCP outage allowances, though events relating to flash flooding following dry weather should be included; algal bloom events should be excluded from autumn MDO outage allowances.

Planned events should be excluded from planning scenarios where they could be avoided. Generally, this means that planned events would not be undertaken during dry year periods of peak summer demand (DYCP scenarios).

WRMP post-screening processing

Duration adjustments

All events should have their durations adjusted to specify the duration that would have occurred in each dry year planning scenario, based on emergency actions that would in likelihood be taken. These actions are likely to vary between scenarios and may depend on the time of year. For example, an event occurring in January in a dry year might have a longer duration than one occurring in October, when the extent of drought conditions is more accurately known.

Capping of events should only be applied to limit event duration to the planning scenario duration (e.g. 12 months for DYAA, 2-4 weeks for DYCP). Otherwise, events should either be adjusted for a dry year planning scenario, left as recorded, or excluded as a result of DO being written down.

Where an outage event spans more than one reporting year, companies should again consider whether this would have happened in a dry year. If so, the event could either be split into two events, the first with duration equal to that recorded in the first calendar year, and the second that which would be expected in a second dry year, or specified as a single event with duration equal to that expected overall in dry conditions. The decision will depend on how the event would impact DO as detailed below:

- If dry year DO is dependent on multi-year drawdowns (for some yield-constrained groundwater sources or reservoir storage), then the event should be specified as a single event

- If the dry year DO is based on, for example, annual abstraction licence constraints, which reset year-on-year, then specifying two separate events may be more appropriate.

In either case, the rules associated with DO write-down for planned/unplanned events, and for boundaries with system resilience assessments should be followed for the individual event (multi-year drawdown conditions), or for the two events individually (annual constraint conditions).

Magnitude adjustments

Event magnitudes for outage allowance modelling should be based on the deployable output of the sourceworks for the planning scenario in question, or the partial outage magnitude, less any reductions due to reduced demand or operating philosophy. This may be equal to the magnitude at the time of failure, but significant changes in DO may have occurred.

The WRSE common outage platform automatically applies current DO, adjusted for partial outage and demand/operating philosophy effects, though manual adjustments can be made.

Manual adjustments might be, for example, to account for more recent capital investment that would have reduced the magnitude of a partial outage event, or to account for water resource system balancing, as assessed with a spreadsheet model or system simulator.

Where sustainability reductions, climate change, severe drought or water quality are forecast to impact DO into the future, magnitude should be changed accordingly at the stage of specifying probability distributions (section below).

DYAA recovery adjustments

Where there is potential for some recovery in lost ADO during a DYAA scenario by increasing output above ADO after the event to make up for the loss, companies should adjust the magnitude and/or duration of the event accordingly for outage allowance modelling.

For example, if a source with PDO 5 Ml/d and ADO 4 Ml/d is impacted by a full outage event for the first 3 months of the year, losing 360 Ml of water into supply in total, 270 Ml of this could in theory be made up in the remaining 9 months. Therefore, the true outage loss for DYAA could be only 90 Ml. This could be accounted for either by reducing modelled outage duration to 22.5 days, or by reducing modelled outage magnitude to 1 Ml/d. Either option could be applied, but if in doing so the impact on outage is material (see section 0), then both alternatives should be tested for materiality as well, and a precautionary choice made between the two.

For conjunctive use systems, spreadsheet calculations may be needed to determine the system impact on DO across surface water and groundwater sources, taking account of all licences, including group licences.
DYAA recovery allowances should take account of the month in which the event occurs relative to the licensing period (see WRMP legitimate outage recovery adjustment). This could be accounted for by adjusting the magnitude distribution for this event type at the source to allow for a range of possible impacts depending on when it happens, allowing for any variation in likelihood between months. Alternatively, a seasonal modelling

approach could be undertaken for DYAA with outage allowances determined for each of four seasons, one of which is then selected to specify the final allowance. This should be more accurate, but should only be carried out when the effects could be material to the outage allowance. For complex water resource systems, full system simulation of all outage events at certain sourceworks may be required.

System simulation

Water resource system simulation is only likely to be required to assess outage for supply systems comprising significant storage across multiple sources in a well-connected water resource zone. The following factors should be considered:

- Simulation required for a given event type at a certain sourceworks – first consider whether the impact of the event could be mitigated by the supply system in some way, either immediately by reconfiguring supplies from other sources, or later through conjunctive use ADO recovery. Then decide whether the impact can be calculated with sufficient accuracy using a simple spreadsheet-type model
- The materiality of the outage – if there are only a few events with limited magnitude and duration, then a simple calculation may suffice to estimate true outage magnitude and duration. If multiple higher impact events have occurred during the year, then running the system model may be necessary to determine actual outage impact
- Where a system simulator is used to model a single event – the simulator results should be used to specify magnitude and duration of the impact on deployable output
- Where a system simulator is used to model multiple events – a single “global” event should be specified in the outage allowance model, to account for all outage events simulated. All outage events and the simulated global event should be reported in annual reporting for that year, to enable regulators to properly assess outage.

Capital investment

Where capital investment has reduced the risk of an outage event occurring, adjustments should be made to the calculated magnitude/duration/likelihood probability distributions, as required. This can be done before or after determining initial calculated distributions in the following circumstances:

- If the effects of capital investment on a specific event can be clearly quantified, then event duration or magnitude should be adjusted accordingly
- If capital investment would affect the likelihood of an event type occurring, or if the impact on magnitude/duration of specific events is uncertain, but generally duration or magnitude is believed to have reduced, this can be applied to the probability distributions themselves (see next section)
- Where the risk of pollution outage events has been reduced as a result of 3rd party activities (e.g. catchment management, factory closure, industrial waste processing improvements, etc) the duration, magnitude or frequency of historical outage events should be adjusted accordingly

- Where the impact of investment cannot be clearly quantified, then outage parameters should only be adjusted downwards where evidence supports this, for example based on changes in outage observed at other sources in response to similar types of investment
- For historic investment, there may be some post-investment evidence to support adjustment
- For future planned investment, it depends what is proposed, but again companies would want evidence from similar past investments to support a reduction in outage parameters

WRMP outage probability distributions

Capital investment

Where historical capital investment has reduced the likelihood of an outage event occurring, or reduced duration/magnitude below that recorded historically, adjustments should be made to the calculated magnitude/duration/likelihood probability distributions, based on post-investment outage evidence where it is available or on appropriate expert judgement.

This can be done either by specifying a factored adjustment to any of the distribution parameters, or by specifying an average distribution for the failure type, water resource zone or sourceworks type. The distributions of similar events at other sourceworks more representative of the post-investment conditions can be used to inform factor adjustments, or similar events from multi-company compiled data, where this is available.

For future capital investment, adjustments should be made by adding another distribution row to the assessment, specifying the year from which investment is scheduled to deliver improvements. The distribution parameters can be specified in the same way as for historical investment adjustments.

Seasonality

Seasonality is important for determining whether events are valid for certain planning scenarios, as described in WRMP legitimate outage screening. It may also affect the duration, magnitude or likelihood of events.
Some events may have a shorter duration if occurring in a summer peak period because resolving them is prioritised compared to their occurrence in winter, even in a dry year (or because it may not yet be recognised as a dry year). Similarly, some events may be more likely to happen during periods of high demand on the system, because assets are being stressed beyond their typical operating range.

Adjustments should be made to probability distributions accordingly, for each relevant planning scenario.
Seasonality can also be important for planning options to reduce outage. If it is known that events of a certain type tend to occur more frequently or with higher impact at a certain time of year, then the causation factors behind these events can be better assessed, and options to mitigate them better developed.

Forecast changes in DO

Changes to forecast DO can be made in the following circumstances:

- Where sustainability reductions, climate change, severe drought or water quality are forecast to impact DO at known times in the future
- where these changes would affect the magnitude of outage impacts on DO
- where these impacts could be material to the supply demand balance, companies should adjust outage magnitude distributions.

This can be done in the outage platform by adding an extra distribution row(s) for the relevant sourceworks and event types for relevant years in the future and adjusting the magnitude distributions as appropriate. For gradual changes, we recommend specifying new rows no more frequently than 5-year intervals. Sensitivity testing should be applied to decide what magnitude of future change in DO is sufficient to justify adjusting outage distributions.

WRMP outage allowance modelling

Sensitivity testing

Sensitivity testing should be carried out to test the impact on outage allowance of any outage analysis or modelling decisions based on assumptions, where these may be material to the supply demand balance.

A strategy for sensitivity testing should be based on an initial review of the contribution to outage of different event types and sourceworks. Where event types/sourceworks make very little contribution, there is no need to test assumptions relevant only to those types/sourceworks, unless the subjective decision could have dramatically reduced the outage contribution.

If materiality is in doubt, an assumption should be tested: the costs of testing are likely to be many orders of magnitude less than the WRMP investment costs or economic drought costs due to an incorrect outage allowance.

Decisions likely to require sensitivity testing are as follows:

- The clipping of historical data records
- Any data infilling
- Partial outage systematic error corrections, or application of generic partial outage distributions
- Including/excluding events that are on the boundary with system resilience: relatively high impact, low likelihood events, where it is unclear whether or not they should be included or not
- Including/excluding events that may be accounted for in target headroom
- Uncertain magnitude/duration/likelihood adjustments or exclusions to account for capital investment

- Uncertainties in DYAA DO recovery
- Uncertainties over seasonality
- System simulation uncertainties
- Event correlation uncertainties
- Applying generic WRZ or event type distributions rather than historical event-based distributions
- Future DO changes' materiality to outage.

Identifying and accounting for WRMP options

Final preferred scenario

Companies should take account of the final preferred programme of options when modelling outage for the final preferred planning scenarios.

How new options are accounted for depends on the option type and nature of the supply demand driver(s) is detailed as follows:

- For new options replacing supply-side losses that are very similar to the sources being lost, the original outage event data may be representative of the new sources. Outage should have been reduced over time to account for the DO loss in the baseline scenario, and in the final preferred scenario, the reductions in outage can simply be removed (outage added back in).
- For new options replacing supply-side losses, whose outage risk is very different to that of the original sources, or for options to mitigate increasing demand, generic outage distributions should be applied using average distributions for the most representative sources (with failure risk similar to that of a new source), or WRZ-average distributions, where WRZ resources are similar enough to the new option from an outage-risk point of view.
- If companies have no representative sources on which to base their outage allowance, they should consider requesting representative outage duration, likelihood and magnitude data from the WRSE group for similar resource types.

Regulators have indicated their expectation that the overall outage allowance as a % of DYAA demand would be expected to fall over time, as companies become more adept at managing outage risk and as a result of capital maintenance investment. Adding outage allowance for new options is likely to be offset by rising demand, and for sources of a similar type, the specified outage allowance should be lower than that in the baseline forecast. This may not always be possible. For example, if inherently reliable groundwater resources are replaced by effluent reuse (perhaps for sustainability reasons), then the complexity of the replacement source may increase, not reduce, outage allowance, and it would do so for legitimate reasons. The key is that companies can explain the increase and demonstrate that they have mitigated outage risks from the new source as far as they can.

Strategic Regional Options (SROs)

For SROs, companies are unlikely to have a sufficient range of events of each type at similar sourceworks, if any, on which to base generic probability distributions. We therefore recommend that companies share their outage event data for all SRO sourcework types, to enable such distributions to be derived.

These distributions should be regularly updated as new events occur, ideally on an annual basis. Data may be anonymised to reduce any risks associated with the security of sources or commercial risks to the water company

Identifying outage options

Companies should aim to identify options to generate DO benefit, and also options to improve system resilience, in line with the WRSE guidance on system resilience.

To identify DO benefit options, companies should review the outage allowance breakdown by source and event type, and identify those making the greatest contribution to outage under the critical planning scenario.

For each of these types, consideration should be given to what interventions could be made to reduce outage magnitude, duration or likelihood. Where feasible options exist, a new model run should be undertaken with the relevant outage distribution(s) adjusted to reflect the intervention. The reduction in outage allowance should then be used to specify the DO (WAFU) benefit of the option.

Other benefits/impacts of the intervention should be specified in line with the company's normal process for evaluating options and the option taken forward for development and appraisal.

For failure types relating to pollution of any sort, companies should look to the wider catchment to find blue-green solutions first, before identifying hard infrastructure options.

To identify potential resilience-only options for WRSE regional planning, and company resilience plans, companies should follow the resilience guidance specified by WRSE to seek out options that would materially increase the score of one or more WRSE resilience metrics. While these are still under development, the most relevant metrics are:

- Metric R3 – Vulnerability of Infrastructure to Other Hazards
- Metric R5 – Catchment & raw water quality risks

Resilience options should be taken forward in the regional planning process for appraisal and selection

Materiality considerations

Our gap analysis showed that all WRSE companies already apply the same event-based, bottom-up method to determine outage allowance, irrespective of problem characterisation. Given data availability and the reliability of this approach, we see no reason for companies to move away from this method, whatever their problem characterisation.

Problem characterisation should be used to inform the effort to which companies go to deliver all aspects of this common methodology, within the methodology proposed.

Two key factors should be considered:

1. The materiality of the outage allowance for a particular WRZ to the water resource planning problem for both the company and WRSE. We propose a material outage allowance is one where either:
   - the outage allowance is >10% of the deficit in a WRZ or any directly neighbouring WRZs; or
   - the outage allowance is > 20 Ml/d.
2. The materiality of each item of the methodology to the outage allowance for the WRZ. We propose a material outage item is one where its impact on the allowance is the lower of:
   - 10% of the total WRZ outage allowance
   - The Ml/d difference between the P75 outage allowance and the P95 outage allowance.

For non-material outage allowances, companies should aim to adopt the methodology here but only to the extent that time and resources allow. Where a WRZ outage allowance is material, each aspect of the WRSE methodology should be tested for sensitivity and then applied as far as necessary to reduce its uncertainty impact on the overall allowance to below 10%.

Materiality is relevant in particular to: partial outage magnitudes; DYAA DO recovery; system simulation of outage magnitude/duration; capital investment adjustments; forecast changes in DO. Companies should always attempt to account for these, but where significant effort is required (e.g. system simulation modelling), this should only be undertaken where the impacts could be material to the outage allowance.

<u>Examples</u>:

1. A WRZ is forecast a surplus >20% of DI throughout the planning period, the WRMP19 outage allowance for the WRZ was 1 Ml/d and DI was 20 Ml/d. The company has a deficit of 5 Ml/d in a neighbouring zone, but no other deficits. In this case, the outage allowance is clearly not material to WRSE, or the WRZ itself. It is unlikely to be material to the neighbouring zone either, but 0.5 Ml/d could enable some additional transfer to be provided. Therefore, the company should only apply methodology items specified here to the extent they would (in combination) impact outage allowance by at least 0.5 Ml/d.

2. A WRZ is forecast a surplus of >20% of DI at all times, but the WRMP19 outage allowance was 30 Ml/d. In this case, the outage allowance is potentially material to WRSE. The initial WRMP24 outage run suggests WRMP24 outage of 28 Ml/d and a range in outage between P75 and P95 of 2 Ml/d. This range is less than 10% of the WRZ outage, so elements of the methodology should be applied to the extent they could impact outage by at least 2 Ml/d. If an area of uncertainty would have only 1.8 Ml/d of impact, no further work is needed to resolve that area of uncertainty.

4 Next steps

4.1 We consulted on this Method Statement from 31st July 2020 to 31st October 2020. This Method Statement has now been updated to take into account the comments we receive during this consultation process and has been published on our website.

4.2 We may need to update parts of our Method Statements in response to regulatory reviews, stakeholder comments or improvements identified during the implementation phase of the methodology.

4.3 If any other relevant guidance notes or policies are issued, then we will review the relevant Method Statement(s) and see if they need to be updated

Appendix 1: Programme

	Activity	Month w/e	June 05-Jun	12-Jun	19-Jun	26-Jun	July 03-Jul	10-Jul	17-Jul	24-Jul	31-Jul	August 07-Aug	14-Aug	21-Aug	28-Aug
2	**Task 1 - Assess current practice**														
2.1	**Define assessment criteria**														
2.1.1	Review relevant guidelines and assessment criteria														
2.1.2	Create framework of questions and assessment criteria														
2.2	**Review practice against criteria**														
2.2.1	Circulate framework of questions to stakeholders														
2.2.2	Review outage reports/assessments														
2.2.3	Conduct interviews with companies & regulators														
2.2.4	Compile results and undertake gap analysis														
2.3	**Task 1 - Report**														
2.3.1	Assess consistency in outage reporting and assessment														
2.3.2	Prepare draft Stage 1 report and issue to WRSE														
2.3.3	Present findings to WRSE														
2.3.4	Finalise report on receipt of feedback														
3	**Task 2 - Develop improved approach**														
3.1	**Develop methodology**														
3.1.1	Develop improved method to address inconsistencies														
3.1.2	Develop methods to record outage data consistently														
3.2	**Test proof of concept**														
3.2.1	Request/receipt of sample data for 1 WRZ for each company														
3.2.2	Review data, build proof of concept models to test method														
3.2.3	Models and guidance sent to companies to complete and run														
3.2.4	Companies apply own data to models to test method														
3.2.5	Provide telephone support to companies														
3.2.6	Compile results and structured feedback from companies														
3.2.7	Consider use of data platform to record/process outage data														
3.2.8	Compile findings and present at stakeholder workshop														
3.3	**Develop full methodology**														
3.3.1	Draft complete methodology including next steps														
3.3.2	Review and QA														
3.3.3	Issue to WRSE for review and discuss feedback														
3.3.4	Update methodology														
3.3.5	Final methodology inc. next steps and further improvements														
3.4	**Project management**														
3.4.1	Regular liaison with steering group														

Appendix 2: Detail of outage approach

Figure 5: Data capture and initial analysis summary of approach

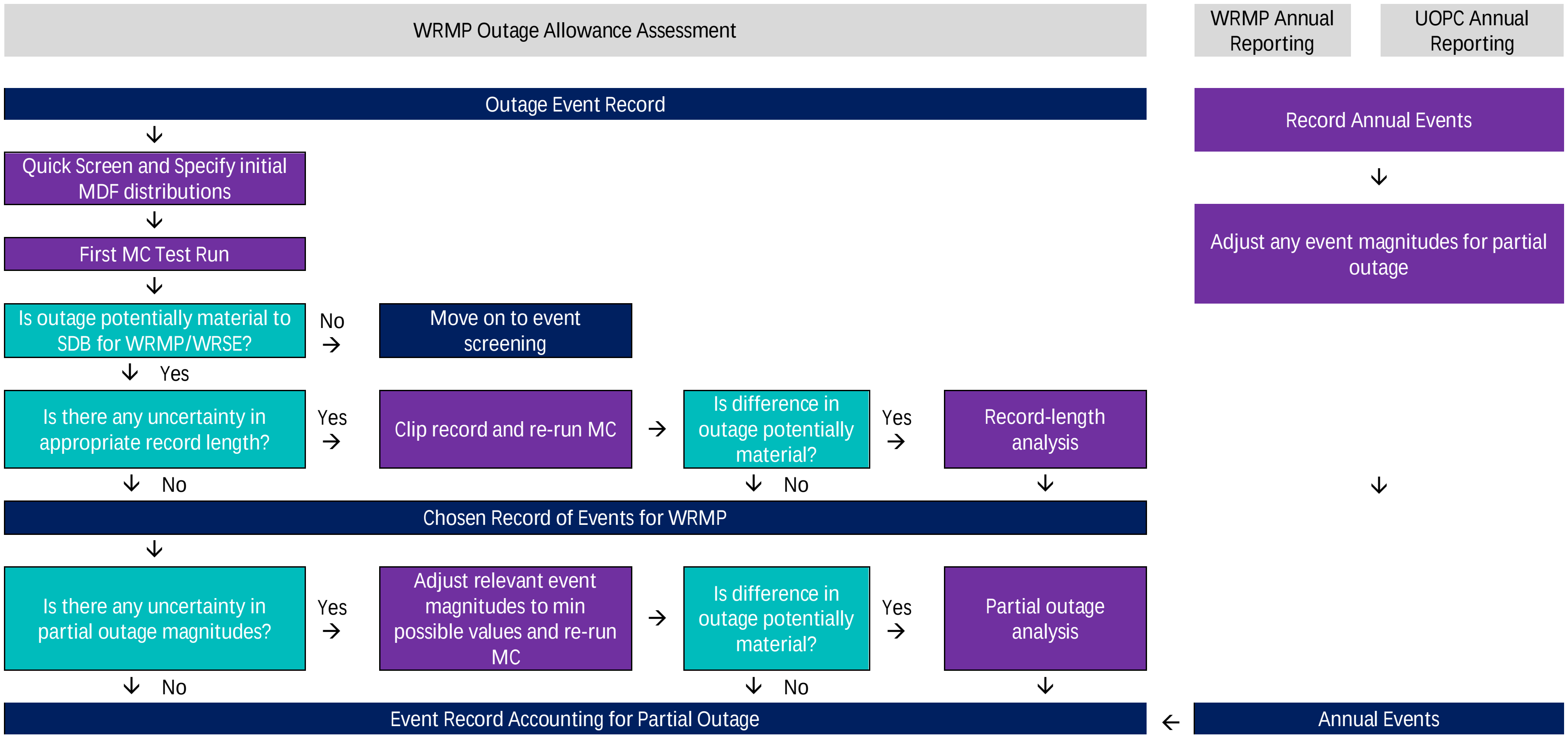


Figure 6: Legitimate event screening summary of approach

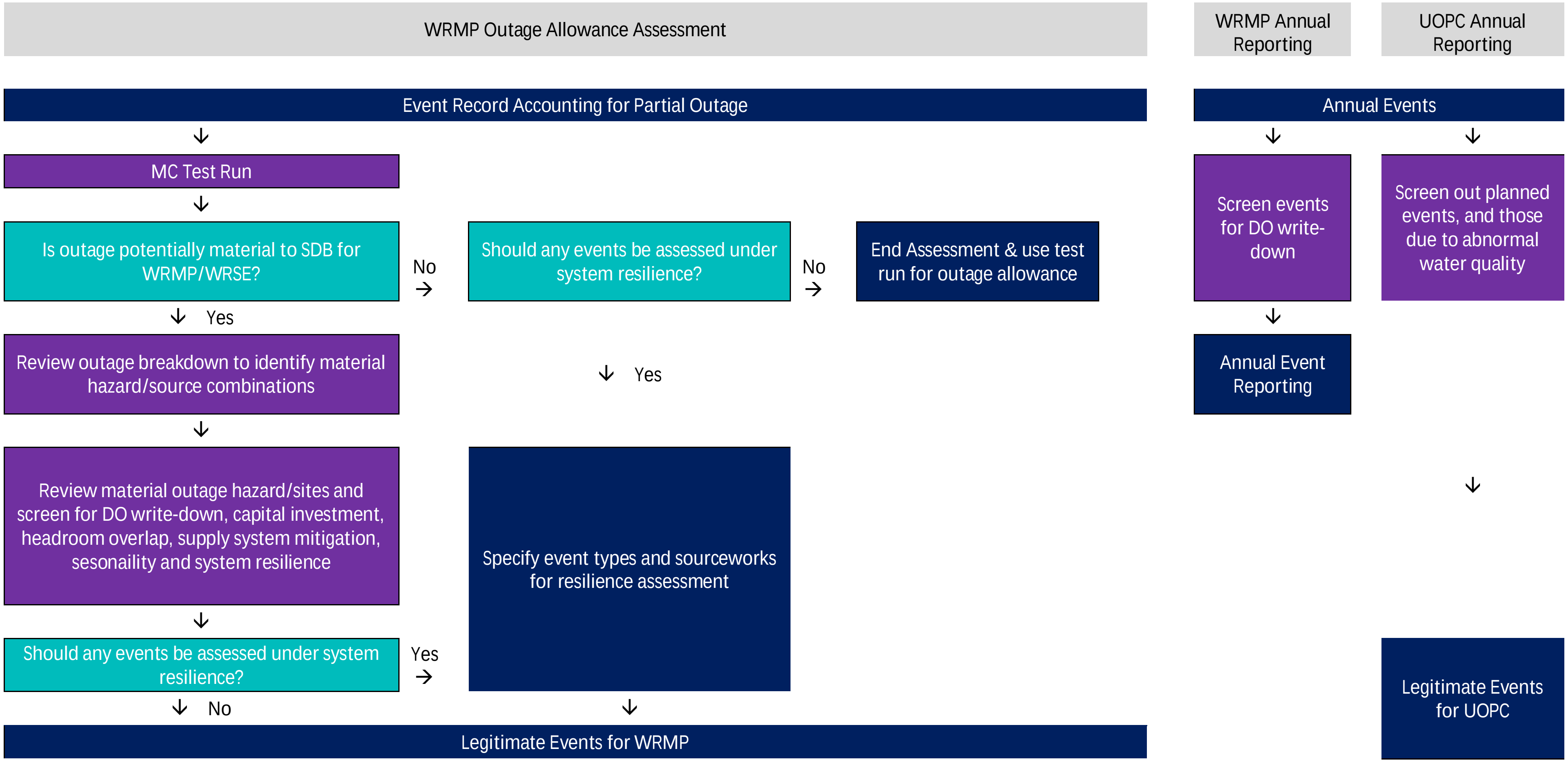


Figure 7: Summary of approach to event adjustments

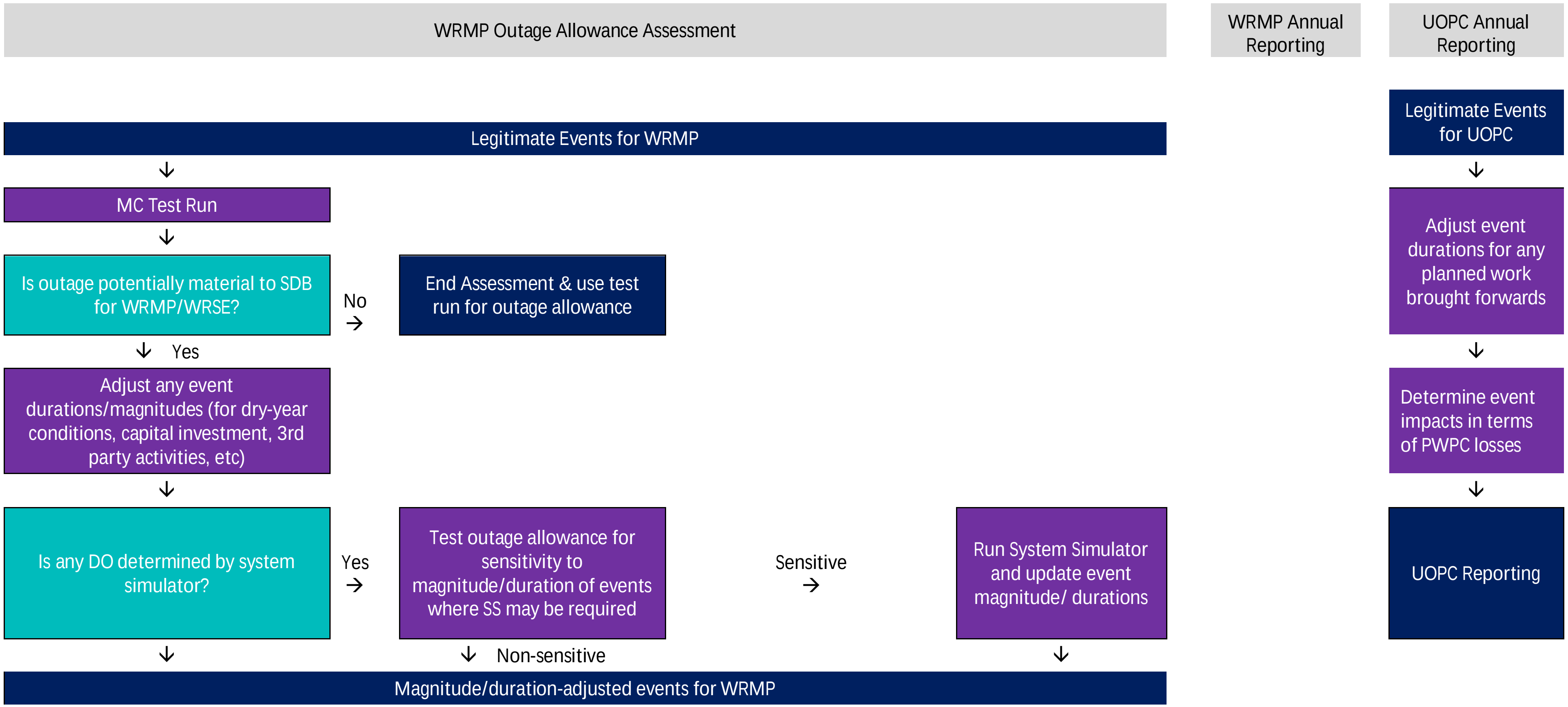


Figure 8: Probability distribution function adjustment summary of approach

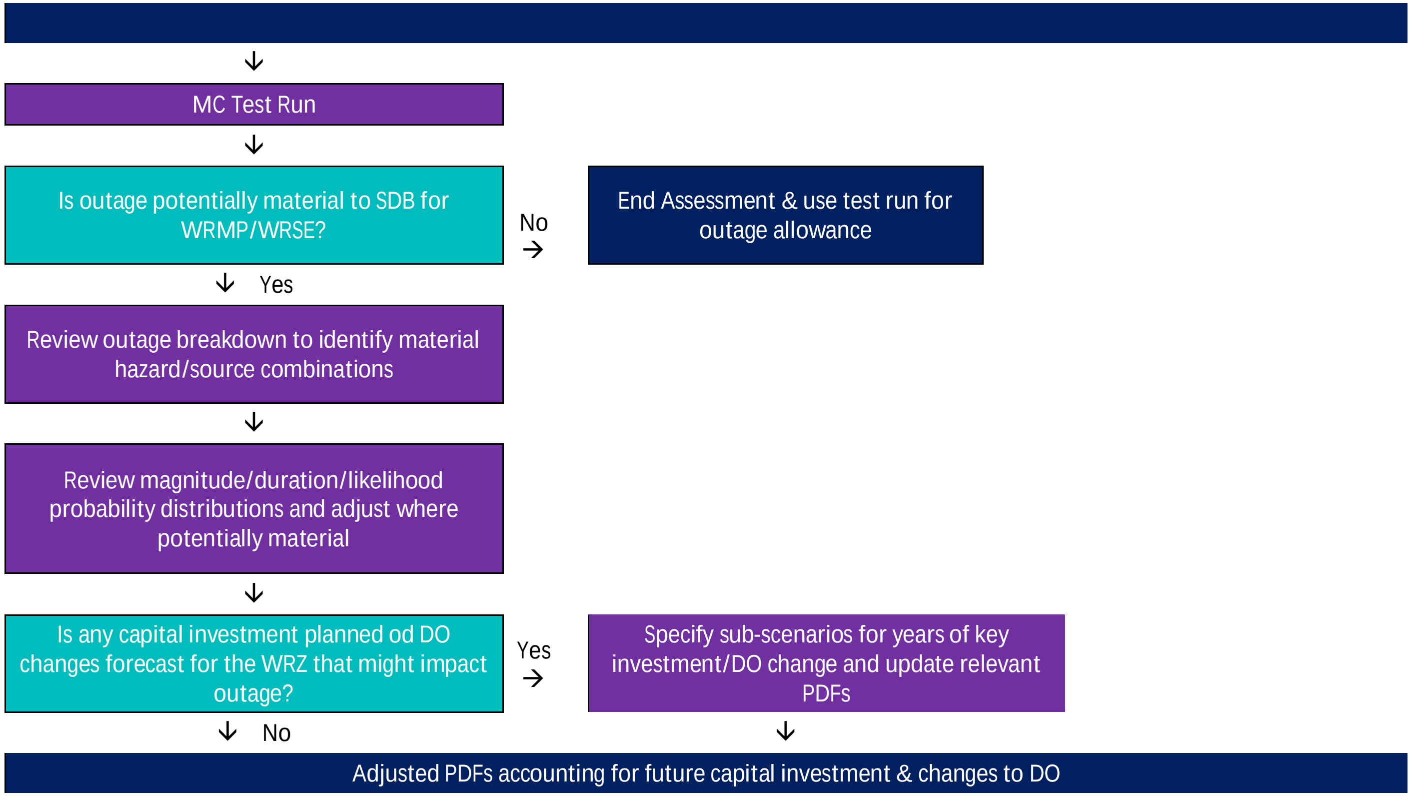
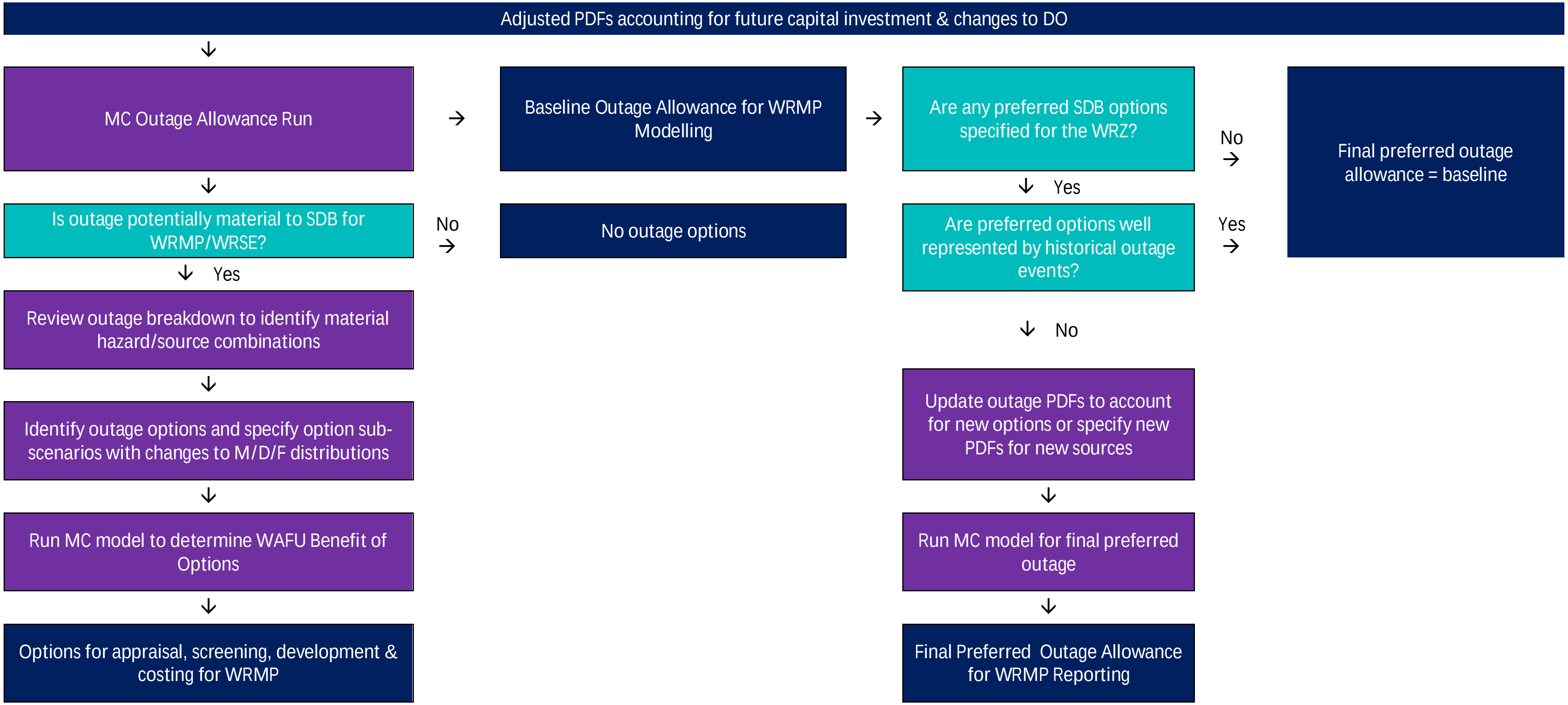


Figure 9: Summary of approach to scenarios & options



Appendix 3: WRSE outage modelling tool

The WRSE outage modelling tool (OMT) is an Excel-based spreadsheet platform developed to enable consistent reporting and analysis for annual reporting to the Environment Agency, reporting to Ofwat for specifying performance against the unplanned outage PC, and for WRMP outage allowance determination

Overview of the OMT

The WRSE outage modelling tool (OMT) is designed to do the following:

- Compile and process company outage events into a single consistent format for all purposes
- Enable consistent screening to identify legitimate events for both sets of annual reporting and for WRMP outage allowance calculations
- Determine appropriate probability distribution functions for the duration, magnitude and likelihood of event types at each relevant sourceworks, taking account of dry year scenario response, potential for deployable output recovery, planned capital investment, etc
- Calculate the WRMP outage allowance for each planning scenario
- Evaluate the key causes of outage and their impacts on the supply demand balance
- Identify WRMP options to reduce the outage allowance required, and therefore increase WAFU
- Determine the WAFU benefits of these options, which can then be taken forward for development and appraisal.

The tool comprises 15 worksheets, as follows.

Worksheet	Purpose	User interaction
Cover	Record dates and user details. Log changes to the OMT between different iterations	Text inputs
Instructions	Describe how the OMT should be used	Reference only
Process	A recommended approach to delivering the outage assessment for outage allowance, with approx. time requirements and an example programme	Reference only
Screening Guidance	Guidance for how to complete the Source DO and Outage Events sheets to identify legitimate events for reporting/modelling	Reference only
Source DO	Specify the source DO and PWPC values for determining outage magnitudes, and licensing information to help inform potential for DO recovery from outage	Data input & user interpretation
Outage Events	Compile all outage events; screening to identify legitimate events; adjustments to event magnitudes or durations for modelling purposes.	Data input & user interpretation

Worksheet	Purpose	User interaction
Settings	Specify the planning scenarios and sub-scenarios to be modelled and their durations, as well as the set of source names, WRZ names and event hazard types	Specification of key information
Fitted Distributions	An initial processing sheet to determine the statistical properties of every event type at each sourceworks	Refresh and reference only
Single Distribution	A review sheet to help inform choice of probability distribution for each event type/sourceworks combination	Drop-down chart review
Simple Fitted (2013)	A simpler version of the fitted distribution sheet for quick review of event type/sourceworks min/max/mean, for those without access to Power Query (Excel 2016)	Reference only
MC Inputs	Specifies the PDF parameters for duration, magnitude and frequency of event types at each sourceworks, under each modelled scenario and sub-scenario	Populate source names event types, (sub)scenarios, and specify distributions
MC Outputs	Outputs Monte Carlo outage allowance values for every decile of the probability distribution for all sources, event types and scenarios	Refresh and review
Charts	Displays the outage allowance results graphically by source and event type for selected percentiles and scenarios	Review to inform screening effort and identify interventions
Scenario Review	Presents graphs of probability and cumulative distribution functions for specified combinations of sources, event types and scenarios, to inform outage allowance for WRMP and specify option WAFU benefits	Drop down review and interpretation
Profiles	Compare outage allowance results for different sub-scenarios, to identify any changes in outage allowance over time or between sub-scenarios	Review and interpretation
@Risk Output	Outputs outage allowance results determined through @Risk to cross-check the Power Query results and compare to previous outage allowance determinations	Reference only, unless @Risk analysis preferred

The OMT is built in Microsoft Excel and uses code written in Microsoft Power Query to process data efficiently via a series of pivot tables. Power query is automatically enabled in Excel 2016 or later versions, but may need Power Query installed as an add-in for earlier versions.

A summary of the process for populating and running the tool is as follows.

Area	Ref	Task
Data Capture	1.1	Create a copy of the OMT for the WRZ
	1.2	Upload DO data and specify DYAA recovery potential
	1.3	Upload all potentially relevant outage data & categories
Initial Analysis	2.1	Run & check OMT model (refresh tables)
	2.2	Check P95 allowance for materiality to the WRMP/regional group
	2.3	Check data record length (clipping) materiality
	2.4	Update data record length

Area	Ref	Task
	2.5	Assess materiality of partial outage
	2.6	Adjust partial outage magnitudes
	2.7	Re-run OMT & re-check for WRSE materiality
Screen Events	3.1	Identify any material source/hazard combinations
	3.2	Screen relevant events as per Methodology
	3.3	Re-run OMT & re-check for materiality to the WRMP/regional group
Process Events	4.1	Review material site/hazard events and carry out M/D adjustments where appropriate
	4.2	Check where system simulation may be necessary and run OMT to check its potential materiality
	4.3	Scope system simulation requirements
	4.4	Carry out system simulation for outage impacts
Adjust PDFs	5.1	Refresh event distributions & review single distributions for material site/hazards. Update where necessary
	5.2	Adjust M/D/F material site/hazards distributions for future changes
	5.3	Re-run OMT & check any remaining areas of uncertainty for materiality. Identify outage allowance for the WRZ
Develop Options	6.1	Identify any material site/hazards that may be suitable for options to increase WAFU or provide wider resilience benefit
	6.2	Propose options to reduce event M/D/F & quantify the potential changes
	6.3	Adjust M/D/F distributions for options and re-run the OMT
	6.4	Re-run the OMT to identify option WAFU benefits
	6.5	Specify any resilience metric impacts
	6.6	Estimate intervention high level costs
	6.7	Identify potentially cost-effective options for the unconstrained list and inform the company's options appraisal team
	6.8	Specify rejected options for inclusion on the WRMP rejection register and inform the company's options appraisal team

Note that in the OMT, "ADO", "PDO" and "MDO" are used interchangeably with "DYAA", "DYCP" and "DYMDO" respectively. "Sourceworks" and "outage types" are used interchangeably with "Sites" and "Hazards" respectively. "Frequency" and "likelihood" are also used interchangeably when referring to probability distributions.