Dŵr Cymru Welsh Water

IAP Response

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Risk of Sewer Flooding in a Severe Storm

1 April 2019

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WSH.OC.A22 Risk of Sewer Flooding in a Severe Storm

Nature of Adjustment (Summarise how you have responded to this action)

1.1. Background

Since the PR19 Business Plan submissions in September, the industry has come together under the auspices of Water UK to address concerns that companies used different approaches and methodologies to calculate their targets for this new measure.

Following an internal review of the November 2017 Atkins report on Developing and Trialling Resilience Metrics and discussions with other WASCs an industry workshop to clarify key aspects of the methodology was held in February 2019. The purpose of the meeting and follow up discussions was to ensure greater transparency and comparability of approach across the industry particularly in those areas where the methodology is silent or unclear.

In order to conform to the common industry view on the standard definition and methodology, we have recalculated our forecast (2019-20) and target (2020-25) numbers and are resubmitting these in our App1 table.

1.2. Approach taken in our Business Plan September 2018

Full and accurate calculation of this measure requires complex and lengthy modelling work across our catchments. This was not possible to achieve in the limited time available before the September 2018 Business Plan submissions. As a result, our targets were based on the results of a necessarily limited exercise that modelled the flooding risk of a small sample of catchments, equivalent to less than 5% of our population with the results extrapolated to the whole of our area of service.

The Atkins methodology requires some major assumptions, notably around whether smaller catchments should be included; the interpretation of the catchment vulnerability definitions; the methodology for flood routing; flooding depth and the criteria underlying when a property is deemed to be "flooded" or not; the average occupancy of properties affected and the denominator used to calculate the percentage of our customers at risk of flooding. All of these factors have a significant impact on the estimated number of customers at risk.

Our September 2018 approach avoided some of these potential areas of uncertainty and estimated that 3.6% of customers in our sample area are subject to flooding risk. This figure was extrapolated to the rest of our operating area to provide our PR19 business plan submission. We were also able to estimate that this figure would increase by around 5.2% over the course of AMP7 without intervention as a result of climate change, urban creep and growth using our Sustainable Drainage Plan models. We then identified a target that would counteract the deterioration and deliver a further 5% targeted reduction to our end of AMP6 outturn over the course of AMP7. The estimates were heavily caveated in our submission, with confidence in our numbers expected to improve as Sustainable Drainage Plans are completed in the coming years.

1.3. Adopting the standard definition

Following the workshop in February this year we have now adopted, in full, the standard definition agreed with Water UK and as reported by Atkins in section 3.6 of the methodology and will report our results using the example tables shown in Appendix D "Worked Example of Assessment and Reporting".

We have included commentary on the following detailed elements of the process in Appendix A:

- The criteria used to assess the vulnerability of catchments and how customers living in high and medium vulnerability catchments have been treated in our report;
- The rationale for including all catchments in the assessment;
- Design rainfall basis and flood routing methodology used;
- Criteria for deeming whether a property is at risk of flooding;
- Occupancy levels and basis of calculating population at risk;
- Model confidence;
- Metric update programme;
- Principle assumptions underpinning the reported figures;

1.4. Impact of adopting a consistent approach

Conforming to the approach agreed by the industry has had a very significant impact on our forecast and target numbers. The reasons for this are due to the significant changes in the basis of the calculation. The three main factors in this change are:

- In place of estimating the number of customers at risk from a sample of modelled catchments, we have calculated an estimate for the 40% of our customers in catchments with suitable hydraulic models based on a flood routing method and all customers in unmodelled catchments that are classified as high or medium vulnerability have also been included in our figures for those at risk. This is in line with the Atkins methodology.
- The flood routing methodology has been altered to one that that better represents the risk to our customers from that used for the figure we included in our PR19 business plan submission last September.
- We have changed the denominator for calculating the percentage of our customers at risk from the total population to resident population only.

We have retained our aim of reducing the number of customers at risk by 5% compared with the figure reported in 2020 over the course of AMP7 as a 'real' improvement that would be delivered by physical resilience improvements in catchments. We also plan to improve our detailed understanding of the flood risk for our customers over the next few years by increasing our hydraulic model coverage. We expect to increase the percentage of customers in modelled catchments from 40 to 80% by the time we report our results in 2020 and increase this coverage further in the following years to around 85%. This investment in improved modelling should significantly reduce the percentage of customers reported to be at risk in the coming years, as it improves our understanding of our networks and reduces the number of customers reported to be at risk because they live in unmodelled high and medium vulnerability catchments.

1.5. Revised Estimate of Customers at Risk of Flooding in a Severe Storm

Table 1 provides summary figures of customers at risk of flooding in a severe storm.

Total operating area PE	PE in Modelled Catchments (at risk of flooding)	PE in Un-modelled High & Medium Vulnerability Catchments	Total PE at risk of flooding	Percentage PE served at risk of flooding
3,096,971	165,146	1,867,742	2,032,888	65.62%

Table 1 – Summary – Customers at risk of flooding in a severe storm.

Detailed tables are as specified in Appendix D of the Atkins guidance document ‘Developing and Trialling Wastewater Resilience Metrics’ and are included in the supporting document produced by

Additional evidence (please elaborate/reference) (Please include where appropriate)

Appendix A – Standard Definition Supporting Information

Appendix B - Ft2. Risk of Sewer Flooding in a Severe Storm

Appendix A – Standard Definition Supporting Information

This appendix provides summary detail of the processes undertaken in the implementation of the agreed approach in the guidance document 'Developing and Trialling Wastewater Resilience Metric' (Atkins for Water UK – November 2017).

CRITERIA USED TO ASSESS THE VULNERABILITY OF CATCHMENTS

The catchment vulnerability assessment is aimed at providing a mechanism to assess the vulnerability of our catchments against a range of characteristics relevant to the risk of flooding for our customers i.e. the impact of an extreme wet weather event on sewer capacity. We have utilised the full range of descriptive characteristics included in Appendix A of 'Developing and Trialling Wastewater Resilience Metric' (Atkins for Water UK – November 2017). To support this process we have developed a set of objective measures to apply to the descriptive criteria in order to determine the vulnerability grade of catchments and to mitigate some of the subjectivity associated with this assessment.

INCLUDING ALL CATCHMENTS IN THE ASSESSMENT

We have chosen not to apply a catchment size exclusion to our assessment of flooding risk. Nearly 10% of our customers would have been excluded from the assessment because they lived in small catchments, whether or not they are at risk of flooding. Consequently all WwTW catchments have been included in the assessment. The rationale for this decision is that this provides the true flooding risk picture for the whole of our operating area and for all of our customers.

FLOOD ROUTING METHODOLOGY

Our decision was to use a different pseudo 2D flood routing methodology than that used for the September 2018 submission. This decision was made following trialling of all potential methodologies outlined in the Atkins guidance. These included flood node buffers, detailed 2D modelling and two pseudo 2D processes. The pseudo 2D methodology selected provided more accurate results than flood buffering and process time was significantly shorter than a detailed 2D approach. Therefore, using a pseudo 2D approach was considered pragmatic and appropriate. Comparison of the pseudo 2D approaches considered showed that one, WSP's FRM tool, provided an answer similar to that generated by full scale 2D approach whilst the other, used to provide the estimate for the September 2018 submission produced a much lower number. We feel the WSP FRM tool gives a better representation of the flood risk for customers and consequently we have adopted this approach.

The pseudo 2D analysis performs surface routing simulations of the flood flows. The routing algorithm accounts for the local relief, as well as local surface characteristics such as surface roughness and infiltration characteristics. The process models flood surface routing over a uniform grid of square cells based upon LiDAR data and land use taken from OS MasterMap.

The simulation results created by the pseudo 2D analysis report the maximum depth of flooding at each cell for that storm. Individual flood maps are produced for each scenario as well as worst case composite maps to show the peak flood levels.

DESIGN RAINFALL

There is no standard methodology for the generation of design rainfall. Currently, design rainfall contained within our model stock has been derived using either the Flood Studies Report (FSR) or Flood Estimation Handbook (FEH) methodologies with the majority derived using the FEH09 version. As new modelling studies are completed, there will be a gradual progression to the use of the newer FEH13 methodology. However, using the new design rainfall forecasts will increase the properties assessed to be at risk on the Ft2 measure because they build in the most recent climate change forecasts and provide a better picture of flooding risk for our customers. Understanding this impact is one of the reasons why we have chosen to use models updated for our sustainable drainage plans, to provide the underlying analysis for this report as well as an understanding of how we expect numbers to increase over the long term if we do not undertake work to increase the resilience of our networks.

CRITERIA FOR DETERMINING IF A PROPERTY IS AT RISK OF FLOODING

To determine which properties are at risk of flooding our address point GIS layer is used to identify habitable properties. The worst case flood routing output is then overlaid on this and if any flooding cell intersects a property (building) polygon it is included in the properties at risk of flooding output GIS layer. A nominal (0.5cm) flooding depth has been applied for modelling purposes but in effect a property, and its occupants, are considered to be at risk of flooding if any part of the building is touched by any depth of flooding.

OCCUPANCY LEVELS AND BASIS OF CALCULATING POPULATION AT RISK

A standard population density of 2.5 people per property has been assumed for this assessment. For the basis of the calculations and reporting 'population' refers to residential population exclusive of business/trade. This definition was agreed at the Water UK meeting on Consistency of Reporting for the Common Performance Measure (MOS Ft2) held on 6th February 2019. This differs from the definition of population that we utilised for the submission of 2017/18 figures, where total population was used, including business/trade flows. The residential population data source is our Table 17 (T17) master spreadsheet. A better occupancy estimate will be developed for future annual returns so that individual catchment occupancy rates can be used but 2.5 was felt to reflect a conservative but realistic estimate for this year's reporting.

MODEL CONFIDENCE

The resilience metric guidance states that a confidence grade must be applied to the models. We do not currently have a methodology for applying confidence grades to models, as it is considered extremely subjective for this purpose. This is because our models are generally very accurate in the areas with known risks but less so in other parts of the catchment. To apply a justifiable grade we would need to estimate an "average" confidence for the whole model which would be a subjective exercise. However, on the basis that all models to be used for estimating the risk of flooding have recently been updated and partially re-verified, as part of the sustainable drainage planning process, we have applied a standard model confidence grade of B3 for the purposes of this assessment. This is considered a precautionary approach as outlined in the Atkins guidance document. Section 3.6.1 of the guidance supports this approach and re-iterates that companies are expected to use their professional judgement when allocating the model confidence grades. This will be continually reviewed as SDP/DWMP models are updated in future AMPs.

METRIC UPDATE PROGRAMME

Modelling to provide information to support the completion of the metric reporting will continue as the SDP/DWMP programme continues. The 1 in 50 year return period simulations are now specified as standard as part of this process and the % of customers covered by modelled catchments will increase further over the coming years. Compilation of all available results will be undertaken annually in March in order to update the required tables for the Ft2 resilience metric.

PRINCIPLE ASSUMPTIONS UNDERPINNING THE FIGURES REPORTED

- It is assumed that the industry's standard software tools used to produce the current hydraulic models are capable of representing flooding at a 1 in 50 year return period with reasonable accuracy.
- There is no standard methodology for the generation of design rainfall. It is assumed the current standard methods employed to derive design rainfall included in the hydraulic models provide a good representation of severe flooding events.
- The modelled results represent flooding from the sewerage system only. It is assumed that the metric should not include pluvial/fluvial flooding.
- Modelling undertaken as part of the metric assessment assumes that our CSOs which protect customers during heavy rainfall will be able to discharge freely to other receiving water courses and drains during a 1 in 50 year return period storm.

Appendix B – Ft2. Risk of Sewer Flooding in a Severe Storm

FT2. RISK OF SEWER FLOODING IN A SEVERE STORM

Dŵr Cymru Welsh Water

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1 INTRODUCTION

RPS have been commissioned to collate the results from the assessments carried out to provide an estimate of percentage of population at risk of sewer flooding in a severe storm. This report details results of this assessment. The purpose of this report is to summarise the percentage of the population which is deemed to be at risk of sewer flooding in a severe storm, based on the analysis methodology outlined within the Atkins "Developing and Trialling Wastewater Resilience metrics" report as agreed at the WaterUK meeting on Consistency of Reporting for the Common Performance Measure (MOS Ft2) held on 6th February 2019.

A methodology for collating these results for DCWW has been provided: the methodology statement "MS MOS PR19 Ft2 Risk of Sewer flooding in a severe storm V6" provided by DCWW. The methodology states precisely how the results of this assessment should be collated and presented. RPS have produced this report in line with this agreed methodology.

1.1 Inputs

The inputs for the assessment are:

- Catchment Vulnerability Assessment results (technical note on methodology used to produce these results will be available on 10th April 2019 and will include a list of limitations of the approach and recommendations on how to improve it for future iterations)
- FRM results from 1-in-50-year return period storm simulations of 60, 240- and 480-minute durations for all available SDP models, as provided by WSP. Detailed QA has been carried out by WSP and an additional high-level sense check has been carried out by RPS on this data.

2 RESULTS

2.1 Assessment Summary

A summary of the level of assessment which has been carried out for each of the 835 level 3 catchments in the DCWW region is shown in Appendix A. A sample of the data is shown in Table 1 below for reference.

Table 1: Assessment Summary

Catchment ID	PE	Assessed vulnerability grade	Model available	Assessment
466	407	5	No	Option 1A assessment
467	139	5	No	Option 1A assessment
468	72	5	No	Option 1A assessment
469	951	5	No	Option 1A assessment
470	420	5	No	Option 1A assessment
471	125	5	No	Option 1A assessment
473	3,727	5	Yes	Option 1B assessment

2.2 Option 1A Results

For all catchments without a suitable model available, an Option 1A assessment has been carried out using the results from the catchment vulnerability assessment to assess percentage of population at risk from sewer flooding in a 1-in-50-year storm. It should be noted that the metrics used to determine catchment vulnerability are subject to considerable limitations. Details on these limitations can be found in the Catchment Vulnerability Assessment Methodology Technical Note which RPS will provide on 10/04/2019. The results of this are summarised in Table 2 below.

Table 1: Unmodelled report

Detailed Vulnerability Grade	Number of Catchments	Total PE in Catchments at Vulnerability Risk Grade	Percentage of Total Option 1A PE
5	622	464,477	24.87%
4	86	275,500	14.75%
3	93	1,127,765	60.37%
2	3	220	0.01%
1	0	0	0.00%
Totals	**804**	**1,867,962**	-

The Atkins report stipulates that for all catchments with a vulnerability grade of greater than or equal to 3 where there is no model available, the entire population of that catchment must be reported as vulnerable to sewer flooding in a severe storm (vulnerability of “medium” or “high”). For DCWW, in all catchments where no models were available at the time of the assessment, the percentage of total population reported as vulnerability grade 3 or higher is 99.99%.

2.3 Option 1B Results

For all catchments where a suitable model is available a more detailed assessment of the percentage of the population at risk from sewer flooding has been carried out by WSP using model simulation results and pseudo 2D analysis of flood routes using WSP's FRM tool. More details can be found on this approach in the methodology used for this report. A summary of the results of this study is shown in Table 3 below. Vulnerability assessed based on the Option 1B approach should be considered higher confidence than vulnerability assessed based on an option 1A approach.

Table 2: Modelled Report

High-level vulnerability grade	Total number of catchments	Total number of modelled nodes	Total number of nodes predicted to flood	Percentage of nodes predicted to flood	Total pe in modelled catchments at vulnerability risk grade	Total pe associated with flooding nodes	pe associated with flooding nodes as a percentage of total modelled pe	Assessed overall model confidence grade
5	14	53,801	8,342	16%	830,274	111,258	13%	B3
4	9	7,609	750	10%	30,513	3,340	11%	B3
3	8	30,653	4,700	15%	368,223	50,548	14%	B3

2.4 Summary of Option Coverage

The table below (Table 4) summarises the proportion of population served for which risk from sewer flooding in a severe storm has been assessed by the different methods available.

Table 3: Summary of Options

Total PE served	Total pe option 1a	percentage of total pe Option 1a	Total pe Option 1b	Percentage of total pe Option 1b
3,096,971	1,867,962	60%	1,229,010	40%

A high proportion of DCWW served population is not covered by a suitable model and consequently, the vulnerability of this proportion of the population is assessed using a lower confidence method. It is assumed that a larger proportion of population assessed using an Option 1A approach will be reported as vulnerable than if the same areas were assessed using an option 1B approach. This is because it is unlikely that model flooding predictions would suggest 100% of population served within the modelled catchment is likely to be at risk of flooding. Therefore, it is expected that as DCWW model coverage increases, the percentage of the population which would be considered vulnerable will decrease.

3 SUMMARY

3.1 Summary of Region Wide High-Level Vulnerability

The guidance document for reporting percentage of population at risk from sewer flooding in a severe storm stipulates that a table be provided to give a high level of understanding of vulnerability for those with less technical background. This can be viewed in Table 5 below.

For reference, population considered to be a low vulnerability grade is a combination of: catchments where no suitable model is available and catchment vulnerability assessment grade is <=2 (0.01% of population served) and; where models are available, the proportion of the population which is not considered at risk of flooding based on modelling assessment and pseudo flood routing carried out by WSP.

Population considered to be a medium vulnerability grade is a combination of all population not covered by a suitable model with a catchment vulnerability grade of 3 or 4, and population covered by suitable models that is predicted to be at risk of sewer flooding during a 1-in-50-year storm using model predictions in combination with pseudo flood routing methods.

Population considered to be highly vulnerable is built up the same way as medium but only for population within catchments that have an assessed catchment vulnerability grade of 5.

Table 4: High-Level Vulnerability Summary

Vulnerability Grade	Percentage of Total Population Served
L	34%
M	47%
H	19%

Appendix A

Assessment Summary