# APPENDIX G – Supporting Information

## G1. Problem Characterisation

*Introduction*

The **problem characterisation** assessment is a tool for assessing a company's vulnerability to various strategic issues, risks and uncertainties, to allow the development of a proportional response, in terms of effort and cost devoted to adopting the selected decision making approach. Its purpose is thus to help guide planners to the most appropriate decision making tools given the planning problem that they face, and provide them with an understanding that will help them select the **Risk Composition** and **component methods** that they need to use[1].

*Assess strategic needs ("How big is the problem?")*

This entails three simple 'headline' questions that explore the size of any potential supply demand deficit, and the cost (in relative terms) of the supply and demand management options.

The supply demand deficit has been separated into a supply component and a demand component, as it is possible to have a significant deficit that is mainly caused by either increasing demand or reducing yield (e.g. from climate change or the Restoring Sustainable Abstraction programme), so only one component may be 'of concern'.

| **Strategic WRMP risks** | **No significant concerns (Score = 0)** | **Moderately significant concerns (Score = 1)** | **Very significant concerns (Score = 2)** | **Don't know** |
|---|---|---|---|---|
| S. Level of concern that customer service could be significantly affected by current or future **supply side** risks, without investment. | 0 | - | - | |
| D. Level of concern that customer service could be significantly affected by current or future **demand side** risk, without investment. | 0 | | | |
| I. Level of concern over the acceptability of the cost of the likely **investment programme**, or that the likely investment programme contains contentious options (including environmental / planning risks). | 0 | | | |

*Table 1 - Assessment of the strategic needs for WRMP purposes*

[1] UKWIR (16/WR/02/11): *WRMP 2019 Methods – Risk Based Planning*

*Assess complexity factors ("How difficult is it to solve?")*

The second part of the problem characterisation stage is an assessment of the 'complexity factors'. The purpose of these is to explore the nature of the risks and vulnerabilities that exist within the WRMP, with a particular emphasis on identifying whether these complexities, in combination with the level of strategic risk, indicate that methods beyond the previous EBSD may be required. These factors will be used to provide general guidance on suitable approaches.

It is recommended that companies record any other concerns that they identify during the assessment of complexity factors. These may need further discussion with regulators and to be taken into account in determining the degree of modelling complexity required.

| **Supply side complexity factors** | **No significant concerns (Score = 0)** | **Moderately significant concerns (Score = 1)** | **Very significant concerns (Score = 2)** | **Don't know** |
|---|---|---|---|---|
| S(a): Are there concerns about near term supply system performance, either because of recent Level of Service failures or because of poor understanding of system reliability / resilience under different or more severe droughts than those contained in the historic record? Is this exacerbated by uncertainties about the benefits of operational interventions contained in the Drought Plan? | ✓ | | | |
| S(b): Are there concerns about future supply system performance, primarily due to uncertain impacts of climate change on vulnerable supply systems, including associated source deterioration (water quality, catchments etc), or poor understanding? | ✓ | | | |
| S(c): Are there concerns about the potential for 'stepped' changes in supply (e.g. sustainability reductions, bulk imports etc) in the near or medium term that are currently very uncertain? | ✓ | | | |
| S(d): Are there concerns that the DO metric might fail to reflect resilience aspects that influence the choice of investment options (e.g. duration of failure), or are there conjunctive dependencies between new options (i.e. the amount of benefit from one option | ✓ | | | |

| | | | | |
|---|---|---|---|---|
| depends on the construction of another option). These can both be considered as non-linear problems. | | | | |

*Table 2 - Assessment of supply side complexity for WRMP purposes*

| **Demand side complexity factors** | **No significant concerns (Score = 0)** | **Moderately significant concerns (Score = 1)** | **Very significant concerns (Score = 2)** | **Don't know** |
|---|---|---|---|---|
| D(a): Are there concerns about changes in current or near term demand e.g. in terms of demand profile, total demand, or changes in economics / demographics or customer characteristics? | ✓ | | | |
| D(b): Does uncertainty associated with forecasts of demographic / economic / behavioural changes over the planning period cause concerns over the level of investment that may be required? | ✓ | | | |
| D(c): Are there concerns that a simple 'dry year / normal year' assessment of demand is not adequate e.g. because of high sensitivity of demand to drought (so demand under severe events needs to be understood), or because demand versus drought timing is critical. | ✓ | | | |

*Table 3 - Assessment of demand side complexity for WRMP purposes*

| **Investment programme complexity factors** | **No significant concerns (Score = 0)** | **Moderately significant concerns (Score = 1)** | **Very significant concerns (Score = 2)** | **Don't know** |
|---|---|---|---|---|
| I(a): Are there concerns that capex uncertainty (particularly in relation to new or untested technologies) could compromise the company's ability to select a 'best value' portfolio over the planning period? | ✓ | | | |
| I(b): Does the nature of feasible options mean that construction lead time or scheme promotability are a major driver of the choice of investment portfolio? | | ✓ | | |
| I(c): Are there concerns that tradeoffs between costs and non-monetised 'best value' considerations (social, environment) are so complex that | ✓ | | | |

| | | | | |
|---|---|---|---|---|
| they require quantified analysis (beyond SEA) to justify final investment decisions. | | | | |
| I(d): Is the investment programme sensitive to assumptions about the utilisation of new resources, mainly because of large differences in variable opex between investment options? | ✓ | | | |

Reviewing the outcomes of problem characterisation

| | | Strategic Needs Score ("How big is the problem") | | | |
|---|---|---|---|---|---|
| | | 0-1 (None) | 2-3 (Small) | 4-5 (Medium) | 6 (Large) |
| **Complexity Factors Score ("How difficult it is to solve")** | Low (<7) | ☺ | | | |
| | Medium (7-11) | | | | |
| | High (11+) | | | | |

Low level of concern

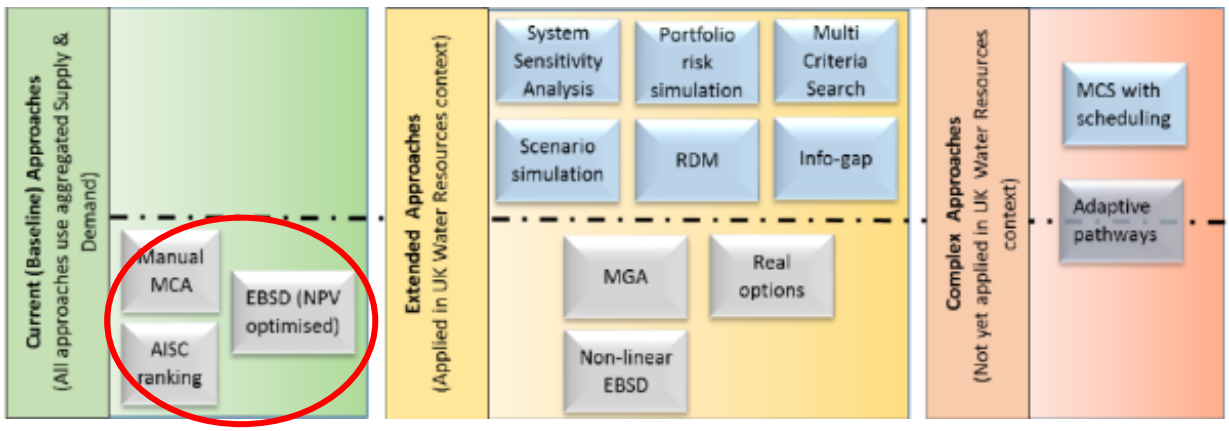
- 'Current' approaches (EBSD) should be adequate, and specific complexities can be examined through the steps recommended in the parallel UKWIR *Risk Based Planning Methods* project.

Moderate level of concern

- 'Extended' approaches to modelling may add considerably to a company's understanding.

High level of concern

- Consider whether it would be useful to apply more than one of the 'extended' approaches to decision making, or even the use of the 'complex' approaches, as these could add considerably to the company's understanding.



| Characterisation Aspect | What to note to support Risk Based Method Decisions | What the notes will be used for |
|---|---|---|
| Overall Strategic Need | Whether the area falls into the Low, Medium or High vulnerability classification. | Higher levels of strategic need are likely to require more complex Risk Composition, and can lead planners towards adopting more complex integration methods. |
| Supply Side Complexity *concerns* | a) Significance of concerns about the uncertainties that the company faces in terms of (current day) drought resilience (question S(a)).<br>b) Significance of concerns about the adequacy of a single 'DO' metric in describing drought risk for the supply system (question S(d)). | Supports the decision about the Risk Composition but also guides practitioners to consider more complex methods for determining:<br>a) The definition of risk / return period for supply / DO variability or generated timeseries.<br>b) The need for, and complexity of methods used for the generation of Drought Events or Libraries outside of the events observed in the historic record. |
| Demand Side Complexity *concerns* | c) Significance of concerns about uncertainties in the demand forecast (question D(a)).<br>d) Significance of concerns about the level of sensitivity of DO calculations to the inter-annual variability and 'shape' of demand profiles (question D(d)). | Supports the decision about the Risk Composition but also guides practitioners to consider more complex methods for determining:<br>c) The possible need for probabilistic demand forecasting (as opposed to simple Target Headroom type assessments).<br>d) The need to define the variability in demand beyond a simple dry year / normal year evaluation. |
| Investment Complexity *concerns* | e) Significance of concerns about the sensitivity of the plan to capex uncertainties.<br>f) Significance of concerns about the sensitivity of the Plan to utilisation and opex of new options (e.g. where options such as desalination or effluent re-use might form part of the Plan). | Leads practitioners to consider the use of the following extended methods for investment / cost analysis:<br>e) Risk based discounting and/or improved methods for evaluating capex uncertainty.<br>f) More complex integration methods (probabilistic methods or complex sampling) that better define utilisation. |

# G2. Target Headroom Assessment

As discussed in Appendix C, we used *A Practical Method for Converting Uncertainty into Headroom (UKWIR Report Ref. 98/13/1)* methodology to determine our target headroom. The assessments for each WRZ are set out below.

## Chester WRZ

*Form 1A*

| | |
|---|---|
| **Purpose** | Summary information and headroom results |
| **Use** | Record company and resource zone details and calculation summary |
| **Ref** | Steps 1, 7 and 8 of the step-by-step guide |

**COMPANY AND RESOURCE ZONE DETAILS**

| | |
|---|---|
| **Company name** | Dee Valley Water |
| Resource zone name / ref | Chester (CHR) |
| Level of service | 1 in 40 |
| Climate change incorporated? | |
| Version | Draft |
| Prepared by | Liz Franks |
| Job Title or Position | Water Resources & Catchment Specialist (Wales) |
| Reviewed by | |
| Job Title or Position | |

**RESULTS OF HEADROOM CALCULATION**

| | | Present day → Planning horizon | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | | 2016/17 | | | | | | 2044/45 |
| H1 | Water available for use (Ml/d) | 28.98 | | | | | | 27.25 |
| H2 | Target Headroom (%) | 6.45 | | | | | | 6.55 |
| | | 0% CC | | | | | | 0.27% CC |
| H3 | Target Headroom (Ml/d) | 1.87 | | | | | | 1.78 |
| | | 0 CC | | | | | | 0.074 CC |
| H4 | Available Headroom (Ml/d) | 3.90 | | | | | | 3.41 |

## Form 1B

| | |
|---|---|
| **Purpose** | To highlight those uncertainties that affect the resource |
| **Use** | Select those factors that affect the resource zone under study |
| **Ref** | Step 2 of the step-by-step guide |

| Row | Factor ref. | Factor | Include (Y or N) | Justification for exclusion of factor |
|---|---|---|---|---|
| H5 | S1 | Vulnerable Surface Water Licences | N | NRW have confirmed no change or unlikely to change |
| H6 | S2 | Vulnerable Groundwater Licences | N | As above |
| H7 | S3 | Time Limited Licences | N | No time limited licences in this WRZ |
| H8 | S4 | Bulk Transfers | N | Negligible (Old Warren - DCWW import) |
| H9 | S5 | Gradual Pollution Causing a Reduction in Abstraction | N | We have not been made aware of any abstractions within the WRZ that are susceptible to gradual pollution |
| H10 | S6 | Accuracy of Supply-Side Data | Y | *This factor must be assessed for all resource zones* |
| H11 | S7 | Single Source Dominance and Critical Periods | Y | River Dee |
| H12 | S8 | Uncertainty of Climate Change on Yield | N | Our climate change assessment for Chester WRZ doesn't meet the methodology criteria. |
| H11 | D1 | Accuracy of Sub-Component Data | Y | *This factor must be assessed for all resource zones* |
| H12 | D2 | Demand Forecast Variation | Y | *This factor must be assessed for all resource zones* |
| H13 | D3 | Uncertainty of Climate Change on Demand | Y | |

## Form 2A

| | |
|---|---|
| **Purpose** | Data requirements and availability |
| **Use** | Check list of data required for the headroom calculation |
| **Ref** | Step 3 of the step-by-step guide |

| Factor Ref. | Factor | Data required | Units | Data available (Y/N) |
|---|---|---|---|---|
| | General | Water Available for Use from the present day to the planning horizon | Ml/d | ✓ |
| S1 | Vulnerable Surface Water Licences | The names of all the surface water licences that the water company believes may be vulnerable to a reduction in abstraction. This does not include reductions due to gradual pollution. | - | - |
| | | Estimate of DO at risk for each source | Ml/d | 0 |
| S2 | Vulnerable Groundwater Licences | The names of all the ground water licences that the water company believes may be vulnerable to a reduction in abstraction. This does not include reductions due to gradual pollution. | - | - |
| | | Estimate of DO at risk for each source | Ml/d | 0 |
| S3 | Time Limited Licences | The names and expiry dates for all the Time Limited Licences that the water company will actively pursue for renewal | YYYY | - |
| | | The Time Limited Licence volume at risk | Ml/d | 0 |
| S4 | Bulk Transfers | Names of all the bulk transfers into the resource zone | | ✓ |
| | | The DO or transfer rate of bulk transfer | Ml/d | ✓ |
| S5 | Gradual Pollution Causing a Reduction in Abstraction | The names of all sources whose abstraction is at risk from reduction due to gradual pollution | - | - |
| | | The DO at risk from gradual pollution for each source | Ml/d | 0 |
| S6 | Accuracy of Supply-Side Data | Average, or typical, length of gauging and/or level record used in calculation of resource zone WAFU | yrs | ✓ |
| | | Sufficiency of data used in analysis | - | ✓ |
| | | Accuracy of flow naturalisation (if applicable) | - | ✓ |
| S7 | Single Source Dominance and Critical Periods | The largest deployable output from a source in the resource zone. This DO figure should be that quoted in the WR | Ml/d | ✓ |
| | | The name of the above source | | ✓ |
| | | The critical period of the resource zone | | ✓ |
| S8 | Uncertainty of Climate Change on Yield | Resource zone WAFU at planning horizon for the four climate change scenarios detailed in the UKWIR/EA 'Effects of climate change on river flows and ground water recharge' report 97/CL/04/1 | Ml/d | ✓ |

*Form 2B*

| | |
|---|---|
| **Purpose** | Data requirements and availability |
| | Check list of data required for the |
| **Use** | headroom calculation |
| **Ref** | Step 3 of the step-by-step guide |

| Factor Ref. | Factor | Data required | Units | Data available (Y/N) |
|---|---|---|---|---|
| D1 | Accuracy of Sub-Component Data | The reliability band for the data components used in the initial water balance and the demand forecasts | | ✓ |
| | | An estimate of the reconciliation item from the initial water balance | Ml/d | ✓ |
| D2 | Demand Forecast Variation | *Either*<br>Dry year annual average unrestricted demand (best estimate) up to planning horizon | Ml/d | ✓ |
| | | Dry year annual average unrestricted demand up to planning horizon - upper forecast | Ml/d | ✓ |
| | | Dry year annual average unrestricted demand up to planning horizon - lower forecast | Ml/d | ✓ |
| | | *Or*<br>Dry year unrestricted crtical demand (best estimate) up to planning horizon | Ml/d | - |
| | | Dry year unrestricted critical demand up to the planning horizon - upper forecast | YYYY | - |
| | | Dry year unrestricted critical demand up to the planning horizon - lower forecast | Ml/d | - |
| D3 | Uncertainty of Climate Change on Demand | Water company best estimate forecast of the impact of climate change on demand | Ml/d | ✓ |

## *Form 3A*

| | |
|---|---|
| **Purpose** | Target Headroom Calculation |
| **Use** | To calculate the target headroom for the resource zone |
| **Ref** | Steps 4, 5 and 6 of the step-by-step guide / Score guidance notes |

| | | | Present day → | | | | | | Planning horizon | $S^2$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Row** | **Factor ref.** | **Factor** | 2016/17 | | | | | | 2044/45 | 2016/17 | 2044/55 | |
| H14 | S1 | Vulnerable Surface Water Licences | 0 | | | | | | 0 | | | |
| H15 | S2 | Vulnerable Groundwater Licences | 0 | | | | | | 0 | | | |
| H16 | S3 | Time Limited Licences | 0 | | | | | | 0 | | | |
| H17 | S4 | Bulk Transfers | 0 | | | | | | 0 | | | |
| H18 | S5 | Gradual Pollution Causing a Reduction in Abstraction | 0 | | | | | | 0 | | | |
| H19 | S6 | Accuracy of Supply-Side Data | 1.5 | | | | | | 1.5 | 2.25 | 2.25 | |
| H20 | S7 | Single Source Dominance and Critical Periods | 7 | | | | | | 7 | 49 | 49 | |
| H21 | S8 | Uncertainty of Climate Change on Yield | 0 | | | | | | 0 | 0 | 0 | |
| | | | | | | | | | | | | |
| H22 | D1 | Accuracy of Sub-Component Data | 2 | | | | | | 2 | 4 | 4 | |
| H23 | D2 | Demand Forecast Variation | 0 | | | | | | 2 | 0 | 4 | |
| H24 | D3 | Uncertainty of Climate Change on Demand | 0 | | | | | | 1 | 0 | 1 | |
| | | | | | | | | | | | | 1 |
| H25 | | SUM OF SCORES FOR S1, S2, S3, S4 AND S5 | 0 | | | | | | 0 | | | 1.66 |
| | | | | | | | | | | | | |
| H26 | | SQUARE ROOT OF $S6^2+S7^2+S8^2+D1^2+D2^2+D3^2$ | 7.43 | | | | | | 7.76 | 55.25 | 60.25 | |
| | | | | | | | | | | | | |
| H27 | | TOTAL SCORE (H25+H26) | 7.43 | | | | | | 7.76 | | | |
| | | | | | | | | | | | | |
| H28 | | TARGET HEADROOM (%) | **6.45** | | | | | | **6.55** | | | |
| | | | | | | | | | 0.11 | | | |

% of score attributable to climate change:

1) $S8^2 + D3^2$

2) Square root of $S8^2 + D3^2$ divided by sum of $S6^2+S7^2+S8^2+D1^2+D2^2+D3^2$ then multiplied by 100

3) % headroom from climate change = target headroom % figure multiplied by result of step 2) and divided by 100

## *Form QA*

| | |
|---|---|
| **Purpose** | To record all data and assumptions used in the Headroom Calculation |
| **Use** | To perform the target headroom calculation |
| **Ref** | Refer to step 4 of the step-by-step guidelines and the guidance notes for further details |

**NOTE**

1) The form is divided into sections relating to the uncertainty factors in the headroom calculation
The factors are:

| | | |
|---|---|---|
| *Supply related* | S1 | Vulnerable Surface Water Licences |
| | S2 | Vulnerable Groundwater Licences |
| | S3 | Time Limited Licences |
| | S4 | Bulk Transfers |
| | S5 | Gradual Pollution Causing a Reduction in Abstraction |
| | S6 | Accuracy of Supply-Side Data |
| | S7 | Single Source Dominance and Critical Periods |
| | S8 | Uncertainty of Climate Change on Yield |
| *Demand related* | D1 | Accuracy of Sub-Component Data |
| | D2 | Demand Forecast Variation |
| | D3 | Uncertainty of Climate Change on Demand |

2) All sections of Form QA MUST be completed. If the uncertainty factor is not relevant to the resource zone, enter N/A in the space provided for a score.
3) 'Action ref.' refers to the guidance action given in the guidance notes for each factor
e.g. For Single Source Dominance and Critical Periods action (b) in the guidance notes is to record the source name - this is referenced as action (b) on this form.

General

NOTE

1) The WAFU should be those figures from the Water Resources Planning Guidelines:

| | Present day → Planning horizon | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2016/17 | | | | | | 2044/45 | |
| WAFU | 28.98 | | | | | | 27.25 | (Ml/d) |

*Form S1*

**S1 Vulnerable Surface Water Licences**

| No. | Name of Vulnerable Licences | DO at risk (Ml/d) | Threat of licensed being revoked or abstraction | | |
|---|---|---|---|---|---|
| | | | Likely | Likely as not | Unlikely |
| 1 | N/A | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

| *Total DO at risk for each category* | Volume (Ml/d) | | |
|---|---|---|---|
| Likely | | *(1)* | |
| Likely as not | | *(2)* | |
| Unlikely | | *(3)* | |
| *Estimated total DO at risk* | | Ml/d *(4)* | *(1)+(2)+(3)* |
| *Estimated total DO as % of WAFU* | | % *(5)* | *(4)/WAFU*100* |

| | | DO as % of total vol at risk | | Score for each likelihood as % of WAFU at risk | | | Weighted headroom scores |
|---|---|---|---|---|---|---|---|
| Likely | (1)/(4)*100 | | *(6)* | | *(9)* | (6)*(9)/100 | |
| Likely as not | (2)/(4)*100 | | *(7)* | | *(10)* | (7)*(10)/100 | |
| Unlikely | (3)/(4)*100 | | *(8)* | | *(11)* | (8)*(11)/100 | |
| | | | Headroom score | | 0 | out of 10 | |

*Form S2*

**S2 Vulnerable Groundwater Licences**

| No. | Name of Vulnerable Licences | DO at risk (Ml/d) | Threat of licensed being revoked or abstraction | | |
|---|---|---|---|---|---|
| | | | Likely | Likely as not | Unlikely |
| 1 | N/A | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

| *Total DO at risk for each category* | Volume (Ml/d) | | |
|---|---|---|---|
| Likely | | *(1)* | |
| Likely as not | | *(2)* | |
| Unlikely | | *(3)* | |
| *Estimated total DO at risk* | | Ml/d *(4)* | *(1)+(2)+(3)* |
| *Estimated total DO as % of WAFU* | | % *(5)* | *(4)/WAFU*100* |

| | | DO as % of total vol at risk | | Score for each likelihood as % of WAFU at risk | | | Weighted headroom scores |
|---|---|---|---|---|---|---|---|
| Likely | (1)/(4)*100 | | *(6)* | | *(9)* | (6)*(9)/100 | |
| Likely as not | (2)/(4)*100 | | *(7)* | | *(10)* | (7)*(10)/100 | |
| Unlikely | (3)/(4)*100 | | *(8)* | | *(11)* | (8)*(11)/100 | |
| | | | Headroom score | 0 | | out of 10 | |

*Form S3*

**S3 Time Limited Licences**

| No. | Name of Source with Time Limited Licence | DO at risk (Ml/d) | Threat of licensed being revoked or abstraction | | |
|---|---|---|---|---|---|
| | | | Likely | Likely as not | Unlikely |
| 1 | N/A | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

| *Total DO at risk for each category* | Volume (Ml/d) | | |
|---|---|---|---|
| Likely | | *(1)* | |
| Likely as not | | *(2)* | |
| Unlikely | | *(3)* | |
| *Estimated total DO at risk* | | Ml/d *(4)* | *(1)+(2)+(3)* |
| *Estimated total DO as % of WAFU* | | % *(5)* | *(4)/WAFU*100* |

| | | DO as % of total vol at risk | | Score for each likelihood as % of WAFU at risk | | | Weighted headroom scores |
|---|---|---|---|---|---|---|---|
| Likely | (1)/(4)*100 | | *(6)* | | *(9)* | (6)*(9)/100 | |
| Likely as not | (2)/(4)*100 | | *(7)* | | *(10)* | (7)*(10)/100 | |
| Unlikely | (3)/(4)*100 | | *(8)* | | *(11)* | (8)*(11)/100 | |
| | | | Headroom score | | 0 | out of 10 | |

*Form S4*

**S4 Bulk Transfers**

| No. | Name of Bulk transfers into Resource Zone | DO or Transfer Rate from Bulk Transfers (Ml/d) |
|---|---|---|
| 1 | N/A | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

| | | |
|---|---|---|
| | *Tick* | |
| Overall reliability of the bulk transfer | Very reliable | |
| | Reliable | |
| | Less reliable | |
| Total DO or transfer rate | | Ml/d |
| Total DO or transfer rate as % of WAFU at the present day | | % |
| Headroom score | 0 | out of 5 |

*Form S5*

**S5 Gradual Pollution Causing a Reduction in Abstraction**

| No. | Name of Source at Risk | DO at risk (Ml/d) | Threat of licensed being revoked or abstraction | | |
|---|---|---|---|---|---|
| | | | Likely | Likely as not | Unlikely |
| 1 | N/A | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

| *Total DO at risk for each category* | Volume (Ml/d) | | |
|---|---|---|---|
| Likely | | *(1)* | |
| Likely as not | | *(2)* | |
| Unlikely | | *(3)* | |
| *Estimated total DO at risk* | | Ml/d *(4)* | *(1)+(2)+(3)* |
| *Estimated total DO as % of WAFU* | | % *(5)* | *(4)/WAFU*100* |

| | | DO as % of total vol at risk | | Score for each likelihood as % of WAFU at risk | | | Weighted headroom scores |
|---|---|---|---|---|---|---|---|
| Likely | (1)/(4)*100 | | *(6)* | | *(9)* | (6)*(9)/100 | |
| Likely as not | (2)/(4)*100 | | *(7)* | | *(10)* | (7)*(10)/100 | |
| Unlikely | (3)/(4)*100 | | *(8)* | | *(11)* | (8)*(11)/100 | |
| | | | Headroom score | | 0 | out of 10 | |

*Form S6*

**S6 Accuracy of Supply-Side Data**

| | | | |
|---|---|---|---|
| *(a)* | Average, or typical, length of gauged and/or level records used in WAFU calculation | 88 | years |

| | | | |
|---|---|---|---|
| *(b)* | Select category to describe sufficiency of data used in WAFU calculation | | *Tick* |
| | | Good | |
| | | Average | ✓ |
| | | Poor | |

Record justification for selecting an average or poor category (if applicable)

NRW provided a historical time series of cutbacks for the River Dee (1927 to 2015) which were fed into the Aquator model for initial DO assessment and we therefore have fairly high confidence in this data. However, our reservoir catchments are ungauged and there was therefore no gauged flow data that could be used as reservoir inflows in Aquator. Overall, therefore, we feel sufficiency of supply side data is **average.**

| | | | |
|---|---|---|---|
| *c)* | Select which category best describes the sufficiency of flow naturalisation used in calculating Resource Zone WAFU (if applicable) | | *Tick* |
| | | Good | |
| | | Average | ✓ |
| | | Poor | |
| | | N/A | |

| | | | |
|---|---|---|---|
| *(d)* | Select the appropriate score from Table S6 in the score guidance notes for each aspect of the supply-side data | | *Enter score* |
| | | Length of gauged record | 0 |
| | | Sufficiency of Data | 1 |
| | | Accuracy of naturalisation | 0.5 |

| | | | |
|---|---|---|---|
| *e)* | Total headroom score (sum individual scores) | 1.5 | out of 5 |

## Form S7

**S7 Single Source Dominance and Critical Periods**

| | | | | |
|---|---|---|---|---|
| *(b)* | Name of source with the largest DO in the resource zone | River Dee | | |
| *c)* | Source is a valid inclusion for factor | YES/~~NO~~ *delete as appropriate | | |

| | |
|---|---|
| Groundwater source | |
| River source | ✓ |
| Impounding reservoir | |
| Pumped storage reservoir | |

| | | | | |
|---|---|---|---|---|
| *(d)* | Deployable output from source | 27.11 | Ml/d | *(1)* |
| *e)* | Percentage of WAFU from largest source | 93.55 | % | [(1)/WAFU at present day]*100 |
| *(f)* | Select which category describes the critical period of the resource zone | | | |

| *Category* | *Tick* |
|---|---|
| more than a single season | |
| single season (defined as 3 months) | |
| 1 to 3 months | |
| > 1 week but < 1 month | |
| ≤ 1 week | |
| not critical | ✓ |

*(g)* Enter any comments on the critical period selected in the space provided below

For WRMP14, the target headroom assessment stated 'more than a single season' but we have been working on the basis of no critical period. However, 'not critical' gives same score so largely irrelevant.

| | | | |
|---|---|---|---|
| *(h)* | Headroom score (refer to guidance notes) | 7 | out of 15 |

## Form S8

**S8 Uncertainty of Climate Change on Yield**

| | Climate Change Scenario | WAFU at planning horizon (Ml/d) |
|---|---|---|
| *(a)* | HADCM1 | |
| *(a)* | GG1m | |
| *(a)* | GS1m | |
| *(a)* | GS1t | |
| *(b)* | EA scenario | |

| *c)* | Case | Description | Tick appropriate box |
|---|---|---|---|
| | CASE 1 | Two high and two low forecasts | |
| | CASE 2 | Three low forecasts and one high forecast | |
| | CASE 3 | Three high forecasts and one low forecast | |

| | | | | |
|---|---|---|---|---|
| *(d)* | Maximum spread in WAFU at planning horizon | | Ml/d | *(A)* |
| *e)* | Maximum spread as % of WAFU at the planning horizon | | [(A)/WAFU at planning horizon]*100 | |
| *(f)* | Headroom score | 0 | out of 10 | |

*Form D1*

**D1 Accuracy of Sub-Component Data**

| Component | Source | Reliability Band | Data type used (tick) |
|---|---|---|---|
| Initial Population Estimates | Local councils | A | ✓ |
| | Census Agency | A | ✓ |
| | OPCS | A | |
| Initial Property Estimates | Billing Records | A | ✓ |
| | Other | A | ✓ |
| Forecast of Future Population | Combination | B | |
| | Local councils | B | ✓ |
| | OPCS | B | |
| | Census Agency | B | ✓ |
| Forecast of Future Properties | Combination | A | ✓ |
| | DoE | B | |
| | Local councils | B | ✓ |

| | | | |
|---|---|---|---|
| Unmeasured Household Consumption | Own consumption monitor | A | ✓ |
| | Other company monitor | B | |
| | Micro-component analysis | C | |
| | Continuous DMZ monitoring | C | ✓ |
| | Same as measured households | D | |
| | Residual in balance | D | |
| Unmeasured Non-household Consumption | Micro-component analysis | A | |
| | Matching to measured customers | B | ✓ |
| | Industry average | D | |
| | Residual in balance | D | |
| Distribution losses | Widespread night flow tests | A | ✓ |
| | Continuous DMZ monitoring | A | ✓ |
| | Nat. Leak. Int. Models | B | |
| | Residual in balance | C | |

| | | | |
|---|---|---|---|
| Unmeasured Household Consumption | Micro-component analysis | A | ✓ |
| | Constant growth rate | B | |
| | Include effect of household size | A | ✓ |
| Measured Household Consumption | Micro-component analysis | A | ✓ |
| | Constant % of measured | C | |
| | Constant growth rate | C | |
| | Same growth as unmeasured | C | |
| | Include effect of household size | B | ✓ |
| | Separate different measured types | B | |
| Measured Non-household Consumption | Econometric forecast | A | |
| | Constant growth rate | B | ✓ |
| | Consultation with large customers | A | |

| | | | |
|---|---|---|---|
| | Price/competition scenarios | A | |

*b)* Overall data reliability

| | *Tick* |
|---|---|
| Mostly class A | ✓ |
| Class A, B and C | |
| Class B, C or worse | |

*c)* Reconciliation item from initial water balance

| | *Tick* |
|---|---|
| Good | |
| Acceptable | ✓ |
| Poor | |

*d)* Headroom score: 2 out of 5

*Form D2*

**D2 Demand Forecast Variation**

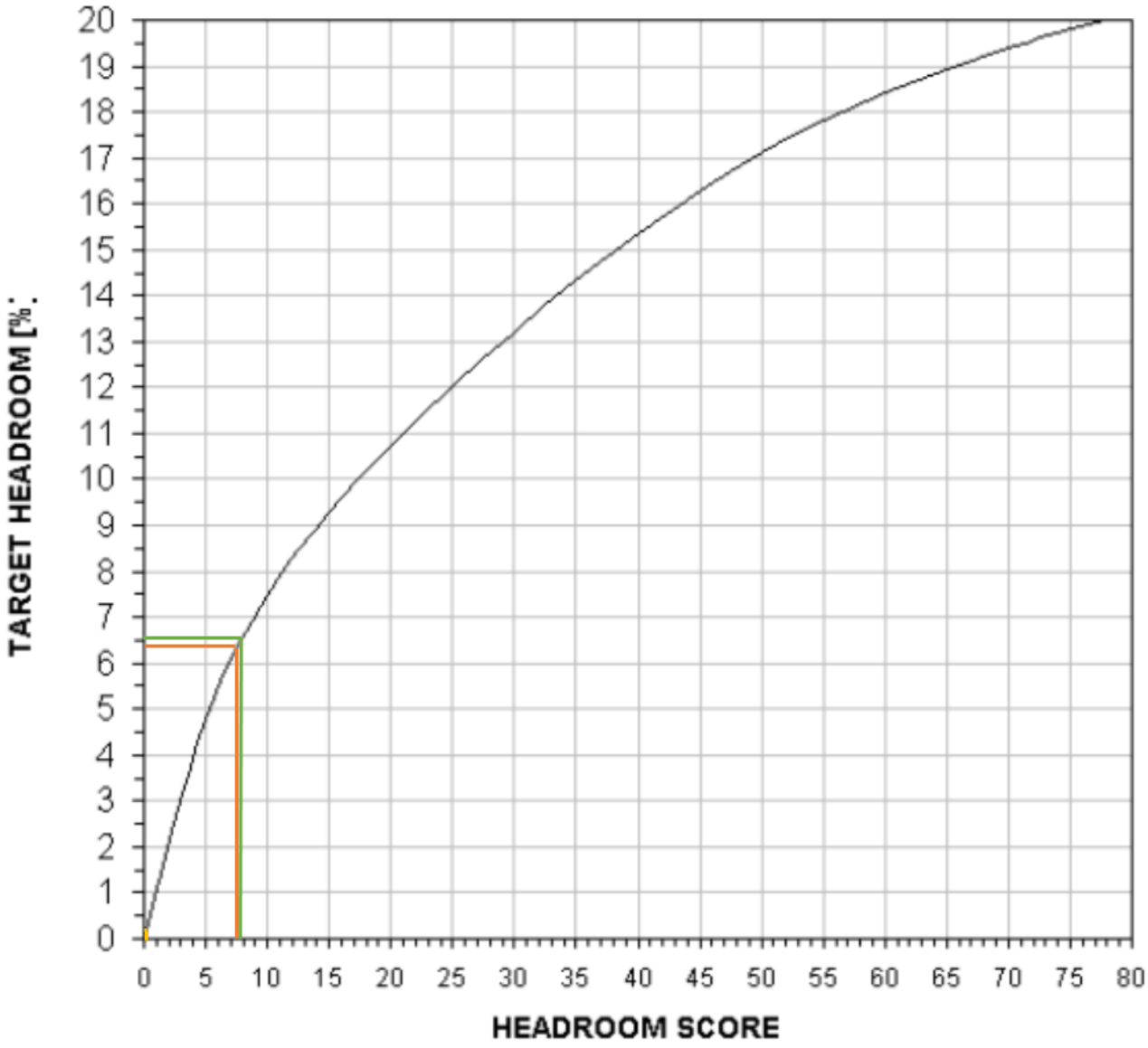
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *(a)* | | Forecast type | Present day → | | | | | | Planning horizon |
| | | | 2016/17 | | | | | | 2044/45 |
| | | Dry year unrestricted daily demand (best estimate) | 26.30 | | | | | | 25.34 |
| | | Dry year unrestricted daily demand - upper forecast | 26.30 | | | | | | 24.45 |
| | | Dry year unrestricted daily demand - lower forecast | 26.30 | | | | | | 22.61 |
| | | *or* | | | | | | | |
| | | Dry year unrestricted critical demand (best estimate) | | | | | | | |
| | | Dry year unrestricted critical demand - upper forecast | | | | | | | |
| | | Dry year unrestricted critical demand - lower forecast | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *(b)* | Case | Description | Tick appropriate box | | | | | | |
| | CASE 1 | Best estimate forecast tends to lower forecast | | | | | | | |
| | CASE 2 | Best estimate forecast tends to upper forecast | ✓ | | | | | | |
| *c)* | Maximum spread in demand forecasts at planning horizon | | 2.73 | Ml/d | *(1)* | | | | |
| *c)* | Spread in demands/WAFU at planning horizon as % | | 10.02 | | [(1)/WAFU at 2044/45]*100 | | | | |
| *(d)* | Headroom Score | | 2 | out of 15 | | | | | |

*Form D3*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **D3 Uncertainty of Climate Change on Demand** | | | | | | | | | |
| | | | | | | | | *Tick* | |
| *(b)* | Select the category that best describes the impact of | | | | | | Low | ✓ | |
| | climate change on resource zone demand | | | | | | Medium | | |
| | | | | | | | High | | |
| | | | | | | | Very High | | |
| *c)* | Justify the selection in the space provided below: | | | | | | | | |
| | We used the *UKWIR (2013) Impact of Climate Change on Water Demand* methodology, as required by the EA/NRW guidance, to determine the likely impact of climate change on our demand forecast. Reference data used was the Severn Trent Household Relationship - Annual Average, 50th percentile scaling factor. This results in a less than 1% increase in demand over the planning period. | | | | | | | | |
| *(d)* | Headroom score | | | 1 | out of 5 | | | | |

*Target Headroom Conversion Chart*



# Wrexham WRZ

*Form 1A*

| | |
|---|---|
| **Purpose** | Summary information and headroom results |
| **Use** | Record company and resource zone details and calculation summary |
| **Ref** | Steps 1, 7 and 8 of the step-by-step guide |

**COMPANY AND RESOURCE ZONE DETAILS**

| | |
|---|---|
| **Company name** | Dee Valley Water |
| Resource zone name / ref | Wrexham (WRX) |
| Level of service | 1 in 40 |
| Climate change incorporated? | Y |
| Version | Draft |
| Prepared by | Liz Franks |
| Job Title or Position | Water Resources & Catchment Specialist (Wales) |
| Reviewed by | |
| Job Title or Position | |

**RESULTS OF HEADROOM CALCULATION**

| | | Present day → | | | | | | Planning horizon |
|---|---|---|---|---|---|---|---|---|
| Row | | 2016/17 | | | | | | 2044/45 |
| H1 | Water available for use (Ml/d) | 49.75 | | | | | | 48.79 |
| H2 | Target Headroom (%) | 4.50 | | | | | | 5.00 |
| | | 0% CC | | | | | | 0.45% CC |
| H3 | Target Headroom (Ml/d) | 2.24 | | | | | | 2.44 |
| | | 0 CC | | | | | | 0.22 CC |
| H4 | Available Headroom (Ml/d) | 7.12 | | | | | | 10.37 |

## Form 1B

| | |
|---|---|
| **Purpose** | To highlight those uncertainties that affect the resource |
| **Use** | Select those factors that affect the resource zone under study |
| **Ref** | Step 2 of the step-by-step guide |

| Row | Factor ref. | Factor | Include (Y or N) | Justification for exclusion of factor |
|---|---|---|---|---|
| H5 | S1 | Vulnerable Surface Water Licences | N | NRW have confirmed no change or unlikely to change |
| H6 | S2 | Vulnerable Groundwater Licences | N | As above |
| H7 | S3 | Time Limited Licences | N | Current time limited licence due for renewal in 2018 so not relevant for this planning period |
| H8 | S4 | Bulk Transfers | N | Negligible (Farndon - UU export; Pontyblew - STW import; Glyndyfrdwy - DCWW import) |
| H9 | S5 | Gradual Pollution Causing a Reduction in Abstraction | N | We have not been made aware of any abstractions within the WRZ that are susceptible to gradual pollution |
| H10 | S6 | Accuracy of Supply-Side Data | Y | *This factor must be assessed for all resource zones* |
| H11 | S7 | Single Source Dominance and Critical Periods | Y | River Dee |
| H12 | S8 | Uncertainty of Climate Change on Yield | Y | |
| | | | | |
| H11 | D1 | Accuracy of Sub-Component Data | Y | *This factor must be assessed for all resource zones* |
| H12 | D2 | Demand Forecast Variation | Y | *This factor must be assessed for all resource zones* |
| H13 | D3 | Uncertainty of Climate Change on Demand | Y | |

## Form 2A

| | |
|---|---|
| **Purpose** | Data requirements and availability |
| **Use** | Check list of data required for the headroom calculation |
| **Ref** | Step 3 of the step-by-step guide |

| Factor Ref. | Factor | Data required | Units | Data available (tick) |
|---|---|---|---|---|
| | General | Water Available for Use from the present day to the planning horizon | Ml/d | ✓ |
| S1 | Vulnerable Surface Water Licences | The names of all the surface water licences that the water company believes may be vulnerable to a reduction in abstraction. This does not include reductions due to gradual pollution. | - | |
| | | Estimate of DO at risk for each source | Ml/d | 0 |
| S2 | Vulnerable Groundwater Licences | The names of all the ground water licences that the water company believes may be vulnerable to a reduction in abstraction. This does not include reductions due to gradual pollution. | - | |
| | | Estimate of DO at risk for each source | Ml/d | 0 |
| S3 | Time Limited Licences | The names and expiry dates for all the Time Limited Licences that the water company will actively pursue for renewal | YYYY | |
| | | The Time Limited Licence volume at risk | Ml/d | 0 |
| S4 | Bulk Transfers | Names of all the bulk transfers into the resource zone | | |
| | | The DO or transfer rate of bulk transfer | Ml/d | 0.03 |
| S5 | Gradual Pollution Causing a Reduction in Abstraction | The names of all sources whose abstraction is at risk from reduction due to gradual pollution | - | |
| | | The DO at risk from gradual pollution for each source | Ml/d | 0 |
| S6 | Accuracy of Supply-Side Data | Average, or typical, length of gauging and/or level record used in calculation of resource zone WAFU | yrs | 80 |
| | | Sufficiency of data used in analysis | - | ✓ |
| | | Accuracy of flow naturalisation (if applicable) | | N/a |
| S7 | Single Source Dominance and Critical Periods | The largest deployable output from a source in the resource zone. This DO figure should be that quoted in the WR | Ml/d | 41.5 |
| | | The name of the above source | | Twll |
| | | The critical period of the resource zone | | n/a |
| S8 | Uncertainty of Climate Change on Yield | Resource zone WAFU at planning horizon for the four climate change scenarios detailed in the UKWIR/EA 'Effects of climate change on river flows and ground water recharge' report 97/CL/04/1 | Ml/d | ✓ Equivalent scenarios used as provided by NRW to Dee catchment |

*Form 2B*

| | |
|---|---|
| **Purpose** | Data requirements and availability |
| **Use** | Check list of data required for the headroom calculation |
| **Ref** | Step 3 of the step-by-step guide |

| Factor Ref. | Factor | Data required | Units | Data available (tick) |
|---|---|---|---|---|
| D1 | Accuracy of Sub-Component Data | The reliability band for the data components used in the initial water balance and the demand forecasts | - | ✓ |
| | | An estimate of the reconciliation item from the initial water balance | Ml/d | ✓ |
| D2 | Demand Forecast Variation | *Either*<br>Dry year annual average unrestricted demand (best estimate) up to planning horizon | Ml/d | ✓ |
| | | Dry year annual average unrestricted demand up to planning horizon - upper forecast | Ml/d | ✓ |
| | | Dry year annual average unrestricted demand up to planning horizon - lower forecast | Ml/d | ✓ |
| | | *Or*<br>Dry year unrestricted crtical demand (best estimate) up to planning horizon | Ml/d | |
| | | Dry year unrestricted critical demand up to the planning horizon - upper forecast | YYYY | |
| | | Dry year unrestricted critical demand up to the planning horizon - lower forecast | Ml/d | |
| | | *All demand forecasts are as defined in the EA/NRW Water Resources Planning Guidelines* | | ✓ |
| D3 | Uncertainty of Climate Change on Demand | Water company best estimate forecast of the impact of climate change on demand | Ml/d | ✓ |

## *Form 3A*

| | | |
|---|---|---|
| **Purpose** | Target Headroom Calculation | |
| **Use** | To calculate the target headroom for the resource zone | |
| **Ref** | Steps 4, 5 and 6 of the step-by-step guide / Score guidance notes | |

| | | | Present day → | | | | | | Planning horizon | $S^2$ | | | | % of score attributable to climate change: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Row** | **Factor ref.** | **Factor** | 2016/17 | | | | | | 2044/45 | 2016/17 | 2044/55 | | | 1) $S8^2 + D3^2$ |
| H14 | S1 | Vulnerable Surface Water Licences | 0 | | | | | | 0 | | | | | 2) Square root of $S8^2 + D3^2$ divided by sum of |
| H15 | S2 | Vulnerable Groundwater Licences | 0 | | | | | | 0 | | | | | $S6^2+S7^2+S8^2+D1^2+D2^2+D3^2$ then multiplied by 100 |
| H16 | S3 | Time Limited Licences | 0 | | | | | | 0 | | | | | 3) % headroom from climate change = target headroom % |
| H17 | S4 | Bulk Transfers | 0 | | | | | | 0 | | | | | figure multiplied by result of step 2) and divided by 100 |
| H18 | S5 | Gradual Pollution Causing a Reduction in Abstraction | 0 | | | | | | 0 | | | | | |
| H19 | S6 | Accuracy of Supply-Side Data | 1.5 | | | | | | 1.5 | 2.25 | 2.25 | | | |
| H20 | S7 | Single Source Dominance and Critical Periods | 4 | | | | | | 4 | 16 | 16 | | | |
| H21 | S8 | Uncertainty of Climate Change on Yield | 0 | | | | | | 2 | 0 | 4 | | | |
| | | | | | | | | | | | | | | |
| H22 | D1 | Accuracy of Sub-Component Data | 2 | | | | | | 2 | 4 | 4 | | | |
| H23 | D2 | Demand Forecast Variation | 0 | | | | | | 2 | 0 | 4 | | | |
| H24 | D3 | Uncertainty of Climate Change on Demand | 0 | | | | | | 1 | 0 | 1 | | | |
| | | | | | | | | | | | | 5 | | |
| H25 | | SUM OF SCORES FOR S1, S2, S3, S4 AND S5 | 0 | | | | | | 0 | | | | | |
| | | | | | | | | | | | | | | |
| H26 | | SQUARE ROOT OF $S6^2+S7^2+S8^2+D1^2+D2^2+D3^2$ | 4.72 | | | | | | 5.59 | 22.25 | 31.25 | | | |
| | | | | | | | | | | | | 2.24 | 7.16 | |
| H27 | | TOTAL SCORE (H25+H26) | 4.72 | | | | | | 5.59 | | | | | |
| | | | | | | | | | | | | | | |
| H28 | | TARGET HEADROOM (%) | **4.50** | | | | | | **5.00** | | | | | |
| | | | | | | | | | 0.36 | | | | | |

## *Form QA*

| | |
|---|---|
| **Purpose** | To record all data and assumptions used in the Headroom Calculation |
| **Use** | To perform the target headroom calculation |
| **Ref** | Refer to step 4 of the step-by-step guidelines and the guidance notes for further details |

**NOTE**

1) The form is divided into sections relating to the uncertainty factors in the headroom calculation
The factors are:

| | | |
|---|---|---|
| *Supply related* | S1 | Vulnerable Surface Water Licences |
| | S2 | Vulnerable Groundwater Licences |
| | S3 | Time Limited Licences |
| | S4 | Bulk Transfers |
| | S5 | Gradual Pollution Causing a Reduction in Abstraction |
| | S6 | Accuracy of Supply-Side Data |
| | S7 | Single Source Dominance and Critical Periods |
| | S8 | Uncertainty of Climate Change on Yield |
| *Demand related* | D1 | Accuracy of Sub-Component Data |
| | D2 | Demand Forecast Variation |
| | D3 | Uncertainty of Climate Change on Demand |

2) All sections of Form QA MUST be completed. If the uncertainty factor is not relevant to the resource zone, enter N/A in the space provided for a score.
3) 'Action ref.' refers to the guidance action given in the guidance notes for each factor
e.g. For Single Source Dominance and Critical Periods action (b) in the guidance notes is to record the source name - this is referenced as action (b) on this form.

General

NOTE

1) The WAFU should be those figures from the Water Resources Planning Guidelines:

| | Present day → Planning horizon | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2016/17 | | | | | | 2044/45 |
| WAFU | 49.75 | | | | | | 48.79 (Ml/d) |

*Form S1*

**S1 Vulnerable Surface Water Licences**

| No. | Name of Vulnerable Licences | DO at risk (Ml/d) | Threat of license being revoked or abstraction | | |
|---|---|---|---|---|---|
| | | | Likely | Likely as not | Unlikely |
| 1 | N/a | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

| *Total DO at risk for each category* | Volume (Ml/d) | | |
|---|---|---|---|
| Likely | | *(1)* | |
| Likely as not | | *(2)* | |
| Unlikely | | *(3)* | |
| *Estimated total DO at risk* | | Ml/d *(4)* | *(1)+(2)+(3)* |
| *Estimated total DO as % of WAFU* | | % *(5)* | *(4)/WAFU*100* |

| | | DO as % of total vol at risk | | Score for each likelihood as % of WAFU at risk | | | Weighted headroom scores |
|---|---|---|---|---|---|---|---|
| Likely | (1)/(4)*100 | | *(6)* | | *(9)* | (6)*(9)/100 | |
| Likely as not | (2)/(4)*100 | | *(7)* | | *(10)* | (7)*(10)/100 | |
| Unlikely | (3)/(4)*100 | | *(8)* | | *(11)* | (8)*(11)/100 | |
| | | | Headroom score | | 0 | out of 10 | |

*Form S2*

**S2 Vulnerable Groundwater Licences**

| No. | Name of Vulnerable Licences | DO at risk (Ml/d) | Threat of license being revoked or abstraction | | |
|---|---|---|---|---|---|
| | | | Likely | Likely as not | Unlikely |
| 1 | N/a | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

| *Total DO at risk for each category* | Volume (Ml/d) | |
|---|---|---|
| Likely | | *(1)* |
| Likely as not | | *(2)* |
| Unlikely | | *(3)* |
| *Estimated total DO at risk* | | Ml/d *(4)* *(1)+(2)+(3)* |
| *Estimated total DO as % of WAFU* | | % *(5)* *(4)/WAFU*100* |

| | | DO as % of total vol at risk | | Score for each likelihood as % of WAFU at risk | | | Weighted headroom scores |
|---|---|---|---|---|---|---|---|
| Likely | (1)/(4)*100 | | *(6)* | | *(9)* | (6)*(9)/100 | |
| Likely as not | (2)/(4)*100 | | *(7)* | | *(10)* | (7)*(10)/100 | |
| Unlikely | (3)/(4)*100 | | *(8)* | | *(11)* | (8)*(11)/100 | |
| | | | Headroom score | | 0 | out of 10 | |

*Form S3*

**S3 Time Limited Licences**

| No. | Name of Source with Time Limited Licence | DO at risk (Ml/d) | Threat of license being revoked or abstraction | | |
|---|---|---|---|---|---|
| | | | Likely | Likely as not | Unlikely |
| 1 | N/a | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

| *Total DO at risk for each category* | Volume (Ml/d) | | |
|---|---|---|---|
| Likely | | *(1)* | |
| Likely as not | | *(2)* | |
| Unlikely | | *(3)* | |
| *Estimated total DO at risk* | | Ml/d *(4)* | *(1)+(2)+(3)* |
| *Estimated total DO as % of WAFU* | | % *(5)* | *(4)/WAFU*100* |

| | | DO as % of total vol at risk | | Score for each likelihood as % of WAFU at risk | | | Weighted headroom scores |
|---|---|---|---|---|---|---|---|
| Likely | (1)/(4)*100 | | *(6)* | | *(9)* | (6)*(9)/100 | |
| Likely as not | (2)/(4)*100 | | *(7)* | | *(10)* | (7)*(10)/100 | |
| Unlikely | (3)/(4)*100 | | *(8)* | | *(11)* | (8)*(11)/100 | |
| | | | Headroom score | | 0 | out of 10 | |

*Form S4*

**S4 Bulk Transfers**

| No. | Name of Bulk transfers into Resource Zone | DO or Transfer Rate from Bulk Transfers (Ml/d) |
|---|---|---|
| 1 | Combination of STW/DCWW/UU | 0.03 |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

| | | *Tick* | |
|---|---|---|---|
| Overall reliability of the bulk transfer | Very reliable | ✓ | |
| | Reliable | | |
| | Less reliable | | |
| Total DO or transfer rate | | 0.03 | Ml/d |
| Total DO or transfer rate as % of WAFU at the present day | | 0.06 | % |
| Headroom score | | 0 | out of 5 |

*Form S5*

**S5 Gradual Pollution Causing a Reduction in Abstraction**

| No. | Name of Source at Risk | DO at risk (Ml/d) | Threat of licensed being revoked or abstraction | | |
|---|---|---|---|---|---|
| | | | Likely | Likely as not | Unlikely |
| 1 | N/a | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

| *Total DO at risk for each category* | Volume (Ml/d) | | |
|---|---|---|---|
| Likely | | *(1)* | |
| Likely as not | | *(2)* | |
| Unlikely | | *(3)* | |
| *Estimated total DO at risk* | | Ml/d *(4)* | *(1)+(2)+(3)* |
| *Estimated total DO as % of WAFU* | | % *(5)* | *(4)/WAFU*100* |

| | | DO as % of total vol at risk | | Score for each likelihood as % of WAFU at risk | | | Weighted headroom scores |
|---|---|---|---|---|---|---|---|
| Likely | (1)/(4)*100 | | *(6)* | | *(9)* | (6)*(9)/100 | |
| Likely as not | (2)/(4)*100 | | *(7)* | | *(10)* | (7)*(10)/100 | |
| Unlikely | (3)/(4)*100 | | *(8)* | | *(11)* | (8)*(11)/100 | |
| | | | Headroom score | 0 | | out of 10 | |

*Form S6*

**S6 Accuracy of Supply-Side Data**

| | | | |
|---|---|---|---|
| *(a)* | Average, or typical, length of gauged and/or level records used in WAFU calculation | 88 | years |

| | | | |
|---|---|---|---|
| *(b)* | Select category to describe sufficiency of data used in WAFU calculation | | *Tick* |
| | | Good | |
| | | Average | ✓ |
| | | Poor | |

Record justification for selecting an average or poor category (if applicable)

NRW provided a historical time series of cutbacks for the River Dee (1927 to 2015) which were fed into the Aquator model for initial DO assessment and we therefore have fairly high confidence in this data. However, our reservoir catchments are ungauged and there was therefore no gauged flow data that could be used as reservoir inflows in Aquator. Overall, therefore, we feel sufficiency of supply side data is **average.**

| | | | |
|---|---|---|---|
| *c)* | Select which category best describes the sufficiency of flow naturalisation used in calculating Resource Zone WAFU (if applicable) | | *Tick* |
| | | Good | |
| | | Average | ✓ |
| | | Poor | |
| | | N/A | |

| | | | |
|---|---|---|---|
| *(d)* | Select the appropriate score from Table S6 in the score guidance notes for each aspect of the supply-side data | | *Enter score* |
| | | Length of gauged record | 0 |
| | | Sufficiency of Data | 1 |
| | | Accuracy of naturalisation | 0.5 |

| | | | |
|---|---|---|---|
| *e)* | Total headroom score (sum individual scores) | 1.5 | out of 5 |

## *Form S7*

**S7 Single Source Dominance and Critical Periods**

| | | | | |
|---|---|---|---|---|
| *(b)* | Name of source with the largest DO in the resource zone | River Dee | | |
| *c)* | Source is a valid inclusion for factor | YES/~~NO~~ | *delete as appropriate | |

| | |
|---|---|
| Groundwater source | |
| River source | ✓ |
| Impounding reservoir | |
| Pumped storage reservoir | |

| | | | | |
|---|---|---|---|---|
| *(d)* | Deployable output from source | 37.86 | Ml/d | *(1)* |
| *e)* | Percentage of WAFU from largest source | 76.10 | % | [(1)/WAFU at present day]*100 |

*(f)* Select which category describes the critical period of the resource zone

| *Category* | *Tick* |
|---|---|
| more than a single season | |
| single season (defined as 3 months) | |
| 1 to 3 months | |
| > 1 week but < 1 month | |
| ≤ 1 week | |
| not critical | ✓ |

*(g)* Enter any comments on the critical period selected in the space provided below

For WRMP14, the target headroom assessment stated 'more than a single season' but we have been working on the basis of no critical period. However, 'not critical' gives same score so largely irrelevant.

| | | | |
|---|---|---|---|
| *(h)* | Headroom score (refer to guidance notes) | 4 | out of 15 |

*Form S8*

**S8 Uncertainty of Climate Change on Yield**

| | Climate Change Scenario | WAFU at planning horizon (Ml/d) |
|---|---|---|
| *(a)* | CC007 | 51.0 |
| *(a)* | CC015 | 50.5 |
| *(a)* | CC032 | 50.6 |
| *(a)* | CC067 | 50.6 |
| *(b)* | CC075 | 50.9 |
| | CC089 | 50.6 |
| | Best estimate | 50.7 |

| *c)* | Case | Description | Tick appropriate box |
|---|---|---|---|
| | CASE 1 | Two high and two low forecasts | ✓ |
| | CASE 2 | Three low forecasts and one high forecast | |
| | CASE 3 | Three high forecasts and one low forecast | |

| | | | | |
|---|---|---|---|---|
| *(d)* | Maximum spread in WAFU at planning horizon | 0.5 | Ml/d | *(A)* |
| *e)* | Maximum spread as % of WAFU at the planning horizon | 1.01 | [(A)/WAFU at planning horizon]*100 | |
| *(f)* | Headroom score | 2 | out of 10 | |

**Supporting Information**

The DO under climate change was assessed for both WRZs. NRW tested 100 scenarios and used the six median scenarios to generate climate change versions of the abstraction tables from the Dee General Directions. The net abstraction volume for DVW was reduced by 1.61 Ml/d based on this assessment. As the Chester zone is 100% consumptive the most efficient way to appy the reduction was at the Dee Chester abstraction point. The cutback levels remained the same as they were in the baseline run, as did the maximum allowable abstraction. For WRX WRZ, this meant that the safe yield allocation, stage 1 and stage 2 cutbacks DO was 41.50 Ml/d.

For WRX WRZ, the monthly climate change factors were applied to the baseline inflows to the DVW reservoirs previously generated using a resampling procedure. This created a perturbed time series of flows for each of the six climate change scenarios, and similarly, new time series for the NRW imposed cutbacks were created for each scenario.

The mean DO results for the climate change scenarios are given in the S8 table (the mean DO is the average daily demand that could be met over every day of the run). The average DO across the six scenarios was 50.7 Ml/d, implying a median climage change impact on DO of 0.5 Ml/d (0.53 Ml/d in the peak month of July).

*Form D1*

**D1 Accuracy of Sub-Component Data**

| | Component | Source | Reliability Band | Data type used (tick) |
|---|---|---|---|---|
| Customer Information | Initial Population Estimates | Local councils | A | ✓ |
| | | Census Agency | A | ✓ |
| | | OPCS | A | |
| | Initial Property Estimates | Billing Records | A | ✓ |
| | | Other | A | ✓ |
| | Forecast of Future Population | Combination | B | |
| | | Local councils | B | ✓ |
| | | OPCS | B | |
| | | Census Agency | B | ✓ |
| | Forecast of Future Properties | Combination | A | ✓ |
| | | DoE | B | |
| | | Local councils | B | ✓ |

| | | | | |
|---|---|---|---|---|
| Major Components of Initial Water Balance | Unmeasured Household Consumption | Own consumption monitor | A | ✓ |
| | | Other company monitor | B | |
| | | Micro-component analysis | C | ✓ |
| | | Continuous DMZ monitoring | C | ✓ |
| | | Same as measured households | D | |
| | | Residual in balance | D | |
| | Unmeasured Non-household Consumption | Micro-component analysis | A | |
| | | Matching to measured customers | B | |
| | | Industry average | D | ✓ |
| | | Residual in balance | D | |
| | Distribution losses | Widespread night flow tests | A | ✓ |
| | | Continuous DMZ monitoring | A | ✓ |
| | | Nat. Leak. Int. Models | B | |
| | | Residual in balance | C | |

| | | | | |
|---|---|---|---|---|
| Major Components of Demand Forecast | Unmeasured Household Consumption | Micro-component analysis | A | ✓ |
| | | Constant growth rate | B | |
| | | Include effect of household size | A | ✓ |
| | Measured Household Consumption | Micro-component analysis | A | ✓ |
| | | Constant % of measured | C | |
| | | Constant growth rate | C | |
| | | Same growth as unmeasured | C | |
| | | Include effect of household size | B | ✓ |
| | | Separate different measured types | B | |
| | Measured Non-household Consumption | Econometric forecast | A | |
| | | Constant growth rate | B | ✓ |
| | | Consultation with large customers | A | |

| | | | | |
|---|---|---|---|---|
| | | Price/competition scenarios | A | |

*b)* Overall data reliability

| | *Tick* |
|---|---|
| Mostly class A | ✓ |
| Class A, B and C | |
| Class B, C or worse | |

*c)* Reconciliation item from initial water balance

| | *Tick* |
|---|---|
| Good | |
| Acceptable | ✓ |
| Poor | |

*d)* Headroom score: 2 out of 5

*Form D2*

**D2 Demand Forecast Variation**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *(a)* | | Forecast type | Present day → | | | | | | Planning horizon | | **Supporting Information:** |
| | | | 2016/17 | | | | | | 2044/45 | | Present day figure = sum of |
| | | Dry year unrestricted daily demand (best estimate) | 45.00 | | | | | | 40.41 | | (34BL+35BL+36BL+37BL+38BL+39BL) + (19BL+20BL+21BL+22BL) - |
| | | Dry year unrestricted daily demand - upper forecast | 45.00 | | | | | | 38.92 | | i.e. consumption plus leakage |
| | | Dry year unrestricted daily demand - lower forecast | 45.00 | | | | | | 36.42 | | |
| | | *or* | | | | | | | | | |
| | | Dry year unrestricted critical demand (best estimate) | | | | | | | | | |
| | | Dry year unrestricted critical demand - upper forecast | | | | | | | | | |
| | | Dry year unrestricted critical demand - lower forecast | | | | | | | | | |
| *(b)* | Case | Description | Tick appropriate box | | | | | | | | |
| | CASE 1 | Best estimate forecast tends to lower forecast | | | | | | | | | |
| | CASE 2 | Best estimate forecast tends to upper forecast | ✓ | | | | | | | | |
| *c)* | Maximum spread in demand forecasts at planning horizon | | 3.99 | Ml/d | *(1)* | | | | | | |
| *c)* | Spread in demands/WAFU at planning horizon as % | | 8.18 | | [(1)/WAFU at 2044/45]*100 | | | | | | |
| *(d)* | Headroom Score | | 2 | out of 15 | | | | | | | |

*Form D3*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **D3 Uncertainty of Climate Change on Demand** | | | | | | | | |
| | | | | | | | | *Tick* |
| *(b)* | Select the category that best describes the impact of | | | | | | Low | ✓ |
| | climate change on resource zone demand | | | | | | Medium | |
| | | | | | | | High | |
| | | | | | | | Very High | |
| *c)* | Justify the selection in the space provided below: | | | | | | | |
| | We used the *UKWIR (2013) Impact of Climate Change on Water Demand* methodology, as required by the EA/NRW guidance, to determine the likely impact of climate change on our demand forecast. Reference data used was the Severn Trent Household Relationship - Annual Average, 50th percentile scaling factor. This results in a less than 1% increase in demand over the planning period. | | | | | | | |
| *(d)* | Headroom score | | | 1 | out of 5 | | | |

*Target Headroom Conversion Chart*