Invitation to Tender: Scope the WRSE simulation model for WRMP 24

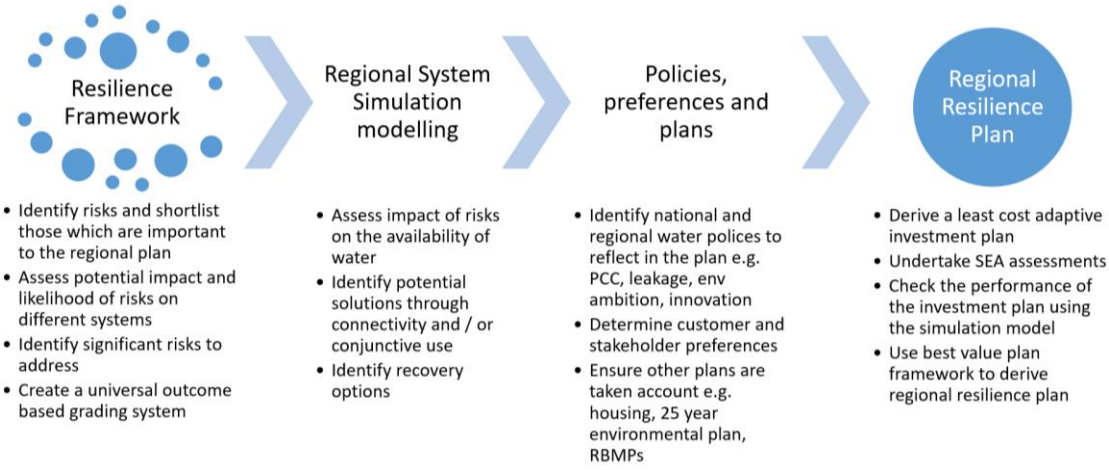
Project:	WRSE WRMP 24 regional plan	**To:**	Issued to Tender
Subject:	Scope the WRSE simulation model	**Created by:**	Meyrick Gough, PMB
Purpose:	To Tender	**Version, Date:**	Final, 04/06/2019

1. Summary

The purpose of this document is to invite bids to undertake the first phase of the regional simulation modelling work. This phase of work asks the consultant to review three potential ways, or more, in which WRSE could progress the regional system simulation modelling work and make a recommendation on which option is the best to proceed with.

2. Introduction

The six companies in the South East of England are seeking to develop a multi-sector, resilient water supply plan for the region by August 2021. To achieve this the group of companies will be developing four key areas of work, coupled with associated models, which will help provide the evidence to support the regional plan. The four areas of work are set out in the diagram below:



This invitation to tender is related to the second element of work, which is the regional system simulation model. Specifically, which modelling approach should the region adopt for the next phase of work.

The companies in the South East of England currently supply water to approximately 19 million people across ~31 water resource zones which have some, but limited, transfer capability as indicated in the adjacent figure. The mode by which systems are operated and the connections between the zones have evolved over time as different needs have occurred. The WRSE regional simulation model for PR24 should be robust and provide insights into how the system will cope with more severe droughts or other challenges in the future.

Currently the region has a mixture of simulation models on different platforms using different data. The purpose of this document is to invite bids to undertake a review of the current situation, the options, the PR24 programme and to recommend the optimal approach for the next regional system simulation model for the South East of England. This scoping is the first of two phases of work for the regional system simulation model. The second phase of work is the actual model development.

It is important that the simulation model can be used and maintained by the WRSE / member water companies, and not be reliant on third parties.

The tasks required for this phase of the work are:

1) Understand the extent to which a regional simulation model provides information to the development of the regional resilience plan (Appendices A-C) through interviews with key WRSE people and the Programme Management Board
2) Review the existing company and regional simulation models and their ability to be used to undertake the type of analysis that has been described in task 1
3) Based on the review (2) undertake an analysis of the additional development work required for these models in order to answer the questions that are being posed
4) Review and recommend, with indicative costs, which of the pathways WRSE could follow. This must consider existing models, potential data connectivity, challenges and opportunities versus the required outputs. The pathways are (but not exclusively):
    a. Option 1: Connect each of the companies' own simulation models together on a universal platform to allow the models to interact with each other
    b. Option 2: Improve the existing regional PYWR model to replicate the company's own simulation models and then use this model to undertake the simulation modelling approach
    c. Option 3: Hybrid approach. Improve the PYWR model different modes of operations and connections with a good degree of confidence. Then test the results of this work with the company specific models
5) Review and recommend how groundwater and water quality representation could be improved in these models by reviewing what companies currently do, and what data is available, in order to:
    a. Develop a series of options to improve the representation of groundwater in the regional and company specific models
    b. Discuss the various approaches and agree the most appropriate method for the chalk and sandstone blocks
    c. Provide evidence where these approaches have been used in the past.
6) Present the findings and the recommendations with WRSE & PMB in a half day workshop
7) Write a scope and draft programme for the development and running of the regional system simulation model(s). This scope will be used to invite tenders for the next, second, phase of the simulation work.

The deliverable for this work is a report that sets out the review undertaken, detailing the outputs of each of the above tasks. It must provide a recommendation for the modelling approach, together with an indicative cost for its development and operation.

3. Timescales

A timescale for the production of the next regional plan is still evolving but it is anticipated that the next regional plan will be produced by August 2021. In order to achieve these timescales and leave sufficient time to undertake the investment modelling work, scheme costing and multi-sectorial engagement, **all of the simulation development work must be completed by 31st March 2020**, i.e. model selection, build, calibration and validation and sign off.

Therefore, the timescale for this aspect of the work: *modelling scope* is as follows:

a) Invitation to bid issued 5th June 2019;
b) Tenders received by 28th June 2019;
c) Award by 12th July 2019; and
d) Final report (detailed, agreed specification) by 30th August 2019.

All bids will be assessed on quality of the bid submission, quality of the proposal, experience and ability to stick to deadlines. In the bid please make a provision to interview the WRSE companies and understand their existing models. Other useful sources of information such as the Pywr model review will be made available to the successful bidder.

4. Background information

The following points are provided to provide an oversight for the consultant:

1. **Company specific simulation models in the South East**: There are a number of water resource simulation models in the South East of England. These range from Aquator, Miser and Pywr through to some bespoke spreadsheet or other modelling platforms. Not all companies have simulation models and typically those that do have developed their models in a similar way but sometimes different ways. For example, some have rainfall runoff models included within them, other company models do not.

1. **Regional system simulation model**: WRSE recently (two years ago) commissioned and produced a regional simulation model in Pywr. This model has not been fully utilised by the companies in the region and still requires some further work to make it robust for use in a regional context, for example on groundwater simulation.

2. **Groundwater**: Whilst a number of the company simulation models summarise groundwater components within them, not all of them do. Also, the level of sophistication of this groundwater representation can be limited.

3. **Water quality:** Whilst it is recognised that raw water quality can inhibit abstraction from some rivers not all member companies have built these relationships into their simulation models. However, some companies do use their simulation models to understand the impact of these constraints on operations and potentially on source yields. We have also not used the simulation models to look at potential blending ratios of treated water quality though this would be advantageous.

4. **Deployable output:** Most companies use their simulation models to determine the conjunctive use of their systems for their own company; not for the region. Producing DO values for the regional is a critical output of the WRSE simulation model.

5. **Input data sequences:** Typically, all member companies have generated their own input sequences for their simulation models. These input sequences are typically generated outside the model and imported although some sequences are generated in the model.

6. **Operational and drought triggers:** Each simulation model that has been generated by the company will contain a set of operational and / or drought trigger levels which have been optimised for their systems.

In addition to the points above it should be noted that a key purpose of the simulation model is to provide information on the current configuration and operation of the water assets, in their broadest definition, which includes other sectors' assets and operations. This is so the simulation model can be used to help determine the performance of regional water sources during different defined events which could impact on the amount of water that can be supplied to customers. Therefore, it is important that the simulation model is flexible and can take account of the above parameters changing. The defined events include:

1) Different climatic events (drought, flood);
2) Different demands for water (leakage, water use) due to temperature fluctuations;
3) Impact of third parties taking their full entitlements during extreme events; and
4) Loss of assets to treat and pump water to the customers of the region (outage, flooding, power outages, third party events such as pollution).

The current configuration of the system and its operation influences the ability to meet the demand for water in the South East. The WRSE wish to use a regional simulation model to analyse the:

5) performance of the current configuration of the system;
6) performance of the current configuration of the system but using a different mode of operation;
7) performance of the current configuration of the system but with enhanced capacities of existing transfers;
8) performance of the system with additional transfers to the current configuration of the system in the South East of England.

The results of this work could identify new physical infrastructure and new modes of operating the system that will improve the overall resilience of the region. This approach is set out in the diagram below.

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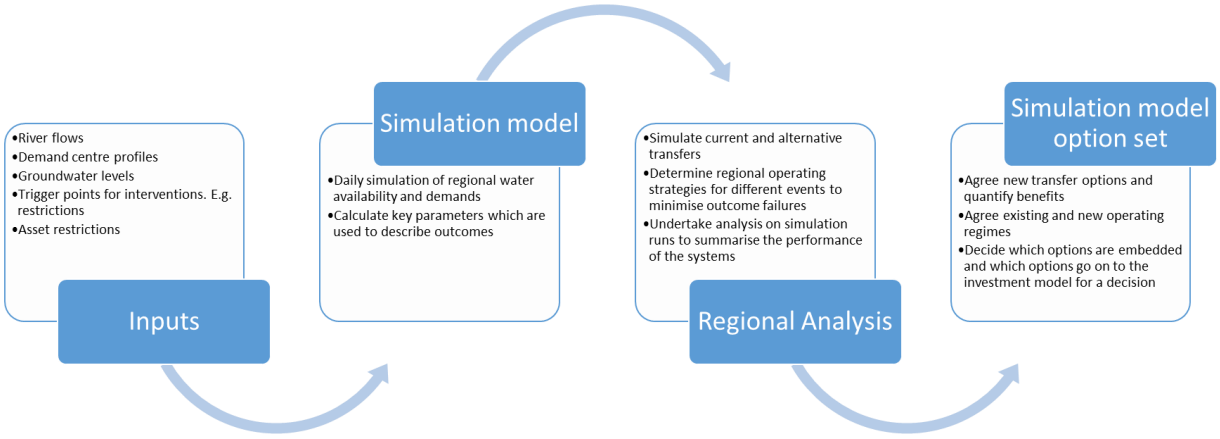


Further details on how the simulation model is intended to be used are set out in Appendices A to C. These are included to allow a greater understanding of how the results from the work will be used and what areas are intended for exploration.

The timescales by which this work has to be completed by are:

1) Recommendation for the modelling approach by August 2019;
2) Regional model(s) calibrated, tested and signed off by February 2020;
3) Primary runs and analysis completed by 31 March 2020;
4) Secondary runs and analysis completed by May 2020;
5) All outputs signed off and written up by July 2020.

This scope of work covers bullet point 1 above, the review and recommendation of the optimal modelling pathway only.

5. Invitation

Please send your bid for this work by midnight on the 28th June to: Meyrick.Gough@wrse.org.uk

Your submissions should include:

1) a description of the proposed work;
2) the project team and CVs;
3) the cost for the proposed work;
4) dates for interviewing the WRSE members;
5) a programme of work including dates for deliverables; and
6) a quality assurance plan

The final report to WRSE must include:

- The recommended pathway and the reasons for its selection;
- A considered view of a forward work plan to execute the recommended pathway, given the timescales that need to be achieved, with indicative costs; and
- The risks and potential mitigation measures required to develop the recommended pathway within the PR24 timeframe.

Appendix A: Purpose and uses of the simulation model

The purpose of the simulation is to understand the resilience of the current asset base and the environment to a range of climatic events. The model would define this through the simulation of daily input date and the consequential performance of the system. The key aspect of the model is to simulate long daily time series sequences of the system, it is not the intention that this model simulates all of the catchment processes explicitly. The team should therefore outline how it proposes to simplify the various complex catchment processes in order to provide sufficient confidence that it is picking up the big challenges on water availability.

The simulation model should be based on the strategic configuration of: other sectors operation in catchments (where relevant); the current water supply systems and key discharges back into the rivers (particularly if they are linked to the operation of the water supply system).

The model will be used to simulate the catchments and regional supply systems to identify the current conjunctive use benefits of operating the system in its current and future configurations. In particular whether the mode of operation could be optimised to improve resilience across the region.

This analysis should be undertaken across a range of historic and stochastically generated climatic events in order to undertake a vulnerability analysis which covers:

1) the availability of raw water to abstract (drought, water quality) based on current and future abstractions and discharges back to the catchments;
2) increase the demand for water (leakage, water use) due to temperature fluctuations; or
3) the availability of assets to treat and pump water to the customers of the region (outage, flooding).

The outputs of this work would be to identify which zones are vulnerable to which climatic extremes and in particular which duration droughts.

Having undertaken this analysis, the model would then be used to determine how the resilience of the existing asset system could be improved through greater connectivity and or improved reliability of assets by enhancing the current system. This approach would then identify those key schemes which could balance out the risk of failure across all of the zones. The enhanced schemes should be noted and introduced as options to the investment model.

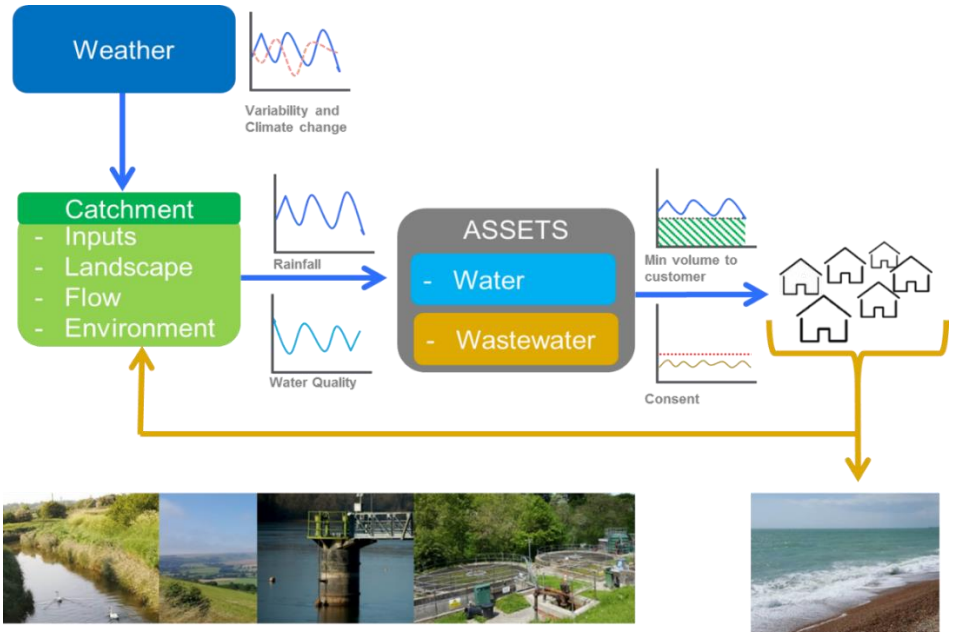
Other uses of the model will be to be used as an operational drought management model capable of demonstrating the likelihood of system failure over the next 12 months based on the simulation of current operational asset base, potential planned outage events and a range of likely climatic events, given the antecedent conditions to date.

The model will also be used to simulate the enhancement of the regional supply system by the assets identified through the investment model.

The model should be developed over a series of stages. Progression to the next stage is based on sign off of the stage, which will be subject to peer review. The proposed bid should make it clear where these break points are and where the team is proposing to seek technical sign off of the model.

Appendix B: Input data anticipated to build the regional model

In order to develop a regional model, it is anticipated that data sets across the following key asset bases would be required:



The reference to the wastewater assets in this modelling context is to highlight that some wastewater discharges are key to supporting flows in rivers which are then subsequently abstracted. These should be scoped and agreed at an early stage of the process. A cursory list of the information required by the project would contain the following data sets, which would have to be collected either from the water companies, the Environment Agency or third-party sources.

1. Catchment rainfall runoff models in order to generate new time series of river flows;
2. Recharge models to generate appropriate groundwater levels, where appropriate;
3. Strategic trunk main maps showing the water supply systems for each of the companies or print outs of existing simulation models;
4. Other abstractors and discharges including an analysis of need and materiality of other abstractions to determine whether to model their uptake. This could lead to the development of potential new schemes including licence trading.
5. Raw water quality in the rivers and groundwater for keys parameters, where available;
6. Input climate data sets would include spatially coherent droughts of different magnitudes and durations (these may require further work to ensure they are coherent with national data sets);
7. Drought triggers for key catchments or key observational hydrometric stations (groundwater levels; river gauging stations, etc)
8. Distribution input data, broken down into WRZs and demand centres from existing models, where appropriate, in order to determine the effect of temperature on the demand for water;
9. Leakage data at a DMA level to understand the impact of temperature on leakage at a water resource zone level;
10. Review the groundwater deployable output assessments undertaken by the companies to understand whether the groundwater modelling used within the companies can be used to generate appropriate input sequences into the regional simulation model;
11. Imports/ exports to the region
12. Standardise cost development method for third parties to provide costs for options to be assessed by any WRSE partner
13. Ensure 3rd parties also using equivalent/ minimum timeframes and drought analysis
14. An agreed level of service for individual companies and the region, which will have to be defined by the Programme Management Board.
15. Other abstractor drought restriction i.e. Section 57 (irrigation) should be concurrent with public water supply restrictions.

Appendix C: Model to simulate/ output

The following list of model outputs is not exhaustive, and the proposed bidder is encouraged to demonstrate what other factors could be displayed, but at a minimum the model should provide information on:

1. Abstraction and discharge data on a daily timestep;
2. Mixing of waters at demand centres;
3. A resilience index for the system based on its configuration, reliability, redundancy and ability to resist the modelled climatic data;
4. Surface water flows both natural and residual
5. An environmental index
6. Planned outages at source levels, noting that for some smaller sources this could represent an amalgamation of sources
7. Demonstrate the coincidence of some events e.g. dry winter and hot summers;
8. Performance of the system through a series of system performance metrics which might include, but an analysis of the time series data against certain thresholds;
9. Resilience of some of the systems to different duration droughts;
10. The number of lost days of pumping (both abstraction and transfers) due to water quality constraints;
11. Threshold analysis of all output time series from the model through a series of summary outputs;
12. Frequency and duration of drought permit/order use – using implementation rather than application

Once the model has been scoped and developed, it should be run at least 50 times to define the performance of the current system and how this could be optimised with the existing configuration of assets as well as the addition of new assets. This work would also include re-optimisation of control curves of key assets in the region.