Department for Environment Food & Rural Affairs

Bidder Pack

Procurement Specific Requirements

Lichfield Groundwater Model - recalibration and update

Procurement Reference Number C20943

September 2023

Version Date: October 2022 (Version 1.2)

Contents

Section 1: The Invitation

Defra group Commercial on behalf of Defra group and its Arm's Length Bodies invite you to bid in this competition.

The Bidder Pack comes in two parts.

This first part, **The Core Requirements**, provides details of the General Requirements, Government Transparency Agenda and Government Priorities.

The second part, **The Procurement Specific Requirements**, provides details of the Specification Requirements, Terms and Conditions of Contract, Evaluation Methodology, Procurement Timetable and Definitions.

The Definitions that apply to both parts can be found in Section 5, Appendix 1 of the Procurement Specific Requirements.

The tendering process seeks to determine the Most Economically Advantageous Tender (MEAT). The Authority will evaluate the Tenders using the tender evaluation criteria and weightings listed in Section 4, Evaluation Methodology.

The Opportunity

This opportunity is advertised by Defra group Commercial on behalf of Environment Agency (EA).
The Environment Agency works to create better places for people and wildlife, and support sustainable development. Within England EA is responsible for:

- regulating major industry and waste
- treatment of contaminated land
- water quality and resources
- fisheries
- inland river, estuary and harbour navigations
- conservation and ecology

We are also responsible for managing the risk of flooding from main rivers, reservoirs, estuaries, and the sea.

The EA's priorities are to:

- work with businesses and other organisations to manage the use of resources
- increase the resilience of people, property and businesses to the risks of flooding and coastal erosion
- protect and improving water, land and biodiversity
- improve the way we work as a regulator to protect people and the environment and support sustainable growth

Read more about Environment Agency: EA2025 creating a better place

Requirement Statement

We are looking for one contractor to complete work for the following project:

Lichfield Groundwater Model - recalibration and update

The Lichfield Permo-Triassic Sandstone aquifer is a regionally significant groundwater resource providing public water supply to areas of south and central Staffordshire. The aquifer is also an important source of baseflow to several tributaries of the River Trent.

The Lichfield groundwater model was developed for the Environment Agency during the period 2005-2008. The main purpose of this model was to increase the ability of the Agency to make abstraction licensing decisions on a sound scientific basis and, in doing so, protect and/or enhance sensitive surface water features on the outcrop of the Lichfield Permo-Triassic Sandstone aquifer. In 2012 the simulation period was extended up to March 2011. Subsequently, the model was recalibrated and the ability to simulate distributed runoff and total stream flows were added with the help of 4R code in 2013.

The main tasks of the current project will be to further extent simulation period up to the end of March 2023, complete various model refinements and improve model calibration and credibility. Moreover, the model will be migrated to Modflow 6. Finally, a set of standard and predictive scenarios will be completed using the refined and updated historical baseline.

Timetable

The timetable below is subject to change from time to time as notified by the Authority. All Tenderers will be informed via the Authority's eSourcing System.

Activity Ref	Activity Title	Date (Time)
1	Opportunity Notice published in Contracts Finder and Bidder Pack released	28 September 2023
4	Deadline for clarification questions	17 October 2023 (15:00)
5	Deadline for Responses	24 October 2023 (15:00)
6	Evaluation of Tender	24 to 31 October 2023
8	Contract award notification	01 November 2023
11	Contract start date	20 November 2023
12	Contract end date	31 March 2024

All timescales are set using a 24-hour clock and when referring to "days" it means calendar days unless otherwise specified (for example, working days).

Variant Tenders

The Authority shall not accept variant Tenders.

For the avoidance of doubt, if the Authority has reserved a right to waive a requirement in this Bidder Pack and chooses to exercise such discretion, the Tender will not be considered a

variant Tender.

Abnormally Low Tenders or Pricing Anomalies

If the Authority considers your Tender to appear abnormally low, an initial assessment will be undertaken using a comparative analysis of the pricing proposals received from all Tenderers [and the Authority's valuation of the procurement]. If that assessment indicates that your Tender is abnormally low the Authority will request a written explanation of your Tender, or of those parts of your Tender which the Authority considers contribute to your Tender being abnormally low. The Authority reserves the right to reject your Tender if the response does not satisfactorily account for the low level of price or costs proposed.

The assessment of abnormally low tenders will be undertaken strictly in accordance with Regulation 69 of the Public Contracts Regulations 2015, which outlines how abnormally low tenders must be assessed and the circumstances in which the contracting authority can reject the tender.

Pricing Anomalies

If in the opinion of the Authority your Tender contains any pricing anomalies (for example apparent discrepancies between the financial submission and other parts of your response) the Authority may seek clarification. If the clarification response indicates that the pricing anomaly was the result of a clear and obvious error, in the interest of fairness the resulting change will be taken into consideration. If the clarification response results in a change to the initial tendered Commercial Response and price, it will not be taken into account.

Section 2: The Specification of Requirements

The Authority's Priorities

Our ability to meet the requirements of the National Framework for Water resources will be underpinned by the availability of critical tools for the assessment, investigation and management of groundwater and its relationship to the wider natural environment. This is especially the case when it comes to our detailed understanding of key water supply aquifers and abstractions and whether/how they can be managed sustainably.

The recalibration and update of Lichfield groundwater model will deliver a product that will improve our ability to make abstraction licensing decisions on a sound scientific basis and protect and/or enhance sensitive surface water features on the outcrop of the Lichfield Permo-Triassic Sandstone aquifer. The delineation of source protection zones will help to protect the quality of the aquifer and water supply abstractions.

With that updated groundwater model and source protection zones we will have a much more reliable decision-support tool for the major decisions that we need to take in line with the great ambitions of the EA2025 Action Plan and other similar aspirations for a healthy water environment.

Scope

Appendix 3 sets out the Specification of Requirements.

Division of the Contract into Lots

This procurement requirement is not divided into Lots because this is a single piece of work, which should be delivered by a Main Contractor. A Contractor may decide to subcontract elements of the work and your intention to do this should be clearly outlined.

Section 3: Terms and Conditions of Contract

The Terms and Conditions of Contract for this procurement is the Short Form contract and can be found on the Authority's e-sourcing system.

The Authority proposes to enter Contract(s) for a maximum period of 4 months with the successful Tenderer(s).

The anticipated commencement date is 20 November 2023.

Suggested Changes to Conditions of Contract

Tenderers may raise clarification questions relating to the amendment of contract terms during the **clarification period only**, as specified in the Timetable, if it can be demonstrated that there is a legal or statutory reason why they cannot be accepted. Where a legal or statutory reason cannot be substantiated the Authority has the right to reject the proposed changed.

Such requests must follow the Clarifications Sought by the Tenderer process set out in the Core Requirements element of this Bidder Pack.

The completed model and outcome from this project work will be subject to external peer review.

Section 4: Evaluation Methodology

The overall aim of the evaluation process is to select the Tender that is the most economically advantageous to the Authority, having regard to the Authority's overall objectives and the criteria set out below.

Evaluation of Tenders comprise of the stages set out in the table below.

The Authority will carry out its evaluations of the Technical and Commercial elements according to the criteria, sub-criteria and weightings set out in the table below:

	Section Reference	Evaluation Criteria	Question Scoring/Weighting (%)
Evaluation Stage 1 - Technical	Selection Stage: Selection Questionnaire (SQ) responses submitted in response to the Contract Notice	**Part 1:** covers the basic information about the supplier, such as the contact details, trade memberships, details of parent companies, group bidding and so on and is provided for information only. **Part 2**: covers a series of self-declarations by the supplier regarding whether or not any of the questionnaire exclusion grounds apply and will be assessed on that basis. **Part 3**: covers a series of self-declaration questions regarding whether or not the company meets the selection criteria in respect of their financial standing and technical capacity.	Pass/Fail Pass/Fail Pass/Fail
	Section Reference	**Evaluation Criteria**	**Question Scoring/Weighting (%)**
	Form of Tender	This stage is not scored but if you do not upload a complete, signed and dated Form of Tender in accordance with the instructions in the eSourcing System/accept the Form of Tender statement in the SQ your Tender will be rejected as non-compliant.	Pass/Fail

<table>
<tr><td rowspan="6">Evaluation Stage 1 - Technical</td><td>Section Reference</td><td colspan="2">Evaluation Criteria</td><td>Question Scoring/Weighting (%)</td></tr>
<tr><td rowspan="5">Evaluation Stage: Technical</td><td colspan="2">This stage will be evaluated in accordance with the criteria set out in the Technical Questionnaire. Responses that do not meet the minimum thresholds will be excluded from the process at the stage where they do not meet the required level – this will be determined during the consensus meeting.</td></tr>
<tr><td colspan="2">E01: Approach, Methodology and Quality Assurance</td><td>35%</td></tr>
<tr><td colspan="2">E02: Experience of similar projects</td><td>20%</td></tr>
<tr><td colspan="2">E03: Staff Technical Expertise, Experience and Resources</td><td>25%</td></tr>
<tr><td colspan="2">E04: Programme, Project, and Risk Management</td><td>20%</td></tr>
<tr><td colspan="5">The Technical evaluation will account for 60% of the total score. All responses will be scored in accordance with the detailed guidance within the Authority’s eSourcing System and the Technical Questionnaire.

Tenderers must achieve a minimum score of 50 for E01 – E04 the ‘Technical Threshold’ in order to progress to the Commercial evaluation. Tenderers who fail to achieve the stated Technical Thresholds will not proceed to the Commercial evaluation.</td></tr>
<tr><td rowspan="2">Evaluation Stage 2 - Commercial</td><td>Section Reference</td><td colspan="2">Evaluation Criteria</td><td>Question Scoring/Weighting (%)</td></tr>
<tr><td>Evaluation Stage: Commercial - Pricing Schedule</td><td colspan="2">Prices will be evaluated in accordance with criteria set out in the Pricing Schedule in the Authority’s eSourcing System.</td><td>Scored</td></tr>
<tr><td colspan="5">The Commercial evaluation will account for 40% of the total score. All responses will be scored in accordance with the detailed guidance within the Authority’s eSourcing System and the Specification of Requirements.</td></tr>
<tr><td rowspan="2"></td><td>Section Reference</td><td colspan="3">Calculation</td></tr>
<tr><td>Final score</td><td colspan="3">The final score is calculated by adding the total quality weighted score with the total commercial weighted score.

The most economically advantageous tender will be the Tender with the highest final score.</td></tr>
</table>

Selection Questionnaire - Financial standing

The Authority will review the economic information provided as part of the Selection Questionnaire response to evaluate a Tenderer’s economic and financial standing. The Authority’s evaluation will be based on all the information reviewed and will not be determined by a single indicator. If, based on its assessment of the information provided in a Response,

the Authority decides that a Tenderer does not meet the Authority's required level of economic standing, the Authority may:

- ask for additional information, including information relating to the Tenderer's parent company, if applicable; and/or
- require a parent company guarantee or a performance bond.

If the Authority decides that a parent company guarantee or performance bond is required, the Authority will reject a Response if the Tenderer is unable to offer a commitment to make such provision. In addition to the information provided in a Response, the Authority may, at its discretion, consult Dun & Bradstreet reports and other credit rating or equivalent reports depending on where a Tenderer is located.

The Authority's assessment of economic and financial standing will consider financial strength and risk of business failure. Financial strength is based on tangible net worth and is rated on a scale of 5A (strongest) to H (weakest) obtained from Dun & Bradstreet. There are also classifications for negative net worth and net worth undetermined (insufficient information). Financial strength will be assessed relative to the estimated annual contract value.

The Authority will also consider annual turnover. For this procurement, the Authority expects the contractor to have an annual turnover for each of its last two financial years of at least 10% of the contract value.

In the case of a joint venture or a consortium bid, the annual turnover is calculated by combining the turnover of the relevant organisations in each of the last two financial years. In addition, the annual turnover of at least one of those organisations is expected to be 10% of the contract value.

Risk of Business Failure is rated on a scale of 1 (minimal) to 4 (significant) obtained from Dun & Bradstreet. There is also a classification of insufficient information. The Authority regards a score of 4 as indicating inadequate economic and financial standing for this procurement. The Authority will also calculate and evaluate the Tenderer's:

- operating performance: growth or reductions in sales, gross profit, operating profit, profit before tax and earnings before interest, tax, depreciation, amortisation, exceptional items and profit/loss on sale of businesses;
- liquidity: net current assets, movements in cash flow from operations, working capital and quick ratios, and average collection and payments periods; and
- financial structure: gearing ratios and interest cover.

Evaluation of Responses

Evaluation of Responses will be undertaken by a panel appointed by the Authority. Each panel member will first undertake an independent evaluation of the Responses applying the

relevant evaluation criteria for each question. Then, a moderation meeting will be held at which the evaluation panel will reach a consensus on the marking of each question.

During the consensus meeting, the decision may be taken that a Response will not be carried forward to the next evaluation stage if the consensus view is that the Tenderer has failed to meet any minimum or mandatory requirements, and/or provided a non-compliant response.

Scoring Criteria

The following scoring criteria is to be used when evaluating responses to Stage 3 Technical Questionnaire. A Tenderer's response will be assessed against the detailed criteria provided for each question E01 – E04 and be assigned a Descriptor and score from the table below:

Descriptor	Score	Definition
Very good	100	Addresses all the Authority's requirements with all the relevant supporting information set out in the Bidder Pack. There are no weaknesses and therefore the tender response gives the Authority complete confidence that all the requirements will be met to a high standard.
Good	70	Addresses all the Authority's requirements with all the relevant supporting information set out in the Bidder Pack. The response contains minor weaknesses and therefore the tender response gives the Authority confidence that all the requirements will be met to a good standard.
Moderate	50	Addresses most of the requirements with most of the relevant supporting information set out in the Bidder Pack. The response contains moderate weaknesses and therefore the tender response gives the Authority confidence that most of the requirements will be met to a suitable standard.
Weak	20	Substantially addresses the requirements but not all and provides supporting information that is of limited or no relevance or a methodology containing significant weaknesses and therefore raises concerns for the Authority that the requirements may not all be met.
Unacceptable	0	No response or provides a response that gives the Authority no confidence that the requirement will be met.

All tenderers should be aware of the timescales set to deliver this requirement and only submit a response where they are fully confident of being able to deliver within these parameters.

Tenders will be evaluated by the Target Programme Management team for appropriateness, on the basis of scope, methods, expertise, and value for money.

Each question will be allocated a score of between 0-100 for the documented response, based on the criteria above. The scores will be weighted against the technical sub-weighting, and a final technical score will be calculated. The highest technical score will then receive the maximum 60% technical score to be added to the commercial score in the overall tender evaluation. Other bidder's technical scores will be calculated pro rata to the highest technical score.

The Authority reserves the right to apply a tie-break mechanism, if the tender responses result in a two or more bids receiving an absolute tie in scores. This will consider the scores of each

criterion in order of importance (determined according to the weighting given to the criterion).

Bids in receipt of a 'fail' or scoring 20 or below for any of the following questions E01 – E04 will be eliminated from the procurement process.

To enable a consistent and fair evaluation of your tender, we require Suppliers to respond to the questions below, making sure you adhere to the page limits detailed in each section. Words submitted beyond these limits will not be evaluated as part of the tender response. All sections are mandatory and will be scored. The weighting given to each question is set out below as a percentage of the technical score available.

Please do not include any commercial information in your response to the technical questionnaire.

Please upload your response to each section (E01 – E04) as an individual document. This will allow evaluators to easily differentiate between the response to each section and allow consistent and fair evaluation of bids. Bidders should not cross reference information provided in each section as they will only be scored on the information requested and provided in each section.

Calculation Method

For both elements, providing the bidder has met any mandatory criteria and minimum quality thresholds, the total weighted scores are calculated as follows (Please See Next Page):

Technical (WT)

$$\left[\frac{\text{Bidder's Total Technical Score}}{\text{Highest Technical Score}} \times 100 = X\right] \text{ then } \left[\frac{X}{100} \times \text{[Weighting]}\right]$$

Commercial (WC)

$$\left[\frac{\text{Lowest Commercial Score}}{\text{Bidder's Total Commercial Score}} \times 100 = X\right] \text{ then } \left[\frac{X}{100} \times \text{[Weighting]}\right]$$

The Total Score (weighted) is then calculated by adding the Total Weighted Technical Score to the Total Weighted Commercial Score: **WT+ WC**.

Technical Evaluation

E01: Approach, Methodology and Quality Assurance (Weighting 35%)

Please detail the approach and methodology to be adopted in order to deliver the full scope of requirements systematically, and in detail also identify the key issues and challenges you foresee. Please include the areas listed below:

- Outline method of how you propose to complete individual tasks outlined in the Specification, within the given timescales.
- Quality assurance procedures which will be implemented to help to prevent quality issues.

Your response must be a maximum of 5 sides of A4, font size 11. Links to other documents will not be considered as part of your response e.g., links to published documents online. The supplier may cite relevant scientific literature. Please upload a document with the filename: 'E01 - Your Company Name'.

Evaluation Criteria:

Higher marks will be awarded to submissions which demonstrate:

- An excellent understanding of the requirements of the project,
- A clear methodological approach to deliver on each of the tasks of the project.
- A justification for the method(s) selected. Realistic and robust methodology for undertaking the project.

E02: Experience of delivering similar projects (Weighting 20%)

Please demonstrate that your organisation has sufficient technical expertise to deliver the project objectives by providing up to three examples of similar projects completed recently. These may include:

- Groundwater modelling projects in which Permo-Triassic sandstone aquifer was the subject of investigation.
- Modflow 6 groundwater models
- Projects in which groundwater models were used to assess impacts associated with groundwater abstractions.

Also please demonstrate how refined groundwater models have been an improvement on existing models if your organisation delivered any model update/refinement project. And how completed projects translated to improved confidence in environmental decision making.

Your response must be a maximum of 4 sides of A4, font size 11. Links to other documents will not be considered as part of your response e.g., links to published documents online. The supplier may cite relevant scientific literature. Please upload a document with the filename: 'E02 - Your Company Name'.

Evaluation criteria:

Higher marks will be awarded to submissions which demonstrate:

- Recent demonstratable experience and capability of effectively delivering comparable projects.
- Evidence of completion of projects on schedule and within budget.
- Evidence of how refined groundwater models have been an improvement on existing models, and how completed projects have translated to improved confidence in environmental decision making.

E03: Staff Technical Expertise, Experience and Resource Allocations (Weighting 25%)

Please demonstrate that the staff members assigned to the project have sufficient technical expertise across the broad range of technical skills required to deliver the project objectives.

This will include examples of skills used in previous projects or from relevant training. The staff making inputs to each stage of the Project (in terms of their expertise, skills and experience) and the quantity of their inputs should be suitable and adequate. The project team should have an appropriate balance of inputs by senior and junior staff. Lines of reporting to staff (to senior staff and/or the project manager) should be clearly presented.

Please note that the Project Manager doesn't need to be the technical lead. We need the name of the backup qualified Project Manager should the need arise.

The information provided should include:

- For each member of the Project team, information on the amount of time input to the project; their roles, responsibilities, levels of seniority, the value added that they will bring to the project and their lines of reporting. Demonstrable evidence of their relevant expertise, skills and experience to deliver the project should also be provided (though this should not repeat the level of detailed information provided in their accompanying CVs (to be provided separately)).
- The name(s) of the individual(s) who will have overall management responsibility for the project and will report to Defra's project manager, and the person who will be responsible for ensuring that the Project is completed satisfactorily. Please provide their project management professional qualifications and how long they have held them. A list of the projects managed in accordance with their qualifications should be provided in their accompanying CVs.
- In a separate attachment, curriculum vitae must be provided for each member of the project team and all sub-contractors. The curriculum vitae should be succinct (maximum length of two pages for each team member) and provide information on: expertise; skills and experience that are relevant to the project.
- A breakdown of the number of hours (or days) each individual team member will be contributing to each task. The breakdown of the number of hours (or days) should also be totalled for each row and column. This information should be provided in a separate appendix (one side of A4). **This should not include financial information** and should be provided within this response to E03.

Your response must be a maximum of 3 sides of A4, font size 11, excluding CV's and the breakdown of the number of hours (or days). Links to other documents will not be considered as part of your response e.g., links to published documents online. The supplier may cite relevant scientific literature. Please upload a document with the filename: 'E03 - Your Company Name'.

Evaluation criteria:

Higher marks will be awarded to submissions which demonstrate:
- Proven expertise in the groundwater modelling field.
- Relevant experience of staff members allocated to individual project tasks.
- The importance of staff resilience – i.e., if key personnel leave.

E04: Programme, Project and Risk Management (Weighting: 20%)

Please outline the project management protocols/methodology that will be used to manage and deliver the project and outline how the project as a whole will be managed and organised to deliver the specification in its entirety by the deadline and within the budget. Identify key project risks and issues and how they will be managed. Please include a description of how you will manage unforeseen technical issues associated with the model, in order to prevent delay to delivery of the project.

The response should include:
- a Gantt chart or equivalent format to convey the programme, which is to be uploaded either within the response or as a separate document.
- a risk matrix, in which potential project risks are assessed together with their respective mitigation measures and the residual risks, which is to be uploaded either within the response or as a separate document (one side of A4).

Your response must be a maximum of 4 sides of A4 font size 11, excluding the Gantt chart and risk matrix. Links to other documents will not be considered as part of your response e.g., links to published documents online. Please upload a document with the filename: “E04 – Your Company Name”

Evaluation Criteria:

Higher marks will be awarded to submissions which demonstrate:
- A clear work plan with resource allocation, by means of a Gantt chart or equivalent programme media.
- Project Management procedures which the project will follow.
- Identification of key milestones, tasks and critical paths, including a robust and credible approach to meeting the deliverables and service levels outlined in the specification.
- Consideration and mitigation of any risks to meeting the objectives.
- Detailed risk matrix

If the supplier passes the technical stage, the commercial stage will be evaluated.

Section 5: Appendices

1. Definitions

Unless the context otherwise requires, the following words and expressions used within the Bidder Pack (except for Section 3: Terms and Conditions of Contract) shall have the following meanings to be interpreted in the singular or plural as the context requires.

TERM	MEANING
"Authority"	the Environment Agency.
"Bidder Pack"	this invitation to tender and all related documents published by the Authority and made available to Tenderers.
"Contract"	the contract (set out in Appendix B) to be entered into by the Authority and the successful Tenderer.
"EIR"	the Environmental Information Regulations 2004 (as amended) together with any guidance and/or codes of practice issued by the Information Commissioner or any Government Department in relation to those Regulations.
"eSourcing system"	eSourcing system is the eSourcing system used by the Authority for conducting this procurement, which can be found at https://defra-family.force.com/s/Welcome for projects run on Atamis.
"FOIA"	the Freedom of Information Act 2000 (as amended) and any subordinate legislation made under that Act together with any guidance and/or codes of practice issued by the Information Commissioner or any Government Department in relation to that legislation.
"Form of Tender"	means the form contained in Annex 2 to the Procurement Specific section of the Bidder Pack which must be signed, scanned and uploaded into the Authority's eSourcing System by the Tenderer to indicate that it understands the Tender and accepts the various terms and conditions and other requirements of participating in the exercise.
"Information"	means the information contained in the Bidder Pack or sent with it, and any information which has been made available to the Tenderer by the Authority, its employees, agents or advisers in connection with the Exploring effective enforcement against littering, fly-tipping and dog fouling procurement.
"Involved Person"	means any person who is either working for, or acting on behalf of, the Authority in connection with this procurement and/or the Contract including, without limitation, any officer, employee, advisor, agent, member, partner or consultant".
"Pricing Schedule"	the form accessed via eSourcing system in which Tenderers are required to submit their pricing information as part of a Tender.
"Regulations"	the Public Contracts Regulations 2015.
"Relevant Body	means any other organisation, body or government department that is working with or acting on behalf of the Authority in connection with this procurement and/or the Contract including, without limitation, its officers, employees, advisors, agents, members, partners or consultants.

"Response"	means the information submitted in response to the Bidder Pack via the online response forms on eSourcing system including the Tenderer's formal Tender.
"Specification of Requirements"	the Authority's requirements set out in Section 2 of the Bidder Pack Procurement Specific Requirements.
"Tender"	the formal offer to provide the goods or services descibed in section 1.1 of part 1 of the Bidder Pack and comprising the responses to the questions in eSourcing system and the Pricing Schedule.
"Tenderer"	anyone responding to the Bidder Pack and, where the context requires, includes a potential tenderer.
"Timetable"	the procurement timetable set out in Section 1 of the Bidder Pack Procurement Specific Requirements.

2. Form of Tender

The Form of Tender document is located on the Authority's eSourcing system.

It is to be printed, signed, scanned and uploaded into the Authority's eSourcing System as instructed within the eSourcing system.

3. Specification

For information. Located on the Authority's eSourcing system.

The following specification describes the activities to be undertaken and invites tendering organisations or consortia to provide services for the following procurement:

Lichfield Groundwater Model - recalibration and update

1. Introduction

The Lichfield Permo-Triassic Sandstone aquifer is a regionally significant groundwater resource providing public water supply to areas of south and central Staffordshire. The aquifer is also an important source of baseflow to several tributaries of the River Trent.

The Lichfield groundwater model was developed for the Environment Agency during the period 2005-2008. The main purpose of this model was to increase the ability of the Agency to make abstraction licensing decisions on a sound scientific basis and, in doing so, protect and/or enhance sensitive surface water features on the outcrop of the Lichfield Permo-Triassic Sandstone aquifer. In 2012 the simulation period was extended up to March 2011. Subsequently, the model was recalibrated and the ability to simulate distributed runoff and total stream flows were added with the help of 4R code in 2013.

The main tasks of the current project will be to further extent simulation period up to the end of March 2023, complete various model refinements and improve model calibration and credibility. Moreover, the model will be migrated to Modflow 6. Finally, a set of standard and predictive scenarios will be completed using the refined and updated historical baseline. The updated model will be also used to delineate Source Protection Zones (SPZs) for a number of public water supply sources.

2. Project

The regional groundwater model will be updated and refined using a phased approach. It should be noted that the following definitions are used throughout this document:

Project – This refers to the programme of work to update and refine Lichfield groundwater model.

Task – This refers to a specific part of the Project. All the Tasks of the Project are listed below:

- Task 1 Review of the current model and conversion to Modflow 6
- Task 2 Time Series data update
- Task 3 Model refinements
- Task 4 Standard and predictive scenarios
- Task 5 Delineation of source protection zones (SPZs)
- Task 6 Calculating Natural Summer Outflows for the Lichfield Permo-Triassic Sandstone aquifer
- Task 7 Reporting, Model Map and project data transfer
- Task 8 National Groundwater Modelling System (NGMS) configuration

The specification does not address any other Tasks of this project.

The Consultant will be expected to undertake the work as outlined in Section 3. To ensure that the work is completed to a sufficiently high standard, the Task work will be monitored by a Task Review Team, which will consist of the following people:

- Project Manager - Groundwater Modelling Specialist - Environment Agency
- Area Technical Specialist - Groundwater - Environment Agency
- South Staffordshire Water Ltd
- TBC - External Peer Reviewer

The principal Environment Agency contact for the Consultant will be the Project Manager to deal with day-to-day contractual matters and data requests.

Project meetings will form the principal method of project review and the Consultant should produce formal minutes for approval by the Project Review Team within three working days of the meeting. Up to four Project meetings (including the project start-up meeting) will be held involving the full Task Review Team. The meetings will be organized as online calls using MS Teams. Except for the meetings, the Consultant should circulate an email with a summary of project progress which includes tasks completion and financial status every two weeks.

Project area

The extent of Lichfield model area is shown in Figure 1. The model area lies between northings 289,000 and 318,000 and between eastings 405,000 and 423,000 and covers approximately 450km^2. The western limit is defined by the edge of the Permo-Triassic Sandstone outcrop, where Carboniferous strata abut against the aquifer. The southern boundary is defined by the River Tame. The northern and eastern boundaries are loosely defined at the point at which boundary effects in the confined Permo-Triassic Sandstone aquifer are not considered to influence the unconfined aquifer. The model comprises three Groundwater Management Units: Lichfield GWMU, Shenstone GWMU and Sutton GWMU.

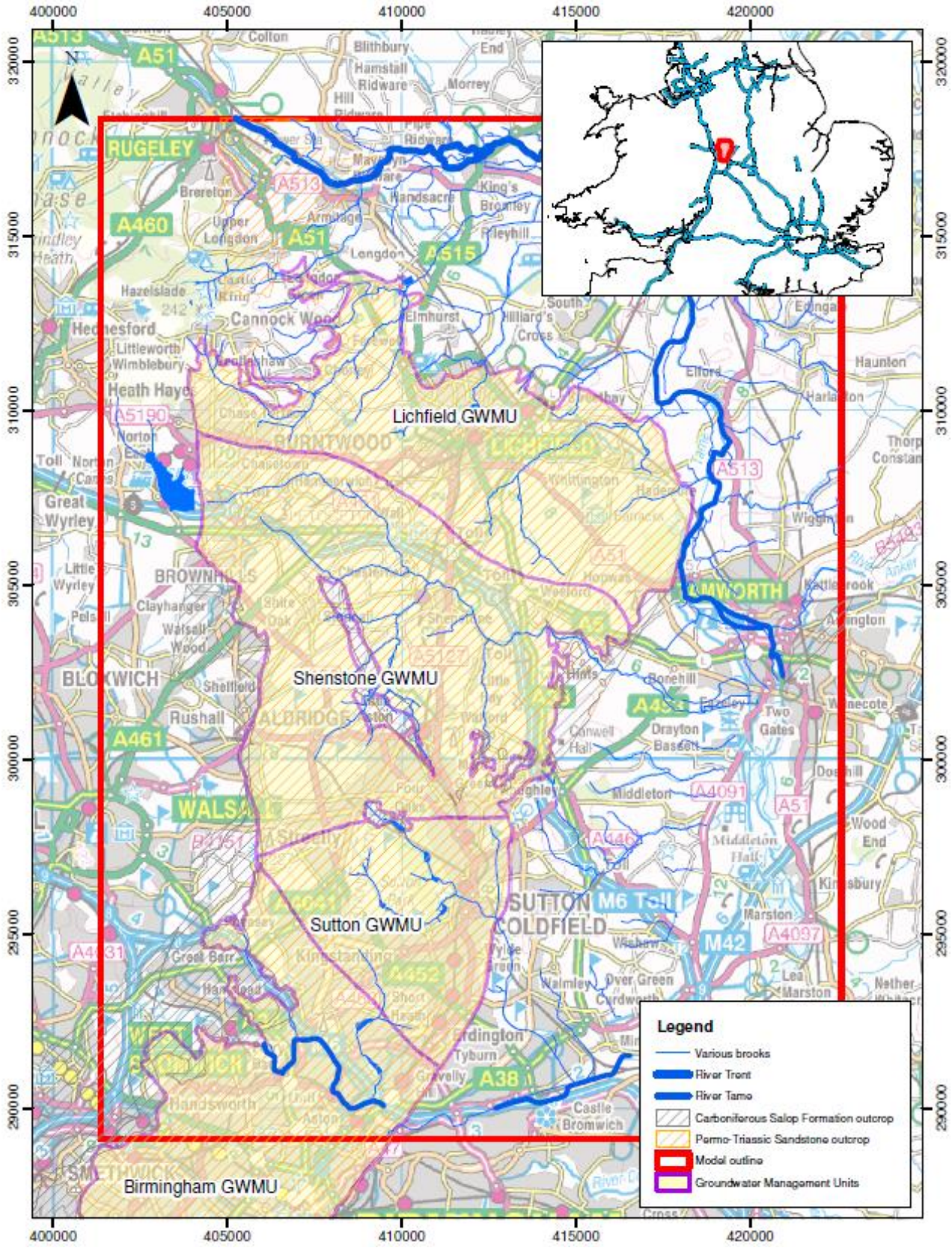

Figure 1 Project Area

Environment Agency Project Timescale

The Environment Agency Project Manager expects the work will start within two weeks from the date of signing the contract. The Consultant's Project Manager and principal technical expert should be available for the start-up meeting in that week. All the project work will need to be completed by the end of March 2024.

3. Task specification

Task 1 Review of the current model and conversion to Modflow 6

The current model should be reviewed to identify possible errors and implement corrections before further processing. The following issues have been already identified when reviewing the latest historical baseline:

- an error in the application of MOSES PE time series was discovered. A single PE time series is used in the 4R model from January 1970 to March 2011. This time series is applied incorrectly in the simulation from January 1969. This means that PE daily rates are applied with one year offset and in the last simulated year from April 2010 to March 2011 constant PE rate from 31/03/2011 is applied.
- Stream bed bottom elevations of two stream reaches are currently below the bottom elevation of containing cell. Such set up is not correct and will prevent Modflow 6 from running. Therefore, these elevations or elevations of model cells should be adjusted.
- The Hanch Tunnel is represented by means of stream reaches in the current model. There is a discrepancy in stream bed conductance value which is specified as 150m^2/d in the report but the value in the model input file (.STR) is 200m^2/d.

Other model input datasets should be reviewed by the Contractor to make sure that parameters used in the 4R and Modflow models are as reported and that the model set up allows for a conversion to Modflow 6.

The current MODFLOW96-VKD historical scenario should be rerun after implementing required corrections and this run will form the baseline for further model development. Subsequently, the new historical baseline should be run with climatic datasets that are going to be used in the updated model, these datasets are HadUK (rainfall) and EA PET (potential evapotranspiration). The comparison of old and new climatic datasets and the respective model results will guide further model refinements and recalibration that will be completed under Task 3.

Finally, the model will be converted to its Modflow 6 equivalent. This will require setting a new 4R run which will generate stream (.SFR) and recharge (.RCH) files in Modflow 6 format and the conversion of other model input files. Modflow 6 model will be based on the same structured grid as the current model and should have applied Newton-Raphson formulation to avoid potential issues associated with drying and rewetting model cells.

Task 2 Model update

All model input time series and calibration time series should be updated for the model extension period, April 2011 – March 2023. The update should comprise the following datasets:

2.1 Update of groundwater abstraction time series

Currently there are 32 abstraction time series in the model input file (.WEL). These time series should be updated with provided historical returns and any newly licensed abstractions should be added to the model input file. There have been four new licences issued for groundwater abstractions through the New Authorizations process. If there are no abstraction returns available for the recent period, abstraction time series should be infilled with annual abstraction profiles from the last year for which historical data is available.

2.2 Update of surface water abstraction and discharge time series

There are no surface water abstractions simulated in the model as existing abstractions on the Bourne Brook are small and not considered significant in relation to discharge from the sewage treatment work or total flows. Therefore, two New Authorization licences will need to be reviewed and added to the model if these licences abstraction rates are significant.

Currently there are four discharge time series in the model, one ALF scheme and three STW discharges. These should be updated in a similar way as groundwater abstractions. A list of existing discharges in the model area will be provided and the contractor will assess if there are any significant discharges that should be added to the model.

2.3 Update of groundwater levels and flow time series

The relevant calibration spreadsheets should be updated with observed data that will be provided for the model extension period.

2.4 Update of climatic datasets

Grids with daily values of rainfall (HadUK) and PE (EA PET) for the current model historical period, up to the end of March 2011 should be generated under Task 1. Subsequently these grids need to be extended up to the end of March 2023. When HadUK rainfall is not available, a long-term average factor grid should be generated and rainfall distribution for this period will be calculated using daily rainfall time series from a gauging station located within the project area.

2.5 Spot flow surveys

Spot flow survey completed during the model extension period should be collected in a spreadsheet and used as calibration datasets for assessing the accuracy of simulated flows. All spot flow data should be captured – including that predating the update and that undertaken in the catchment for other purposes.

Task 3 Model refinements and recalibration

While the model layering (4 layers) and model grid size (250m) will remain the same, the following model refinements subtasks should be completed or tested in the new Modflow 6 model:

3.1 Review of surface geology mapping and geological model

The latest BGS mapping changed outcrops of solid geology, therefore the updated model should have this new delineation incorporated as it may affect the extent of permeable and impermeable sediments represented in the groundwater model and surface geology representation in the 4R model which will affect spatial distribution of runoff and recharge. The presence and influence of faults within the active model area will also need to be reviewed as this may improve model calibration.

3.2 Review of representation of Carboniferous strata

The model has currently implemented Carboniferous strata as Layer 4. It is recommended to review parametrisation of this layer and compare with the parametrisation and the conclusions of implementing Carboniferous strata in the recent groundwater models, namely, East Shropshire and Cannock Chase model. The relevant reports and datasets will be provided.

3.3 Representation of Mercia Mudstone in the model

Currently these sediments are represented by the GHB boundary in the eastern part of the model where the sandstone aquifer is covered by substantial thickness of mudstone. This results in unphysical vertical gradients simulated when abstraction from the sandstone aquifer is simulated in this area as the GHB boundary elevation does not change during simulation and leakage will increase due to decreasing simulating groundwater levels. It may be more appropriate to represent Mercia Mudstone sediments as a separate model layer or alternatively to use river boundary condition.

3.4 Review of minimum thickness in model cells

In the original model minimum thickness was set to 1m but the recalibrated model from 2013 has it increased to 5m. As the implementation of Newton-Raphson formulation in Modflow 6 model will prevent issues associated with drying model cells, the minimum thickness can be revised and replace with smaller value.

3.5 Cross boundary flows between Lichfield model and Cannock Chase model

The neighbouring Cannock Chase model completed in 2020 overlaps the northwest area of the Lichfield model. A part of the eastern boundary of the Cannock Chase model is represented by the GHB boundary with heads based on groundwater levels simulated in appropriate cells of Lichfield model. It would be recommended to implement similar boundary in the Lichfield model and assess if cross-boundary flows simulated in the Cannock Chase model can be recreated in the Lichfield model. To complete this task, historical GHB boundary flows,

simulated groundwater levels, GHB cell locations and parameters from the Cannock Chase model will be provided.

3.6 The representation of Hanch Tunnel in the model

Hanch Tunnel is a 6 km long Victorian tunnel that partially drains the sandstone aquifer around Lichfield. It was represented by the means of 'adit' code (a modification of USGS MODBRNCH code) in the original model. However, when the model was migrated to MODFLOW-VKD in 2013, the application of 'adit' code was no longer possible and instead the tunnel was represented with Modflow STR boundary reaches. The major drawback of this solution is that constant heads (stages) are set up for these reaches, whereas water levels in the tunnel were calculated by the 'adit' code which resulted in the simulation of variable water volume hold by the tunnel in the original model. When the model is converted to Modflow 6, a separate SFR file that will represent the tunnel with simulated reach depth rather than constant stage can be tested in the model and permanently implemented if this solution does not affect model stability and does not result in the lack of convergence or significant mass balance errors.

3.7 Review and refinement of 4R routing and groundwater model stream network

The alignment of 4R routing will need to be checked against the Water Bodies shapefile in the WRGIS database and 4R routing network should be refined if significant differences in delineation of 4R sub-catchments and Water Bodies that cover the model area are identified. Subsequently stream reaches in the groundwater model should be extended towards the eastern model boundary over the area of Mercia Mudstone outcrops to represent the main streams and brooks up to the outflow points of the relevant Water Bodies.

3.8 Review of mains leakage rates in 4R model

This subtask is a subject to mains leakage data provided by the water company (South Staffs Water). As the current version of 4R model allows for simulation of variable leakage over time, the implementation of this functionality should be considered if the available data justify changes to leakage rates along the historical simulation period, for example the increase of leakage can be a result of population growth.

3.9 Adjustment of 4R and groundwater model parameters

Adjustment of 4R parameters may be required as the climatic datasets are changed to HadUK (rainfall) and EA PET (evapotranspiration). Especially, the second dataset may be expected to significantly affect model simulation when compared with the existing model version that uses MOSES dataset. Subsequently, groundwater model parameters may need to be adjusted to improve model calibration. The primary calibration goals should include improvement of the calibration of low flows in the Black/Bourne Brook at Hints Hall and improvement of long-term trends and annual fluctuation of simulated groundwater levels.

Task 4 Running standard and predictive scenarios

A set of standard scenarios which will include Naturalised (Nat), Recent Actual (RA) and Fully Licensed (FL) scenarios will be run using the new historical baseline which should be the outcome of **Task 3**. Annual abstraction profiles for the RA scenario will be calculated using historical abstraction rates from the recent period, the length of this period for abstraction averaging will be confirmed later.

Application of Batch Abstraction Modelling (BAM) tool to assess impacts from individual abstraction points. This tool allows for running a series of scenarios with a modification of abstraction rate for a single abstraction point or a group of points, e.g reduction of abstraction rate from 100% of FL rate to 10% of FL rate with 10% rate decrease in each run (10 runs in total). The BAM tool can be set up to automatically postprocess required model outputs (flows time series, groundwater level time series, spatial distribution of groundwater levels) and provide statistics of impacts on flows and groundwater levels associated with each abstraction rate simulated at a single abstraction point or group of points. This assessment should include all PWS sources and the largest non-PWS abstractions, in total 15 sources are expected to be included in this exercise.

Five predictive scenarios will be completed to look into changes to impacts as a result of reduction of mains leakage due to water company leakage reduction programs and modifications of licensed abstraction rates for selected PWS sources. The detailed scenarios specifications will be provided and discussed at one of the project meetings.

The outputs from standard and predictive scenarios will be post-processed and the comparison of groundwater levels and flows time series between scenario and its baseline or between Nat and RA or FL scenario will be presented in hydrographs in Excel spreadsheets. The differences in spatial groundwater level simulation (Scenario minus Baseline) for representative ‘dry’, ‘average’ and ‘wet’ periods will be calculated and saved in a grid or raster format available to plot in ArcGIS. FlowMaps tool will be used to calculate flow statistics for standard and predictive scenarios.

Simulated flows compliance in RA and FL scenarios (Environmental Flow Indicator methodology, output from FlowMaps) will be compared with respective compliance calculated in the WRGIS database. This will be achieved by identifying stream reaches in the model that are aligned with outflow points of relevant WRGIS Water Bodies and applying the simulated compliance Band colour from these reaches to the relevant Water Body polygons. This exercise will be completed in ArcGIS.

Detailed model water balances for standard scenarios will be presented in the form of time series and in a table which will summarize long term average (LTA) and ‘dry’ ‘wet’ and ‘average’ flow rates. These water balances will be calculated for the whole model and for individual Groundwater Management Units.

Task 5 Delineation of source protection zones (SPZs)

The updated model will be used to delineate SPZs for the following groundwater sources:

GWMU Name	Licence Number	Source
Lichfield	03/28/07/0097	Maple Brook* (SS)
	03/28/07/0097	Seedy Mill* (SS)
	03/28/22/0004	Trent Valley#~ (SS)
	03/28/07/0006	MIZKAN UK LTD (Manor Vinegar)
	03/28/22/0081	Fradley# (SS)
	03/28/22/0087	Hopwas (SS)
Shenstone	03/28/17/0006	Bourne Vale* (SS)
	03/28/17/0006	Little Hay* (SS)
	03/28/17/0006	Sandhills* (SS)
	03/28/17/0006	Shenstone* (SS)
	03/28/17/0006	Pipe Hill*~ (SS)
Sutton	03/28/10/0035/1/R01	Good Hope Hospital

The methodology developed for the delineation of SPZs for numerical groundwater models used by the EA should be applied. This will require completing particle tracking with Modpath and calculating flow capture zones with Flowsource. The processing will need to be completed for wet, dry and average conditions. Subsequently, the capture zones will be manually digitised. The output of this task should be shapefiles with delineated SPZs for 50 and 400 days travel time for individual groundwater sources.

The contractor will produce all relevant information and GIS layers required for upload onto the Environment Agency's National database.

Task 6 Calculating Natural Summer Outflows for the Lichfield Permo-Triassic Sandstone aquifer

The Available Groundwater Resource (AGR) is effectively the amount of water that can be sustainably licensed for our Groundwater Management Units (GWMUs) for use in water abstraction licensing. In order to calculate the AGR you need the following information:

AGR = Recharge – environmental flow allocation + any cross-boundary flows

The AGR approach has been adopted in Water Framework Directive (WFD) Groundwater Balance Test from RBMP Cycle 3.

For modelled principal aquifers, the GW models are the best available tool for deriving the environmental flow allocation. Based on extensive experience, Midlands Groundwater Modelling specialists consider the Q85 'Natural' Summer Outflow (Q85NSO) to be a fair representation of the flow allocation for the sandstone aquifers. Further information can be found in a paper entitled 'The estimation of 'natural' summer outflows from the Permo-Triassic Sandstone aquifer, UK' M.G. Shepley and M. Streetly Quarterly Journal of Engineering Geology and Hydrogeology 2007; v. 40; p. 213-227'

We require for this task the 'environmental flow allocation' to be derived using the Lichfield Groundwater model. The Q85 'Natural' Summer Outflow (Q85NSO) is considered to be a fair representation of the flow allocation for the sandstone aquifers.

When using recharge and Q85NSOs from a model, you must use 'paired' values i.e. they are taken from the same version of the Groundwater model.

Task 7 Reporting, Model Map and project data transfer

The development process, parametrisation and calibration status of the 4R and Modflow 6 models should be recorded in the final report. The report should also comprise sections where standard and predictive scenarios are summarised. Moreover, the report should include a section where areas that require further monitoring or improved conceptualisation (backed up by further monitoring) will be identified to inform work before a future update. The final content of the report will be discussed when individual tasks are completed. A draft report version should be provided for a review by the Project Review Team. A period of four weeks for reviewing the draft report should be included in the project programme which will be followed by a period required for completing the final report.

Model Map ArcGIS project will be another deliverable. This project should comprise layers with 4R and groundwater model parameters, boundary conditions and basic geographical datasets (OS map, rivers, topography etc.). Moreover, the outputs from 4R model (distribution of recharge, interflow, runoff) and groundwater model historical and standard scenarios (groundwater levels, total flows, groundwater and surface water interaction for representative stress periods) should be added to model map.

When the project is successfully completed, model input files required to run individual scenarios (4R and Modflow), tools needed for model data pre- and post-processing and any files with the

visualisation of model outputs, e.g., calibration spreadsheets will need to be transferred to the Environment Agency.

Task 8 National Groundwater Modelling System (NGMS) configuration

In this task, the files required for loading Lichfield model onto the NGMS will be created.

The Consultant should prepare the NGMS standard data sets that will include:

- Completion of standard template for model location data, which should include details on abstractions, discharges, accretion profiles, CAMS assessment points, surface water gauging stations and observation boreholes.
- NGMS configuration files for all main model scenarios, namely, Historical, Naturalised, Recent Actual and Fully Licensed.

Timetable

The expected timetable for this project is estimated to be around 5 months. Timings and payment milestones will be agreed in the contract. Indicative timings are presented below

Inception Meeting		First week of contract
Progress updates		Fortnightly
Data analysis and outputs		Ongoing
Completion of phase 1 (**Milestone 1** payment)	The outcome of completing phase 1 (Tasks 1 to 3) will be updated and refined historical Lichfield groundwater model	Around 6-8 weeks
Completion of phase 2 (**Milestone 2** payment)	After completing phase 2, all standard and predictive scenarios (Task 4) and the NSO calculations (Task 6) will be completed	Around 6-8 weeks
Completion of phase 3 (**Milestone 3** payment)	The outcome of completing phase 3 (Tasks 5) will be delineated Source Protection Zones for 12 PWS sources	Around 4-6 weeks
Final Report (**Milestone 4** payment)	The final report will be delivered at the end of this phase. NGMS configuration (Task 8) will be included in the project if the price of this task will not exceed project budget	Around 4-6 weeks

Financial Arrangement

Contractors should provide a full and detailed breakdown of costs. This should include staff (and day rate) allocated to specific tasks. Contractors should provide an outline of the indicative milestones and phasing of payments.

Bids should at a minimum include costs for the below activities:

- Quantitative methods including design and analysis
- Qualitative interviews and/or focus groups
- Desk based research

4. Conditions of Contract

For information. Located on the Authority's eSourcing system.

5. Pricing Schedule

For information. Located on the Authority's eSourcing system. Please complete and return the schedule with your proposal, in the excel format provided.