



Framework: Collaborative Delivery Framework

Supplier: Ove Arup & Partners Ltd

Company Number: 01312453

Geographical Area: Midlands

Project Name: River Ryton Modelling

Project Number: ENV0002885C

Contract Type: Professional Service Contract

Option: Option E

Contract Number: 29648

| Revision | Sta | itus | Origi | nator | Revi | ewer | Date | |
|----------|-----|------|-------|-------|------|------|------|--|
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PROFESSIONAL SERVICE CONTRACT under the Collaborative Delivery Framework **CONTRACT DATA**

Project Name

River Ryton Modelling

Project Number

ENV0002885C

This contract is made on 13 April 2020 hetween the Client and the Consultan

- This contract is made pursuant to the Framework Agreement (the "Agreement") dated 01st day of April 2019 between the Client and the Consultant in relation to the Collaborative Delivery Framework. The entire agreement and the following Schedules are incorporated into this Contract by reference
- Schedules 1 to 22 inclusive of the Framework schedules are relied upon within this contract.
- The following documents are incorporated into this contract by reference CDF PSC Technical Scope Ryton v2, NEC4 Minimum Technical Requirements for Modelling_v1, Ryton PSC Management Scope v2

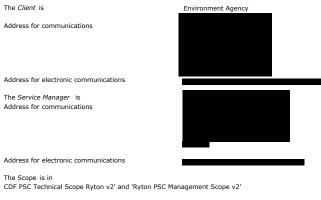
Part One - Data provided by the Client Statements given in all Contracts

1 General

The conditions of contract are the core clauses and the clauses for the following main Option, the Option for resolving and avoiding disputes and secondary Options of the NEC4 Professional Service Contract June 2017.

Option for resolving and Option E Option avoiding disputes Secondary Options X2: Changes in the law X9: Transfer of rights X10: Information modelling X11: Termination by the Client X18: Limitation of liability X20: Key Performance Indicators Y(UK)2: The Housing Grants, Construction and Regeneration Act 1996 Y(UK)3: The Contracts (Rights of Third Parties) Act 1999 7: Additional conditions of contract

The service is To produce a flood model to gain a better understanding of the flood risk from the River Ryton in North Nottinghamshire



The partner contract is

The language of the contract is English

the law of England and Wales, subject to the jurisdiction of the courts of England and Wales

The period for reply is 2 weeks

The period for retention is

6 years following Completion or earlier termination

The following matters will be included in the Early Warning Register

Covid19 restrictions

Early warning meetings are to be held at intervals no

2 weeks

2 The Consultant's main responsibilities

The key dates and conditions to be met are

key date conditions to be met 'none set' 'none set' 'none set' 'none set' 'none set'

The $\it Consultant$ prepares forecasts of the total Defined Cost plus Fee and $\it expenses$ at intervals no longer than

3 Time

The starting date is 13 April 2020

The Client provides access to the following persons, places and things

access date access

The ${\it Consultant}$ submits revised programmes at intervals no longer 4 weeks than

The completion date for the whole of the service is 30 September 2021

The period after the Contract Date within which the *Consultant* is to submit a first programme for acceptance is

4 Quality management

The period after the Contract Date within which the ${\it Consultant}$ is to submit a quality policy statement and quality plan is

The period between Completion of the whole of the <code>service</code> and the

26 weeks

5 Payment

The currency of the contract is the £ sterling

The assessment interval is Monthly

The expenses stated by the Client are as stated in Schedule 9

The interest rate is 2.00% per annum (not less than 2) above the

Base rate of the Bank of England

The locations for which the *Consultant* provides a charge for the cost of support people and office overhead are

6 Compensation events

These are additional compensation events

- Managing and mitigating the impact of Covid 19 and working in accordance with Publ
- 'not used'
- 'not used'

8 Liabilities and insurance

These are additional Client's liabilities

- 'not used'
- 'not used

The minimum amount of cover and the periods for which the Consultant maintains insurance are

MINIMUM AMOUNT OF COVER PERIOD FOLLOWING COMPLETION OF THE WHOLE OF THE SERVICE OR TERMINATION EVENT

The Consultant's failure to use the skill and care normally used by professionals providing

45,000,000 in respect of each claim, without limit to the number of claims services similar to the service

12 years after Completion

All UK Offices

Loss of or damage to property and liability for bodily injury to or death of a person (not an employee of the Consultant) arising from or in connection with the *Consultant* Providing the Service

12 years after Completion

Death of or bodily injury to the employees of the Consultant arising out of and in the course of their employment in connection with the contract Legal minimum in respect of each claim, without limit to the number of claims and in the contract

For the period required by law

The Consultant's total liability to the Client for all matters arising under or in connection with the contract, other than the excluded matters is limited to

Resolving and avoiding disputes

The tribunal is litigation in the courts

The Adjudicator is 'to be confirmed' Address for communications

Address for electronic communications 'to be confirmed'

The Adjudicator nominating body is The Institution of Civil Engineers

Z Clauses

Z1 Disputes

Delete existing clause W2.1

- Z2 Prevention
 The text of clause 18 Prevention is deleted.
 Delete the text of clause 60.1(12) and replaced by:
 The service is affected by any of the following events

 War, civil war, rebellion, revolution, insurrection, military or usurped power;

 Strikes, riots and civil commotion not confined to the employees of the Consultant and sub consultants,

 Ionising radiation or radioactive contamination from nuclear fuel or nuclear waste resulting from the combustion of nuclear fuel,
- fuel,

 Radioactive, toxic, explosive or other hazardous properties of an explosive nuclear device,

 Natural disaster,

 Fire and explosion,

 Impact by aircraft or other aerial device or thing dropped from them.

Z3 Disallowed Costs

Add the following in second bullet of 11.2 (18) add:
(including compensation events with the Subcontractor, i.e. payment for work that should not have been undertaken).
Add the following additional bullets after 'and the cost of':
Mistakes or delays caused by the Consultant's failure to follow standards in Scopes/quality plans

- Reorganisation of the Consultant's project team
- Additional costs or delays incurred due to Consultant's failure to comply with published and known guidance or document Recurrence of the second statement of the

- Production or preparation of self-promotional material
- Excessive charges for project management time on a commission for secondments or full time appointments (greater than 5% of commission value)
- Any hours exceeding 8 per day unless with prior written agreement of the Service Manager
 Any hours for travel beyond the location of the nearest consultant office to the project unless previously agreed with the Service Manager
- Attendance of additional individuals to meetings/ workshops etc who have not been previously invited by the Service
- Costs associated with the attendance at additional meetings after programmed Completion, if delay is due to Consultant performance
 • Costs associated with rectifications that are due to *Consultant* error or omission
- Costs associated with the identification of opportunities to improve our processes and procedures for project delivery through the Consultant's involvement

- Was incurred due to a breach of safety requirements, or due additional work to comply with safety requirements
 Was incurred as a result of the Client issuing a Yellow or Red Card to prepare a Performance Improvement Plan
 Was incurred as a resulting of rectifying a non-compliance with the Framework Agreement and/or any call off contracts following an audit

Z6 The Schedule of Cost Components

The Schedule of Cost Components are as detailed in the Framework Schedule 9.

Z23 Linked contracts

Issues requiring redesign or rework on this contract due to a fault or error of the Consultant will neither be an allowable cost under this contract or any subsequent contract, nor will it be a Compensation event under this contract or any subsequent contract under this project or programme.

Z24 Requirement for InvoiceAdd the following sentence to the end of clause 51.1:

The Party to which payment is due submits an invoice to the other Party for the amount to be paid within one week of the Service Manager's certificate.

- Delete existing clause 51.2 and replace with:
 51.2 Each certified payment is made by the later of
 one week after the paying Party receives an invoice from the other Party and
 three weeks after the assessment date, or, if a different period is stated in the Contract Data, within the period stated. • three weeks are the assessment date, or, in a dimension period is stated in the Contact Data, within the period stated.

 If a certified payment is late, or if a payment is late because the Service Manager has not issued a certificate which should be issued, interest is paid on the late payment. Interest is assessed from the date by which the late payment should have been made until the date when the late payment is made, and is included in the first assessment after the late payment is made

725 Risks and insurance

The Consultant is required to submit insurances annually as Clause Z4 of the Framework Agreement

Secondary Options

OPTION X2: Changes in the law

The *law of the project* is the law of England and Wales, subject to the jurisdiction of the courts of England and Wales

OPTION X10: Information modelling

The period after the Contract Date within which the *Consultant* is to submit a first Information Execution Plan for acceptance is 6 weeks

OPTION X18: Limitation of liability

The Consultant's liability to the Client for indirect or consequential loss is limited to

£1,000,000

The Consultant's liability to the Client for Defects that are not found until after the defects date is limited to

£5,000,000

The *end of liability date is*Completion of the whole of the *service*

6 years

after the

OPTION X20: Key Performance Indicators (not used with Option X12)

The incentive schedule for Key Performance Indicators is in

Schedule 17

A report of performance against each Key Performance Indicator is provided at intervals of

3 months

Y(UK)2: The Housing Grants, Construction and Regeneration Act 1996

The period for payment is

14 days

after the date on which payment becomes

due

Y(UK)3: The Contracts (Rights of Third Parties Act) 1999

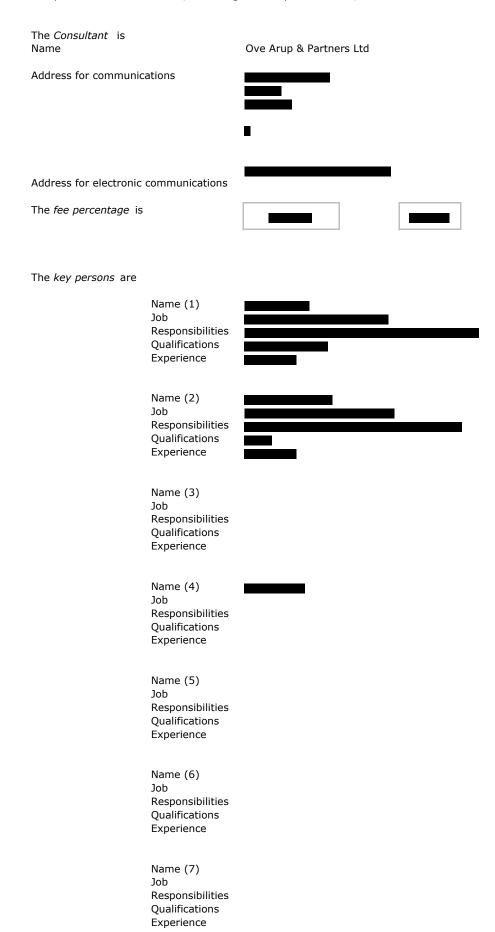
term

beneficiary

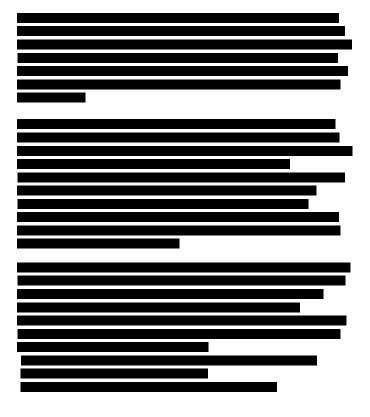
Part Two - Data provided by the Consultant

Completion of the data in full, according to the Options chosen, is essential to create a complete contract.

1 General



The following matters will be included in the Early Warning Register



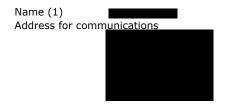
3 Time

The programme identified in the Contract Data is

To be provided within 4 weeks

Resolving and avoiding disputes

The Senior Representatives of the Consultant are



Address for electronic communications

Name (2) Address for communications

Address for electronic communications

X10: Information Modelling

The *information execution plan* identified in the Contract Data is
To be provided within 6 weeks

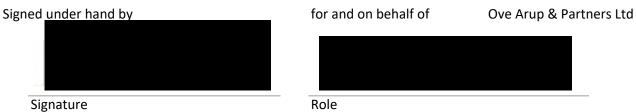
Contract Execution

Client execution



Consultant execution

Consultant execution



Environment Agency NEC3 Professional Services Contract (PSC) Scope

Project / contract information – Management scope

| Project name | River Ryton modelling |
|--------------------|-----------------------|
| SOP reference | ENV0002885C |
| Contract reference | 29648 |
| Date | 06/05/20 |
| Version number | 2.0 |
| Author | |

Revision history

| Revision date | Summary of changes | Version number |
|---------------|--|----------------|
| 30/04/20 | First issue | 1 |
| 06/05/20 | Following Defra Commercial Lead review | 2 |

This Scope should be read in conjunction with the version of the Minimum Technical Requirements current at the Contract Date. In the event of conflict, this Scope shall prevail. The services are to be compliant with the version of the Minimum Technical Requirements.

1 Overview

This contract is for a single modelling project in the IDT operational areas of the Midlands hub. This Scope details the overarching management arrangements that are to be applied to the individual project Scope listed in 1.2.

1.1 Objectives

The objective of the project is to improve the *Client's* understanding of flood risk by delivering a range of modelling outputs. These outputs are listed in the individual project Scope and may include, but are not limited to:

- Hydrological and Hydraulic model reviews;
- Flood history reviews;
- Hydrological assessments;
- New hydraulic models;
- Flood mapping.
- Climate change updates.

1.2 Project Details

The project details are listed in the table below:

| Scope number | Task | Key PSO Contact | Area |
|-----------------|-------------|-----------------|------|
| 01 | River Ryton | | EMD |
| | | | |

The Client has provided an individual project Scope, detailing the technical services required.

2 Services required

Attendance

2.1.1.

2.1.2.

2.1 Consultant project management

The overall management of the *services* shall include the following:

| a) Project Start-up meeting b) monthly progress meetings, alternating monthly between telephone and face-to-face meetings at one of the <i>Client's</i> venues with attendance at |
|---|
| the minimum by the <i>Consultant's</i> Service Manager (either or a |
| The Consultant ensures the management of actions arising from these meetings. |
| Monthly project progress reports to be provided to the <i>Client</i> , including: a financial update and forecast; an updated programme; and a summary of work completed in month, an overview of upcoming stages and milestones, and key issues and risks using the <i>Client's</i> Modelling and Forecasting Monthly Reporting Tool template. These must be provided by the 8 th of every month unless stated otherwise by the <i>Client</i> . |

- 2.1.3. Monthly risk register review, update (including *Consultant* risk budget) and implementation of resulting actions.
- 2.1.4. Fortnightly progress updates via phone and/or email to the *Client* throughout the duration of the project. Any key decisions agreed with the *Client* must be documented by the *Consultant* and issued within a week to the *Client*.
- 2.1.5. All meetings (including progress and consultations) shall be recorded by the *Consultant* with actions identified (responsible party, date required). Minutes shall be provided within 1 working week of meeting date for review by the *Client*.
- 2.1.6. Recording and updating a list of data required to provide the services, which must be provided to the *Client* at the project start-up meeting and weekly intervals thereafter.
- 2.1.7. Quarterly input into the project efficiency register (CERT Tool).
- 2.1.8. Obtaining data from *Others* in order to provide the *services* and ensuring it is correctly licensed for use by the *Client*.
- 2.1.9. Following completion of a project, provide responses to *Client* queries about the completed project until the Services are completed. The *Consultant* provisions no more than 1% of the total contract value for delivering this task.
- 2.1.10. Highlights any slippage on the timescales identified in Section 3 immediately to the *Client's* Service Manager.
- 2.1.11. Model handover meetings face to face anticipated at the *Client's* office, location as identified previously

at:

3 Requirements of the programme

3.1 Programme

- 3.1.1. The *Consultant* shall provide a detailed programme in Microsoft Project 2013 meeting all requirements of the *conditions of contract*. The programme must show critical path activities, gateway, risk buffers and activities requiring *Client* input, for example review periods, and allowances for stakeholder/third party engagement.
- 3.1.2. Allow 10 working days for the *Client* review of standard draft deliverables and provide 2 weeks' notice of submission for review. The exception to this will be for *Client* review of all the draft baseline models, for which 20 working days will be allowed.
- 3.1.3. Allow 25 working days for the initial data collection by the *Client* following the data review by the *Consultant*.
- 3.1.4. Allow 20 working days for the *Client* to arrange site visits if specified in the project Scopes.

4 Data

4.1 Previous studies and data sources

See the individual project Scopes for previous studies and data sources.

- 4.1.1. The *Client* is responsible for the accuracy & sufficiency of existing data owned by the *Client*. The *Client* will only cover costs of sourcing new data, if existing data is proven to be incomplete or to contain mistakes or errors.
- 4.1.2. The *Consultant* is responsible for any new data requirements and third party data. The *Consultant* is to scope, procure and manage the acquisition of any new surveys or data requirements and third party data. The *Consultant* will ensure any Intellectual Property Rights remain with the *Client* after final delivery.
- 4.1.3. The Consultant completes a data review to analyse the completeness, accuracy, content and size of previous studies and data and identifies any risks or issues associated with these within 6 weeks of the Project Start-up Meeting. The Consultant produces a data review report to identify any major concerns within 6 weeks of the project start up meeting and attends a call to discuss the content of the report to allow appropriate action to be taken.

5 Specifications and guidance

Where applicable, the *Consultant* shall use the following specifications and guidance:

- 5.1.1. Operational Instruction 379_05 'Computational modelling to assess flood and coastal risk'.
- 5.1.2. Operational Instruction 197_08 Flood Estimation Guidelines
- 5.1.3. NEC4 Minimum Technical Requirements for Modelling_v1.xlsm
- 5.1.4. Fluvial Design Guide (online): http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide.aspx
- 5.1.5. Operational Instruction 466_15 Guidelines on high flow rating curve development using hydraulic models.
- 5.1.6. Development of flood warning thresholds must comply with Operation Instruction 137_05, Flood Warning Levels of Services (06/01/2014) and Operational Instruction 55_07 Threshold Setting in Flood Incident Management (26/10/10) where the 0.1% AEP flood outline exists.
- 5.1.7. PDM Model Calibration Principles 20151109.docx
- 5.1.8. Operational Instruction 57_07 Assessment of flood risk topographic and hydrographic surveys.
- 5.1.9. Carry out any required surveys in accordance with the National Standard Contract and Specification for Survey Services version 4.1.

6 Services and other things provided by the Client

The *Client* will provide the following services:

- 6.1.1. Access to land to carry out surveys and site visits.
- 6.1.2. Arrangement of progress meetings, meetings with landowners and site visits with the *Client* in attendance.
- 6.1.3. Any other data owned by the *Client* which is requested by the *Consultant* will be provided along with a data licence.

Environment Agency NEC4 professional services contract (PSC) Scope

Project / contract Information

| Project name | River Ryton |
|-----------------------|-------------|
| Project SOP reference | ENV0002885C |
| Contract reference | 29648 |
| Date | 06/05/2020 |
| Version number | 2 |
| Author | |

Revision history

| Revision date | Summary of changes | Version number |
|---------------|---|----------------|
| 30/04/20 | First issue | 1 |
| 06/05/20 | Following review by Defra Commercial Lead | 2 |

This Scope should be read in conjunction with the version of the Minimum Technical Requirements current at the Contract Date. In the event of conflict, this Scope shall prevail. The *services* are to be compliant with the version of the Minimum Technical Requirements.

| Document | Document Title | Version No | Issue date |
|----------|---|------------|------------|
| n/a | NEC4 Minimum Technical Requirements for Modelling | v1 | 03/12/19 |

Details of the Scope

Details of the Scope are as follows.

1. Description of the work:

1.1. Objective

The aim of this project is to gain a better understanding of the flood risk from the River Ryton in North Nottinghamshire, with particular focus on the communities of Shireoaks, Worksop and Blyth. There is a history of flood events affecting Worksop, with a large event occurring in June 2007 and more recently in November 2019. The June 2007 event resulted in internal flooding to an estimated 200 properties and the November 2019 event over 300 properties.

1.2. Outcome Specification

The River Ryton is the primary source of flood risk in this area though as with all urban areas surface water is known to cause flooding issues.

This study shall identify the source(s) and key mechanisms of fluvial flooding in the communities highlighted above with particular focus on Worksop being the community with by far the most properties at risk. The results of this study will be used to identify potential flood risk management options, inform incident response, justify asset investment and maintenance as well as inform spatial planning.

A 1D ISIS model was constructed for the River Ryton in 2008. Since then new modelling techniques and methodologies have become available which will enable us to create an improved understanding of the flood risk and flooding mechanisms within the catchment.

A significant amount of hydrometric data has been collected since the last study, including a very significant event which will aid in the development, calibration and validation of the model. In addition new channel cross section survey was collected in 2019 for the whole study reach and 1m resolution LiDAR has been collected in this area as part of the national programme. A review of the new survey is required in order to capture any key information (cross sections, structures) that may be missing. Where gaps are identified they should be highlighted to the local team.

The River Ryton is a tributary of the River Idle and flows through a predominantly rural catchment covering around 245km2. The main area of flood risk being the communities of Shireoaks, Worksop and Blyth. The catchment is gauged at Worksop and Blyth with a flood warning service provided to the local communities.

The extents of the study are:

River Ryton from SK 53837 82778 (HOMR) to SK 65749 92138 (River Idle Confluence) Approx 40 km.

2. Outcomes required

a) The Consultant shall

- The Consultant shall produce a written commentary in the Interim Hydrology Report or Hydrology Review Report to document local flood history analysis. The commentary shall consider the following:
 - o Ranking and severity / probability of events where possible.
 - o Likely causal mechanism of flooding (including combined sources).
 - o The Consultant shall collect and evaluate data from the Client.
 - o The *Consultant* shall collect and evaluate data from social media / other potential sources of information.

Site Visit and Topographic Survey

Visit the site to understand the local flood flow pathways and flood history. The Client will facilitate this visit(s) and arrange for appropriate staff to accompany the Consultant to provide local knowledge. The Consultant shall give the Client at least 20 working days' notice prior to any required visits.

Hydrological Assessment & Hydrometric Review

The *Consultant* shall undertake the following activities to provide a hydrological assessment and / or hydrometric review in accordance with the Environment Agency's Flood Estimation Guidelines.

Reporting

- Submit a Hydrology Method statement for acceptance by the Client before commencing the hydrological assessment and/or hydrometric review. This shall set out the proposed approach, review of hydrometric data, catchment schematisation, and set out the methods and outputs.
- Submit a Draft Hydrology Report to the Client for acceptance prior to the commencement of design simulations.
- Submit a Final Hydrology Report to the Client for acceptance prior to commencement of design event simulations.

Review Data Availability

- Undertake a review of the hydrometric data (rainfall, levels, flow, flood extent) that are available for use for in the study (including donor catchments, model calibration and verification of models).
- Assess data availability, and the uncertainties in the accuracy of the data and what effect this could have on the reliability and accuracy of model outputs.
- Review the performance of all rating relationships that will be used in this study during high flow conditions. The rating throughout the full range of flows shall also be assessed, albeit in a less rigorous manner. The review shall include commentary on the extrapolation above validated range, modular limits, likely hydraulic control in drowned mode and inter-site comparison.

- Clear conclusions on the suitability of ratings for rainfall-runoff model development and calibration of hydraulic models must be provided. Conclusions must include an estimate of likely gauge accuracy (% error in flow) for flows up to and including AMAX1. An indication of gauge accuracy at high and extreme flows (0.1% AEP or similar) shall be provided where possible.
- Use model constructed to improve the rating relationship at required gauging stations. State the extent of model required, any new survey requirements, and the most appropriate modelling approach. Consider whether simpler methods (e.g. velocity/area) can produce the required results.
- Recommend any improvements to hydrometric networks and data collection in floods.

High-Flow Rating Development.

- Use model constructed to derive high-flow rating curves at required gauging stations at Blyth and Worksop
- Document new high flow ratings and their derivation.
- Report the updated AMAX and POT series (where appropriate) for use in the flood estimation methods (e.g. within the FEH Calculation record).

Catchment Understanding

- Schematise the catchment. Sub catchment schematisation shall represent key hydrological features (e.g. changes in catchment response, key tributaries/confluences and flood storage reservoirs). Catchment delineation must be verified including use of surface water sewer data in urbanised catchments. A GIS shape file of sub catchment boundaries must be provided for acceptance by the Client as part of the Draft Hydrology Report. Boundary unit type (ReFH, FEH, pumped catchment, etc.) and inflow locations (point, distributed lateral) shall be described and justified.
- Update sub catchment schematisation to improve delineation of (urbanised areas, improve resolution of inflows, changes on the ground).

Design flow estimation – general

 Tabulate the hydraulic model node labels corresponding to the locations of all level and flow recorders and other points of interest within the modelled area.

Design flow estimation - statistical method

- Agree peak flow data to be used for the analyses with the Client. The data will be based on available data as modified during the study (e.g. by the modelled rating curves).
- Undertake flood frequency analysis at all gauging stations using the agreed peak flow data. By default, FEH statistical methods (using the latest updates) will be applied changes to these methods shall be agreed with the *Client*. Compare with any relevant previous estimates. The degree of uncertainty in the estimates shall be assessed. The effect of these uncertainties on the modelled levels and flood extents shall be assessed and documented.

Where available use historical information to inform flood frequency analyses and choice of design values.

<u>Design flow estimation - rainfall-runoff methods</u>

- Assess the applicability of rainfall-runoff methods such as ReFH1 and ReFH2.
- Determine the critical design storm(s), including storm duration, DDF and ARF parameters. If the modelled area has a large variation in catchment size and response at different points of interest, the selection of design storms shall take this into account.
- Derive design flood hydrographs (e.g. ReFH, factor ReFH to fit statistical \ accepted design peaks, Archer method).
- Improve estimated rainfall-runoff parameters in accordance with the FEH Guidelines.

Reconcile Results and Produce Final Design Values.

- Reconcile the results from different approaches (e.g. rainfall-runoff and statistical). If peak flows are significantly changed, the effect on runoff volumes shall be investigated and hydrograph shapes amended if necessary.
- Compare flood estimates with previous studies at all gauging stations and other points of interest. Justify the final selection of methodology to be taken forward to design runs.

Fluvial - New Hydraulic Model Build

- The Consultant shall construct and deliver a new hydrodynamic hydraulic model extending over all. Main River. For fluvial models a single model is required and the Consultant must advise and obtain the Client's acceptance should multiple models be needed to achieve acceptable simulation times. Acceptable run-times are considered 72 hours for 7-day 0.1% AEP simulation on the Client's CMP computer. The model must be able to simulate flood events for: Fluvial undefended: 1%, 0.1%; Fluvial defended: 50%, 20%, 10%, 5%, 3.3%, 2%, 1.33%, 1%, 0.5%, 0.1% AEPs.
- Climate change scenarios are required as part of this project. Please refer to Minimum Technical Requirements for Modelling for details of climate change requirements.

Model Proving Calibration, Verification & Sensitivity.

- The *Consultant* shall provide written interpretation of results, including impact on model calibration/proving, design configuration, onset of flooding, standard of protection and recommendations for prioritisation of maintenance.
- Calibrate the River Ryton through simulation of up to 3 events and verify performance through simulation of up to a further 2 events. Suggested events include: November 2019, June 2007. Inflows shall be generated using observed rainfall and flow data and the *Consultant* is expected to select events to maximise available information. Variation in antecedent conditions between events must be explicitly computed.
- The Consultant shall achieve peak level fit at all gauged locations of ± 150 mm, with replication of overall hydrograph shape. Variance between the observed and modelled hydrographs shall be presented to the Client at a face to face calibration review meeting along with draft flood outlines for any out of bank calibration events.

The *Client's* acceptance of the calibration is required before progression to design event simulation.

Fluvial Models:

- o ±20% flows
- ±20% roughness
- ± 20% slope change in downstream boundary

The following project specific sensitivity tests are required:

- Addition and removal of 300mm silt (depth to be confirmed and submitted for acceptance by the *Client*) through modification to the in-channel cross-section geometry.
- Simulations to determine sensitivity to blockage of culverts up to a maximum of 5.
 Specifics TBC
- Simulations to determine sensitivity to operation of structures up to a maximum of 5.
 Specifics TBC.

Design Simulations & Results

- All scenarios listed below must be delivered for defended scenarios. Fluvial scenarios are modelled with the flood defence system scenario of defended, no failure by breaching.
- Scenarios: Fluvial undefended: 1%, 0.1%. Fluvial defended: 50%, 20%, 10%, 5%, 3.3%, 2%, 1.33%, 1%, 0.5%, and 0.1% AEPs. Climate change scenarios are required as part of this project. Please refer to Minimum Technical Requirements for Modelling for details of climate change requirements.
- The Consultant shall provide written commentary on the %AEP of onset of flooding, standard of protection (including freeboard, in accordance with the Client's Updated Fluvial Freeboard Guidance Note, 2017) and suitability of fit with the anecdotal historic evidence of flooding. Limitations with historical evidence results shall be clearly identified in the conclusions and further recommendations shall be given if appropriate (e.g. state where new telemetry gauges shall be installed, where new survey / LiDAR would improve model accuracy etc). This commentary is to be included within the draft and final Model Report.

In addition the *Client* requires:

- Identify the design event probabilities for which the defence provides benefit this shall include all events where retained water level is above local ground levels. The assessment shall include identification of receptors protected. The analysis must be sufficiently detailed to distinguish between individual communities and include strategic infrastructure (trunk road, railways, power sub-stations). Provide this commentary as part of the Model Report.
- Animations of flow and velocity vectors for the 2D model domain for:
 - Location Worksop
 - Design Event 5%AEP, 1%AEP

- Simulate removal/addition of sediment for:
 - Locations Worksop
 - o Scenarios 100mm, 300mm
 - Design Event 5%AEP, 1%AEP
- Produce a table of the number of residential, critical infrastructure and other nonresidential properties within all defended, undefended and blockage %AEP outlines referring to the flood level at the nearest relevant river gauge(s) - if applicable).
- Assess the performance of up to 5 structures: locations TBC

Flood Warning Improvements

The *Consultant* shall deliver the following services in accordance with Operational Instruction 137_05 Flood Warning Levels of Services and OI 55_07 Threshold Setting in Flood Incident Management. The following services are anticipated following receipt of the improved flood outlines but allowance shall be made by the *Consultant* for liaising with the Flood Resilience team for specific guidance on the process and at key points:

- Review the existing Flood Alert Areas and / or Flood Warning Areas extents in comparison with the updated modelled outputs and advise whether modifications are required to the extents. Review the first impacts (out of bank), first property to flood and trigger thresholds using the updated and accepted flood maps / levels. There are 2 existing Flood Alert Areas and 7 existing Flood Warning Areas.
- Update the existing Flood Alert Areas and / or Flood Warning Areas extents based on the updated modelled outputs (without defences 0.1% AEP plus historic flood extents, where appropriate) following the *Client's* acceptance of recommended modifications from 11.1 and provide revised extents.
- Deliver an Excel spreadsheet which includes %AEP, land use type, risk category assigned and number of commercial / residential properties for each FWFRA. Information on suggested FWAs shall include names of FWFRAs aggregated to make the FWA, highest AEP, total number of properties, breakdown of commercial and residential properties, vulnerable receptors (utilities, hospitals, care homes etc) and overall assigned risk category.
- Produce flood extent shapefiles with associated level at Flood Warning gauge for each of the existing Flood Warning Areas. Outlines are required for each simulated (with defences) %AEP between onset of flooding and the Extreme Flood Outline. Submit the proposal for the *Client's* acceptance whether onset of flooding is first property to flood, first impacts or overtopping of defences.
- Review the data quality of the gauge sites in the study area and provide a detailed recommendation for the gauges to be used in level-level correlation for each FWA.
- Produce level-level correlation between the onset of flooding location and Flood Warning Gauge Site for each Flood Warning Area. Determine the frequency the trigger level will be exceeded. Make recommendations for improvements, explaining the benefits.
- Produce travel time between the onset of flooding location and Flood Warning Gauge Site based on model results and verify these results through comparison with the available hydrometric data.

| Constraints on how the Consultant provides the service |
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a) The *Consultant* shall ensure that appropriate use is made of existing data, to avoid duplicating work already undertaken.

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- a) TBC
- b) TBC

5. Specifications or standards to be used

- a) NEC4 Minimum Technical Requirements for Modelling_v1
- b) TBC

6. Specific Project Requirements

- a) TBC
- b) TBC

7. Services and other things provided by the Client

- a) Fastdraft for Contract Mgt.
- b) Facilitate site visits this visit(s) and arrange for appropriate staff to accompany the Consultant to provide local knowledge

Appendix A Existing Information

| Title | Format | Available from |
|-------|--------|-----------------|
| TBC | TBC | Manager Service |
| | | |
| | | |

Appendix 1 BIM Protocol – Production and Delivery Table

All *Client* issued information referenced within the Information Delivery Plan requires verifying by the *Consultant* unless it is referenced elsewhere within the *Scope*.

The IDP is now accessed and created through Asite. The extent of BIM compliance is expected to extend only to final reports associated with the services as mapping and modelling data cannot be stored within the CDE due to size constraints.

www.Pow.bim4.info

You need google chrome for this link to work. Once the table is completed it should be printed for issue in the tender document, so that the correct baseline position can be seen by tenderers and price