Framework:	**Mapping & Modelling Framework**
Supplier:	**Jeremy Benn Associates Ltd**
Company Number:	**03246693**
Geographical Area:	**National**
Project Name:	**GMMC Modelling Programme 2021/22**
Project Number:	[redacted]
Contract Type:	**Professional Service Contract**
Option:	**Option C**
Contract Number:	**34687**
Stage:	**All_Work_Types**

Revision	Status		Originator		Reviewer		Date

PROFESSIONAL SERVICE CONTRACT under the Mapping and Modelling Framework
CONTRACT DATA

Project Name GMMC Modelling Programme 2021/22

Project Number [redacted]

This contract is made on
between the *Client* and the *Consultant*

- This Contract is made pursuant to the Framework Agreement (the "Agreement") dated 16th day of May 2019 between the *Client* and the *Consultant* in relation to the NGSA Mapping and Modelling Support Framework. The entire Agreement and the following schedules are incorporated into this Contract by reference

- Schedules 1 to 22 inclusive

- The following documents are incorporated into this contract by reference
  21-22 GMMC Modelling Programme PSC_Scope v1

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.

Main Option: Option C

Option for resolving and avoiding disputes: [redacted]

Secondary Options

X2: Changes in the law

X5: Sectional Completion

X7: Delay damages

X9: Transfer of rights

X10: Information modelling

X11: Termination by the *Client*

X18: Limitation of Liability

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

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

Z: *Additional conditions of contract*

The *service* is *This contract is for a package of projects to develop non-real time flood risk mapping models for the Environment Agency's (the Client's) Greater Manchester, Merseyside and Cheshire Area (GMMC Area).*

The *Client* is *The Environment Agency*

Address for communications

Horizon House
Deanery Road
Bristol
BS1 5AH

Address for electronic communications [redacted]

The *Service Manager* is [redacted]

Address for communications

The Environment Agency
Richard Fairclough House
Knutsford Road
Warrington
WA4 1HT

Address for electronic communications [redacted]

The Scope is in
21-22 GMMC Modelling Programme PSC_Scope v1

The *language of the contract* is English

The *law of the contract* is
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
1
2
3
4

Early warning meetings are to be held at intervals no longer than 2 weeks

2 The *Consultant's* main responsibilities

The *key dates* and *conditions* to be met are

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

The *Consultant* prepares forecasts of the total Defined Cost plus Fee and *expenses* at intervals no longer than 4 weeks

3 Time

The *starting date* is 30 March 2022

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

access	*access* date

The *Consultant* submits revised programmes at intervals no longer than 4 weeks

The *completion date* for the whole of the *service* is 29 August 2023

The period after the Contract Date within which the *Consultant* is to submit a first programme for acceptance is 4 weeks

4 Quality management

The period after the Contract Date within which the *Consultant* is to submit a quality policy statement and quality plan is 4 weeks

The period between Completion of the whole of the *service* and the *defects date* is 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 the *Consultant* provides a charge for the cost of support people and office overhead are All UK Offices

The *Consultant's share percentages* and the *share ranges* are

share range						*Consultant's share percentage*
less than			80	%		0 %
from	80	%	to	120	%	50 %
greater than			120	%		100 %

6 Compensation events

These are additional compensation events

1. 'not used'

2. 'not used'
3. 'not used'
4. 'not used'
5. 'not used'

8 Liabilities and insurance

These are additional *Client's* liabilities
1. 'not used'
2. 'not used'
3. 'not used'

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

EVENT	MINIMUM AMOUNT OF	PERIOD FOLLOWING COMPLETION OF THE WHOLE OF THE *SERVICE* OR TERMINATION
The *Consultant's* failure to use the skill and care normally used by professionals providing services similar to the *service*	[redacted] in respect of each claim, without limit to the number of claims	[redacted]
Loss of or damage to property and liability for bodily injury to or death of a person (not an employee of the *Consultant)* from or in connection with the *Consultant* Providing the Service	[redacted] in respect of each claim, without limit to the number of claims	[redacted]
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	Which ever is the greater of [redacted] or the amount required by law in respect of each claim, without limit to the number of claims	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 limited to		[redacted]

Resolving and avoiding disputes

The *tribunal* is	Litigation in the courts
The *Adjudicator* is	'to be confirmed'
Address for communications	'to be confirmed'
Address for electronic communications	*'to be confirmed'*
The *Adjudicator nominating body* is	The Institution of Civil Engineers

Z Clauses

Z1 Disputes
Delete existing clause [redacted]

Z2 Prevention
The text of clause 18 Prevention is deleted.
Delete the text of clause 60.1(12) and replaced by:
The *service* is are 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,
• 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 sub contractor, 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 formats.
• Exceeding the Scope without prior instruction that leads to abortive cost
• Re-working of documents due to inadequate QA prior to submission, i.e. grammatical, factual arithmetical or design errors.
• 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 Manager*
• 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

Z4 Share on termination
Delete existing clause 93.3 and 93.4 and replace with:
92.3 In the event of termination in respect of a contract relating to services there is no *Consultant's* share'

Z6 The Schedule of Cost Components
The Schedule of Cost Components are as detailed in the Framework Schedule 9.

Z24 Requirement for Invoice
Add 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 approval of a fee note.
Delete existing clause 51.2 and replace with:
51.2 Each certified payment is made within one week after the paying Party receives an invoice from the other Party and
If a certified payment is late, 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

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 X7: Delay damages

X7 only Delay damages for Completion of the whole of the *service* are [redacted]

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 2 weeks

OPTION X18: Limitation of Liability

The *Consultant's* liability to the *Client* for indirect or consequential loss is limited to [redacted]

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

The *end of liability date is* [redacted] after the Completion of the whole of the *service*

Y(UK2): The Housing Grants, Construction and Regeneration Act 1996

The period for payment is 14 days after the date on which payment becomes due

Y(UK3): 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 *Consultant* is

Name: Jeremy Benn Associates Ltd

Address for communications: [redacted]

Email address: [redacted]

The subcontract *fee percentage* is: Option C [redacted]

The *key persons* are

Name (1) [redacted]
Job
Responsibilities
Qualifications
Experience

The *key persons* are

Name (2) [redacted]
Job
Responsibilities
Qualifications
Experience

The *key persons* are

Name (3) [redacted]
Job
Responsibilities
Qualifications
Experience

The *key persons* are

Name (4) [redacted]
Job
Responsibilities
Qualifications
Experience

The *key persons* are

Name (5) [redacted]
Job
Responsibilities
Qualifications
Experience

The *key persons* are

Name (6)
Job
Responsibilities
Qualifications
Experience

The *key persons* are

Name (7)
Job
Responsibilities
Qualifications
Experience

The following matters will be included in the Early Warning Register

5 Payment

The *activity schedule* is
See 34687 21-22 GMMC Modelling - JBA Full Package Activity Scl

The tendered total of the Prices is
£129,042.00

Resolving and avoiding disputes

The *Senior Representatives* of the *Consultant* are

Name (1) [redacted]
Address for communications
[redacted]
Address for electronic communications
[redacted]

Name (2) [redacted]
Address for communications
[redacted]
Address for electronic communications
[redacted]

X10: Information Modelling

The information execution plan identified in the Contract Data is
TBC

Contract Execution

Client **execution**

Signed Underhand by [**PRINT NAME**] for and on behalf of the Environment Agency

Consultant **execution**

Signed Underhand by [**PRINT NAME**] for and on behalf of Jeremy Benn Associates Ltd

Environment Agency
NEC4 Professional Services Contract (PSC) Scope

Project / contract information

Project name	GMMC Modelling Programme 2021/22
Project 1B1S reference	[redacted]
Contract reference	
Date	6th December 2021
Version number	1.0
Author	[redacted]

Revision history

Revision date	Summary of changes	Version number
06/12/2021	First issue	1

This Scope should be read in conjunction with LIT 56326 Fluvial Modelling Standards current at the Contract Date. In the event of conflict, this Scope shall prevail. The service is compliant with the Minimum Technical Requirements set out in LIT 56326 Fluvial Modelling Standards and the NEC4 Minimum Technical Requirements for Modelling (LIT 18686) current at the contract date.

Document	Document Title	Version No	Issue date
LIT 56326	Fluvial Modelling Standards	3.0	16/07/2021
LIT 18686	NEC4 Minimum Technical Requirements for Modelling	5.0	12/08/2021

1 Overview

This contract is for a package of projects to develop non-real time flood risk mapping models for the Environment Agency's (the *Client's)* Greater Manchester, Merseyside and Cheshire Area (GMMC Area). There are currently 3 (named) scoped projects which will form the basis of this contract.

This Scope details the overarching management arrangements that are to be applied to all individual project Scopes 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 and the specific products required are detailed in the individual project Scopes and include, but are not limited to:

- Flood history reviews;
- New topographic surveys
- Hydrological assessments;
- New hydraulic models;
- Flood mapping.
- Review of Flood Warning Areas
- Climate change updates.
- Pumping station scenario and sensitivity testing.

1.2 Projects within the package

The package at the time of contract award comprises the projects listed in the table below. The *Client* has provided individual project scopes, detailing the technical services required for each project. These are attached as Appendices:

Appendix	Project Name
01	Pennington Pumping Station River Model Update
02	Chorlton Platt Gore Flood Map Update
03	Dean Brook Flood Map Update

There is the possibility that further currently un-named projects may arise during the contract period, which may be added into this contract by way of Compensation Events.

2 Services required

2.1 *Consultant* project management

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

2.1.1. Attendance at a Start-up meeting and monthly progress meetings (these can be held remotely, with agreement of the *Client)*, and management of actions arising from these meetings.

2.1.2. Monthly project progress reports to be provided to the *Service Manager*, 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. These must be provided by the 10th of every month unless stated otherwise by the *Service Manager.*

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 *Service Manager* throughout the duration of the project. Any key decisions agreed with the *Service Manager* must be documented by the *Consultant* and promptly issued to the *Service Manager*.

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 *Service Manager.*

2.1.6. Recording and updating a list of data required to provide the *service*, which must be provided to the *Service Manager* at weekly intervals.

2.1.7. Quarterly input into the project efficiency register (CERT Tool).

2.1.8. Co-operate with the *Client* in the role of the BIM Information Manager.

2.1.9. Obtaining data from Others in order to provide the *service* and ensuring it is correctly licensed for use.

3 Requirements of the programme

3.1 Programme

3.1.1. The *Consultant* shall provide a detailed programme in Microsoft Project 2016 meeting all requirements of Clause 31 of the *conditions of contract*. The programme must show critical path activities, gateway, time risk allowance and activities requiring *Client* input, for example review periods, and allowances for stakeholder/third party engagement.

3.1.2. A clause 31.1 programme shall be provided for the project start up meeting and this will be updated monthly (as per clause 31.2) for progress meetings, with actual and forecast progress against the baseline. The programme shall cover all the activities to be undertaken by the *Consultant* and other members of the project team. Include all major project milestones.

3.1.3. Allow 10 working days for the *Client* review of draft deliverables and provide 2 weeks' notice of submission for review.

3.1.4. Allow 25 working days for the initial data collection by the *Client* following the data review by the *Consultant.*

3.1.5. 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. Any proposals to obtain new data from a third party must be accepted by the *Service Manager* prior to acquisition.

5 Specifications and guidance

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

5.1.1. The current Minimum Technical Requirement for Fluvial Modelling referred to in Appendix 18.2 of the CDF Schedules. This is: 'LIT 56326 Fluvial Modelling Standards v3.0 (July 2021)', supplemented by 'NEC4 Minimum Technical Requirements for Modelling v5.0 (August 2021)'. LIT 56326 also refers to some very specific points in Operational Instruction 379_05 "Computational modelling to assess flood and coastal risk" (October 2010), although other elements of this older document are now superseded, so LIT56326 should be used as the primary reference.

5.1.2. Fluvial Design Guide (online): http://evidence.environment-agency.gov.uk/FCERM/en/FluvialDesignGuide.aspx

5.1.3. Technical Guidance 466_15. High flow rating curve development using hydraulic models (05/08/2015).

5.1.4. 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.

5.1.5. Real Time Model Development Guidance (July 2019)

5.1.6. Accounting for residual uncertainty: updating the freeboard guide (Report SC120014 – February 2017).

5.1.7. Technical guidance 197_08 'Flood Estimation Guidelines' (July 2020)

5.1.8. Operational Instruction 57_07 Assessment of flood risk – topographic and hydrographic surveys (March 2015)

5.1.9. Carry out any required surveys in accordance with the National Standard Contract and Specification for Survey Services version 5.0 (March 2021).

5.1.10. MapEdit Data Validation Rules (Operational Instruction, June 2020).

5.1.11. MapEdit Model Data Template Guide V2020_02 (February 2020)

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.

Project Details

Environment Agency

NEC4 Professional Service Contract (PSC)

Modelling Technical Scope

Project / contract Information

Project name	Pennington Pumping Station River Model update
Expected completion date	Refer to Contract Data
Version number	9
Environment Agency Area	GMMC
Area lead	[redacted]
Modelling technical lead	[redacted]
Contact for additional information	

This scope should be read in conjunction with LIT 56326 Fluvial Modelling Standards current at the Contract Date. In the event of conflict, this Scope shall prevail. The service is compliant with the minimum technical requirements set out in LIT 56326 Fluvial Modelling Standards and LIT 18686 NEC4 Minimum Technical Requirements for Modelling current at the Contract Date.

Project Overview

a) This project is primarily to update the modelling for flood mapping purposes and complete sensitivity analysis of the interaction of Pennington Pumping Station with the wider system of watercourses located at SJ64695 98486 in Leigh, Greater Manchester. The pumping station is located on Landside Brook and pumps out water that accumulates from land and road drainage in the surrounding low-lying catchment into Hey Brook. The model will need to consider both the main rivers and the drainage network the pumping station provides for. Current mapping of the area is 12 years old and this commission will produce new flood maps for the study based on current modelling and hydrology minimum technical requirements.

Key deliverables/objectives:

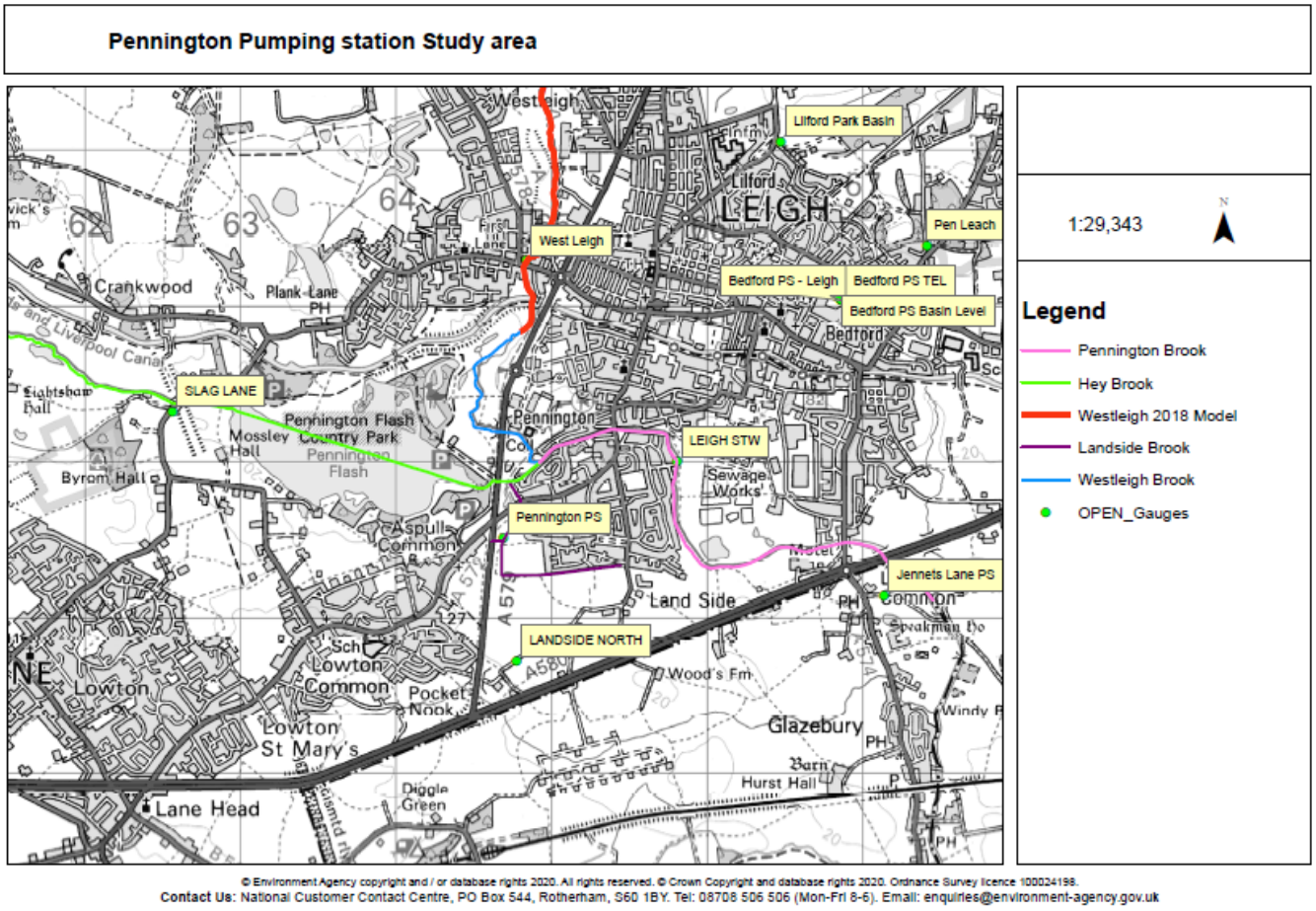
Pennington Pumping Station was refurbished in 2016 with an increased pumping capacity of 700l/s (two pumps of 350 l/s each). The study area has no records of flooding within the pumped catchment area, but there has been flooding on the nearby watercourses. The study will need to review the operation of the pumping station and undertake sensitivity tests for blockage and capacity exceedance at key locations to establish whether the current automated pumping system will be fit for purpose for the long-term future.

Key deliverables/objectives:
- Update existing flood maps (MapEdit)
- Review Flood Warning Areas
- Review previous flood incidents
- Review inflow hydrology
- A topographic survey of the area needs to be specified and completed.

b) The study area includes: Landside Brook approx 1.45km (u/s 365454, 398330; d/s 364733, 398875)
Pennington Brook approx 3.2km - (u/s 367453, 398102; d/s 364925, 398995).
Hey Brook approx 1.3km (to meet with Hindley Modelling) (u/s 360590, 400899; d/s 364925, 398995)
Westleigh Brook approx 1.6km (to meet with 2018 Westleigh Brook model) (u/s 364884, 399994; d/s 364955, 398378)

c) A new model of the upper reaches of Westleigh Brook (not included in this study) was completed in 2018.

Map of Study Area



3: Local Flood History

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:

3.3 The *Consultant* shall collect and evaluate data from the *Client*.

3.4 The *Consultant* shall collect and evaluate data from social media / other potential sources of information.

4: Site Visit and Topographic Survey

The *Consultant* shall:

4.1 Visit the site to understand the local flood flow pathways and flood history. The *Client* will facilitate this visit / these visits and arrange for appropriate staff to accompany the *Consultant* to provide local knowledge. The *Consultant* shall give the *Client* 10 working days' notice prior to any required visits.

4.2 The *Consultant* shall specify the survey scope in accordance with the *Client's* standard survey specification and agree this with the *Client* prior to survey procurement. The following locations and survey types shall be considered:
Upstream Location: Extents should reflect study area; Extent (km): ; Survey Type: Bank top survey, EA asset survey , In channel cross section survey, Structure survey

The *Consultant* shall procure and manage a survey sub-contract to deliver the required survey. The *Consultant* shall:

- Obtain 3 quotations and an outline of proposed approach from survey contractors;
- Supply the *Client* with copies of all survey tender documents for the purposes of audit;
- Review the surveyor's methodology and H&S assessment and provide prompt feedback on any areas of concern.
- Review compliance of draft survey deliverables with the specification and provide timely written feedback; and
- Supply a copy of the final survey deliverables to the *Client* upon completion of the survey.

The cost and time associated with the survey sub-contract shall be approved and accepted by the *Client* via agreement of a compensation event for a change to the Scope of the services prior to survey commencement.

5: 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

5.1.1 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.

5.1.2 Submit a Draft Hydrology Report to the *Client* for acceptance prior to the commencement of design simulations.

5.1.4 Submit a Final Hydrology Report to the *Client* for acceptance prior to commencement of hydraulic modelling.

5.2.1 Undertake a review of the hydrometric data (rainfall, levels, flow, flood extent) that are available for use 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.

5.2.2 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. If this is not possible then the *Consultant* shall provide reasons.

5.2.3 Review the available survey data and any existing hydraulic models to determine whether a detailed model can be updated / 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.

5.2.4 Recommend any improvements to hydrometric networks and data collection in floods.

Catchment understanding

5.4.1 Schematise the catchment. Subcatchment schematisation shall represent key hydrological features (e.g. changes in catchment response, key tributaries/confluences, flood storage reservoirs). Catchment delineation must be verified including use of surface water sewer data in urbanised catchments. A GIS shape file of subcatchment 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.

5.4.2 Update subcatchment schematisation to improve delineation of urbanised areas, improve resolution of inflows, changes on the ground.

Design flow estimation - general

5.5 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

5.6.1 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).

5.6.2 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.

5.6.3 Estimates of peak flows of different annual exceedence probabilities shall also be made at the following locations: Locations to be proposed by the *Consultant* in their Hydrology Method Statement should include (but not be limited to) upstream and downstream model boundaries, river level gauge locations and significant confluences.

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

Design flow estimation - rainfall-runoff methods

5.7.1 Assess the applicability of rainfall-runoff methods such as ReFH1 and ReFH2.

5.7.2 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.

5.7.3 Derive design flood hydrographs (e.g. ReFH, factor ReFH to fit statistical \ accepted design peaks, Archer method).

Reconcile results and produce final design values

5.9.1 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.

5.9.2 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.

7: 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 shall 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 no defences exist: 50%, 20%, 10%, 5%, 3.3%, 2%, 1.33%, 1%, 0.5%, 0.1%; Fluvial defences removed: 50%, 0.1%, 0.5%, 1%, 1.33%, 2%, 3.3%, 5%, 10%, 20%; 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.

9: Model Proving, Calibration and 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.

9.1 Calibrate the new model through simulation of up to 3 events and verify performance through simulation of up to a further 2 events. Inflows shall be generated using observed rainfall and flow data and the *Consultant* is expected to select events to make best use of 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.

Where a +/- 150 mm peak level fit cannot be reasonably achieved, the *Consultant* must clearly document the calibration/verification work undertaken, the reasons why the fit could not be achieved, and recommendations for further work. Verification is required where calibration is not possible.

9.4 The *Consultant* shall undertake sensitivity analysis on the model. Sensitivity analysis shall be undertaken for the 1% AEP or AEP closest to bank top level (where the 1% AEP event is in bank), shall be submitted to the *Client* for acceptance and at a minimum shall comprise:

- ±20% flows
- ±20% roughness
- ±20% slope change in downstream boundary
- Greater and smaller grid cell size than the proposed grid cell size

9.7 The *Consultant* shall undertake as part of model proving/calibration:

9.7.3 Simulations to determine sensitivity to operation of structures: Capacity of Pennington Pumping Station - the *Consultant* should initially assume testing the pumping station at 3 different capacities (current, reduced and increased) x 3 different %AEPs, to be agreed with the *Client* at the start of the project.

10: Design Simulations & Results

All scenarios listed below must be delivered for defended scenarios:

Fluvial, tidal, coastal and surface water hazard scenarios are modelled with the flood defence system scenario of defended, no failure by breaching.

Scenarios:
Fluvial no defences exist: 50%, 20%, 10%, 5%, 3.3%, 2%, 1.33%, 1%, 0.5%, 0.1%; Fluvial defences removed: 50%, 0.1%, 0.5%, 1%, 1.33%, 2%, 3.3%, 5%, 10%, 20%; 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.

In addition the *Consultant* shall:

10.1 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.

10.4 Simulate structure blockage scenarios for 1 locations x 3 scenarios x 3 %AEPs.

10.6 Simulate structure removal for 1 location x 3 %AEPs.

10.7 Produce a table of the number of residential, critical infrastructure and other non-residential properties within all defended and defences removed or no defences exist and blockage % AEP outlines referring to the flood level at the nearest relevant river gauge(s) - if applicable.

11: Flood Warning Improvements

The *Consultant* shall deliver the following services in accordance with the guidance as referred to within the latest version of the Minimum Technical Requirements for Modelling document. 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:

11.1 Review the existing Flood Alert Area extent in comparison with the updated modelled outputs and advise whether modifications are required to the extent. Review the first impacts (out of bank), first property to flood and trigger thresholds using the updated and accepted flood maps / levels. There is 1 existing Flood Alert Area.

11.1.1 Update the existing Flood Alert Area extent based on the updated modelled outputs (defences removed / no defences exist 0.1% AEP plus historic flood extents, where appropriate) following the *Client's* acceptance of recommended modifications from 11.1 and provide revised extents.

11.4 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.

11.5 Produce a flood extent shapefile with associated level at Flood Warning gauge for the existing Flood Warning Area 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.

11.6 Produce a flood hazard shapefile with associated level at the Flood Warning gauge for the existing Flood Warning Area. 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.

11.7 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.

11.8 Produce level-level correlation between the onset of flooding location and Flood Warning Gauge Site for each Flood Warning Area. Determine the frequency at which the trigger level will be exceeded. Make recommendations for improvements, explaining the benefits.

11.9 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.

Available Data - Treat as Site Information

All datasets supplied for the project must be returned to the *Client* upon project completion. Datasets returned should adopt the appropriate security marking, be accordance with the latest government guidelines. Data that will be made available to the *Consultant* include:

Hydrometric data:

Station	Location	Type (Flow / Level / Rainfall, Wind, Wave Height / Direction	Period of record	Time interval (15 min/ daily)	Fluvial/ Coastal	Known data quality issues
Slag Lane	SJ6257099320	Flow/Level			Fluvial	
Pennington Pumping Station	SJ6469698509	Flow/Level			Fluvial	
West Leigh	SD6484700287	Level			Fluvial	
Pennington Flash Downstream	364601, 398842	Level + gauging?	Nov 2002- Jul 2006		Fluvial	Closed gauge
Hey Brook Westleigh Brook u/s	364850, 399080	Level + gauging?	Nov 2002- Jul 2006		Fluvial	Closed gauge
Pennington Flash Teal Hide	364416, 399420	Level	Dec 2008- Nov 2011		Fluvial	Closed gauge
Pennington Flash	364177, 399197	Level	Dec 2008- Nov 2011		Fluvial	Closed gauge
Clifton Street	364977, 400382	Level	May 2012- Feb 2017		Fluvial	Closed gauge
New Bear Hey Farm	361988, 399555	Level	Dec 2003- Feb 2006		Fluvial	Closed gauge
Dover Flash	361245, 400264	Level	Apr 2004- Mar 2011		Fluvial	Closed gauge

In addition to the sites listed above, there is data available from 12 closed Event Rainfall and Daily Rainfall gauge sites in the vicinity of the study area. Data from these can be supplied to the *Consultant* if required.

Asset data types:
The *Client* will provide an AIMS Database containing all asset details at the beginning of the project. Assets to be included are:

Types	Other details
Raised Defences - Walls/Embankments	Pennington Pumping Station

Flood history information:

Event date	Location	Data type	Other details	Known data quality issues
2000	Pennington Flash	Flood extent		
2000	West Leigh Brook	Flood extent		

Existing Model Summary - Fluvial Hydraulic

Model Name	Date	Length of modelled watercourse (km)	Hydraulic model type	Other type	Description	Information only or to be updated
Middle and Lower Mersey 2008	2008		Flood Modeller Pro			Info only

Project Details

Environment Agency

NEC4 Professional Service Contract (PSC)

Modelling Technical Scope

Project / contract Information

Project name	Chorlton Platt Gore Flood Map Update 2021
Expected completion date	Refer to Contract Data
Version number	4
Environment Agency Area	Gtr Man, Merseyside & Cheshire
Area lead	[redacted]
Modelling technical lead	[redacted]

This scope should be read in conjunction with LIT 56326 Fluvial Modelling Standards current at the Contract Date. In the event of conflict, this Scope shall prevail. The service is compliant with the minimum technical requirements set out in LIT 56326 Fluvial Modelling Standards and LIT 18686 NEC4 Minimum Technical Requirements for Modelling current at the Contract Date.

Project Overview

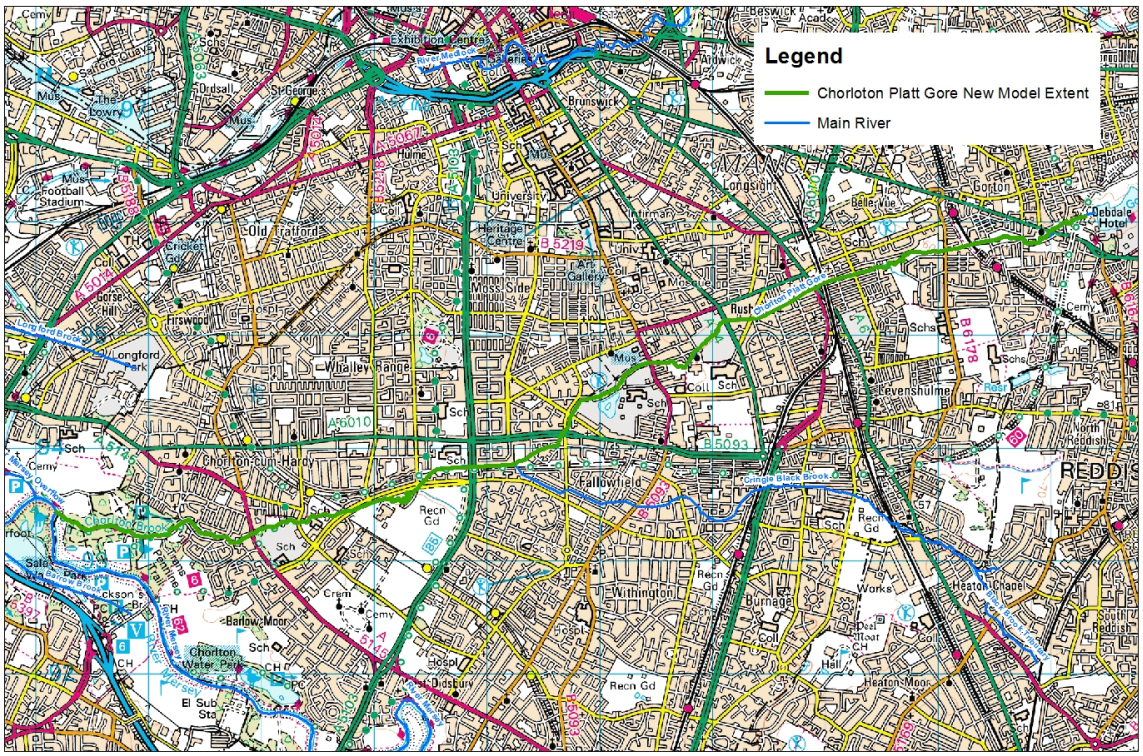
a) This model scope is to produce an updated Flood Map of Cholrton Platt Gore in Greater Manchester. Current mapping of the study area is around 10 years old. This commission will produce new flood maps based on current modelling and hydrology minimum technical requirements. It will also be used in the future to support the development of the River Mersey South Manchester Strategy)
Key deliverables/objectives:

- Update existing flood maps (MapEdit)
- Review Flood Warning Areas
- Review inflow hydrology.
- A topographic survey of the area is required as part of the commission.

There is an ongoing appraisal study for Cringle Brook, which is confluent with Chorlton Platt Gore. This is currently at Strategic Outline Case case, and will include the the development of updated hydrology and modelling for Cringle Brook (currently programmed for delivery in March 2022). The Chorlton Platt Gore project team will need to liaise with the Cringle Brook team to ensure that the new hydrology and modelling for Cringle Brook inform and as far as possible align with the Chorlton Platt Gore modelling project.

b) Chorlton Platt Gore runs through the urban areas of Chorlton-Cum-Hardy, Rusholme and Gorton, South Manchester. The watercourse begins at SJ8938696088 (Lower Gorton Reservoir) and ends at SJ8018193437 (Sale Water Park) where it falls into the River Mersey. Chorlton Platt Gore is approximately 10km with several culverts along its stretch. The majority of the catchment is urban and has a flat topography. There are existing formal flood defences along the study reach.

Map of Study Area



3: Local Flood History

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:

3.3 The *Consultant* shall collect and evaluate data from the *Client*,

3.4 The *Consultant* shall collect and evaluate data from social media / other potential sources of information.

4. Site Visit and Topographic Survey

The *Consultant* shall:

4.1 Visit the site to understand the local flood flow pathways and flood history. The *Client* will facilitate this visit / these visits and arrange for appropriate staff to accompany the *Consultant* to provide local knowledge. The *Consultant* shall give the *Client* 10 working days' notice prior to any required visits.

4.2 The *Consultant* shall specify the survey scope in accordance with the *Client's* standard survey specification and agree this with the *Client* prior to survey procurement.

The *Consultant* shall procure and manage a survey sub-contract to deliver the required survey. The *Consultant* shall:

- Obtain 3 quotations and an outline of proposed approach from survey contractors;
- Supply the *Client* with copies of all survey tender documents for the purposes of audit;
- Review the surveyor's methodology and H&S assessment and provide prompt feedback on any areas of concern.
- Review compliance of draft survey deliverables with the specification and provide timely written feedback; and
- Supply a copy of the final survey deliverables to the *Client* upon completion of the survey.

The cost and time associated with the survey sub-contract shall be approved and accepted by the *Client* via agreement of a compensation event for a change to the Scope of the services prior to survey commencement.

5: Hydrological Assessment and 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

5.11 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.

5.12 Submit a Draft Hydrology Report to the *Client* for acceptance prior to the commencement of design simulations.

5.14 Submit a Final Hydrology Report to the *Client* for acceptance prior to commencement of hydraulic modelling.

Review data availability

5.2.1 Undertake a review of the hydrometric data (rainfall, levels, flow, flood extent) that are available for use 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.

5.2.2 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.

5.2.3 Review the available survey data and any existing hydraulic models to determine whether a detailed model can be updated / 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.

5.2.4 Recommend any improvements to hydrometric networks and data collection in floods

Catchment understanding

5.4.1 Schematise the catchment. Subcatchment schematisation shall represent key hydrological features (e.g. changes in catchment response, key tributaries/confluences, flood storage reservoirs). Catchment delineation must be verified including use of surface water sewer data in urbanised catchments. A GIS shape file of subcatchment 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.

5.4.2 Update subcatchment schematisation to improve delineation of urbanised areas, improve resolution of inflows, changes on the ground.

Design flow estimation - general

5.5 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

5.6.1 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).

5.6.2 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.

5.6.3 Estimates of peak flows of different annual exceedence probabilities shall also be made at the following locations: Locations to be proposed by the *Consultant i*n their Hydrology Method Statement should include (but not be limited to) upstream and downstream model boundaries, river level gauge locations and significant confluences.

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

Design flow estimation - rainfall-runoff methods

5.7.1 Assess the applicability of rainfall-runoff methods such as ReFH1 and ReFH2.

5.7.2 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.

5.7.3 Derive design flood hydrographs (e.g. ReFH, factor ReFH to fit statistical \ accepted design peaks, Archer method).

Reconcile results and produce final design values

5.9.1 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.

5.9.2 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.

7: 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 shall 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 defences removed: 50%, 0.1%, 0.5%, 1%, 1.33%, 2%, 3.3%, 5%, 10%, 20%; 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.

9: Model Proving, Calibration and 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.

9.1 Calibrate the new Chorlton Platt Gore model through simulation of up to 3 events and verify performance through simulation of up to a further 2 events. 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. Coastal models must be calibrated using available tide gauges and wave buoys. 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.

Where a +/- 150 mm peak level fit cannot be reasonably achieved, the *Consultant* must clearly document the calibration/verification work undertaken, the reasons why the fit could not be achieved, and recommendations for further work. Verification is required where calibration is not possible.

9.4 The *Consultant* shall undertake sensitivity analysis on the model. Sensitivity analysis shall be undertaken for the 1% AEP or AEP closest to bank top level (where the 1% AEP event is in bank), shall be submitted to the *Client* for acceptance and at a minimum shall comprise:

- ±20% flows
- ±20% roughness
- ±20% slope change in downstream boundary
- Greater and smaller grid cell size than the proposed grid cell size

10: Design Simulations & Results

All scenarios listed below must be delivered for defended scenarios:

Fluvial, tidal, coastal and surface water hazard scenarios are modelled with the flood defence system scenario of defended, no failure by breaching.

Scenarios:
Fluvial defences removed: 50%, 0.1%, 0.5%, 1%, 1.33%, 2%, 3.3%, 5%, 10%, 20%; 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.

In addition the *Consultant* shall:

10.1 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.

10.4 Simulate structure blockage scenarios for 3 locations x 3 scenarios x 3 %AEPs. Locations to be agreed in advance with the *Client.*

10.7 Produce a table of the number of residential, critical infrastructure and other non-residential properties within all defended and defences removed or no defences exist and blockage %AEP outlines referring to the flood level at the nearest relevant river gauge(s) - if applicable.

11: Flood Warning Improvements

The *Consultant* shall deliver the following services in accordance with the guidance as referred to within the latest version of the Minimum Technical Requirements for Modelling document. 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:

11.1 Review the existing Flood Alert Area(s) and / or Flood Warning Areas extent(s) in comparison with the updated modelled outputs and advise whether modifications are required to the extent(s). Review the first impacts (out of bank), first property to flood and trigger thresholds using the updated and accepted flood maps / levels. There is / are 1 existing Flood Alert Area(s) and 2 existing Flood Warning Area(s).

11.1.1 Update the existing Flood Alert Areas and / or Flood Warning Areas extents based on the updated modelled outputs (defences removed / no defences exist 0.1% AEP plus historic flood extents, where appropriate) following the *Client's* acceptance of recommended modifications from 11.1 and provide revised extents.

11.4 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.

11.5 Produce flood extent shapefiles with associated level at Flood Warning gauge for each of 2 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.

11.6 Produce flood hazard shapefiles with associated level at the Flood Warning gauge for each of 2 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.

11.7 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.

11.8 Produce level-level correlation between the onset of flooding location and Flood Warning Gauge Site for each Flood Warning Area. Determine the frequency at which the trigger level will be exceeded. Make recommendations for improvements, explaining the benefits.

11.9 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.

Available Data - Treat as Site Information

All datasets supplied for the project must be returned to the *Client* upon project completion. Datasets returned should adopt the appropriate security marking, be accordance with the latest government guidelines. Data that will be made available to the *Consultant* include:

Hydrometric data:

Station	Location	Type (Flow / Level / Rainfall, Wind, Wave Height / Direction	Period of record	Time interval (15 min/ daily)	Fluvial/ Coastal	Known data quality issues
Brighton Grove Debris Screen	385615, 394768	Level			Fluvial	
Platt Fields TBR	384942, 394449	Rainfall			Fluvial	
Platt Fields Debris Screen	384940, 394462	Level			Fluvial	
Athol Road Debris Screen	383537, 393799	Level			Fluvial	
Mauldeth Road Debris Screen	383113, 393550	Level			Fluvial	
Gorton (692828)	388751, 395874	Level	Jan 1994-Sept 1997		Fluvial	Closed gauge
Hough End (SJ89-229)	383280, 393500	Groundwater level (observation boreholes)				
In addition to the sites listed above, there is data available from 10 closed Event Rainfall and Daily Rainfall gauge sites in the vicinity of the study area. Data from these can be supplied to the *Consultant* if required.						

Asset data types:

The *Client* will provide an AIMS Database containing all asset details at the beginning of the project. Assets to be included are:

Types	Other details
Raised Defences - Walls/Embankments	

Existing Model Summary - Fluvial Hydraulic

Model Name	Date	Length of modelled watercourse (km)	Hydraulic model type	Other type	Description	Information only or to be updated
Chorlton Platt Gore	2012	15	Flood Modeller Pro-Tuflow			Info only

Project Details

Environment Agency

NEC4 Professional Service Contract (PSC)

Modelling Technical Scope

Project / contract Information

Project name	Dean Brook Flood Map update
Expected completion date	Refer to Contract Data
Version number	8
Environment Agency Area	GMMC
Area lead	[redacted]
Modelling technical lead	[redacted]
Contact for additional information	[redacted]

This scope should be read in conjunction with LIT 56326 Fluvial Modelling Standards current at the Contract Date. In the event of conflict, this Scope shall prevail. The service is compliant with the minimum technical requirements set out in LIT 56326 Fluvial Modelling Standards and LIT 18686 NEC4 Minimum Technical Requirements for Modelling current at the contract date

Project Overview

a) This model scope is to produce an updated Flood Map for Dean Brook. located on the outskirts of Bolton, Greater Manchester. Current mapping of Dean Brook is 10 years old, and Smithills has been identified as a potential Community at Risk. We need better data to assess this risk. This commission will produce new flood maps for the study area based on current modelling and hydrology minimum technical requirements.

Key deliverables/objectives:

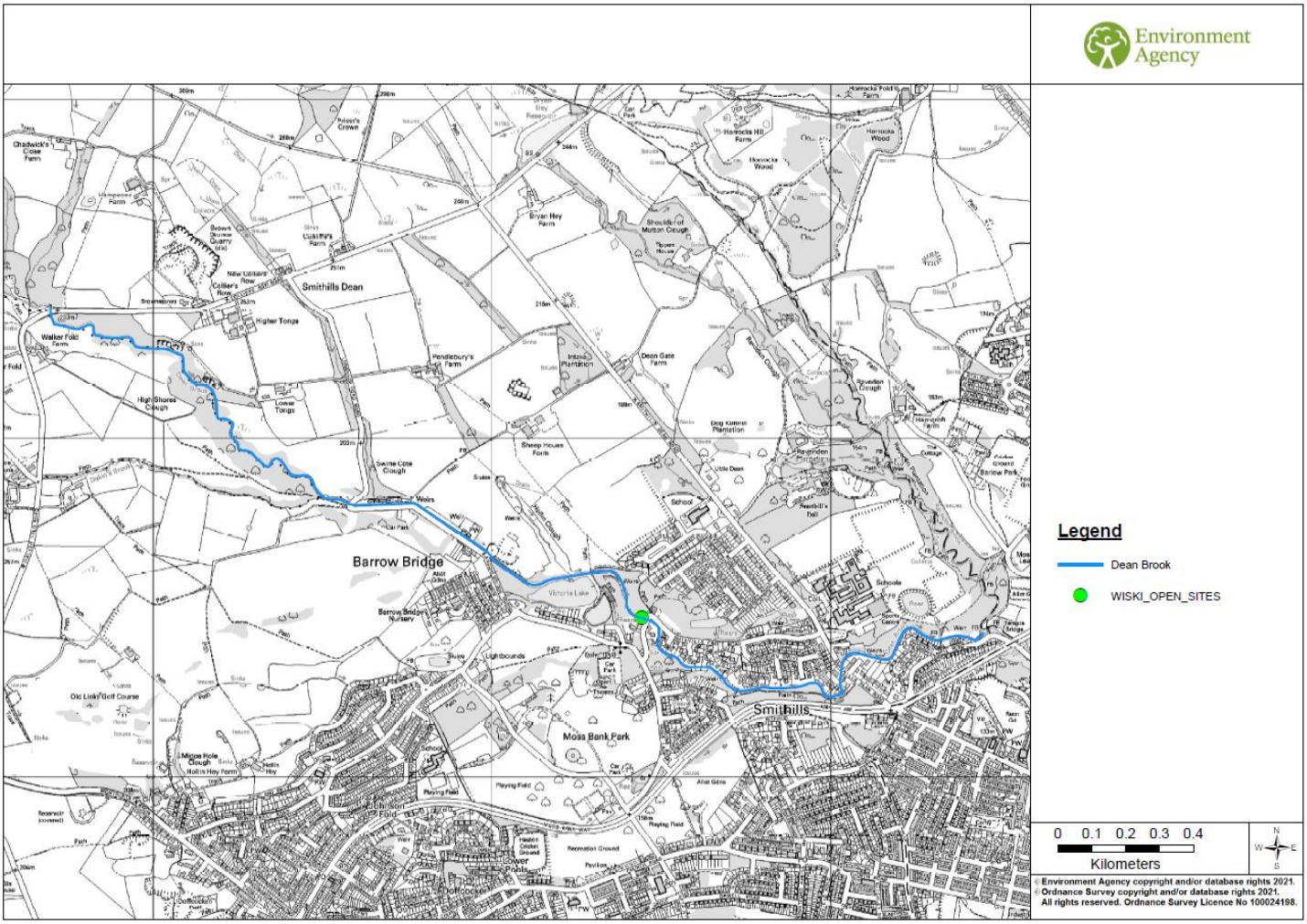
- Update existing flood maps (MapEdit)
- Review inflow hydrology.
- A topographic survey of the area is required as part of the commission.

b) Dean Brook is a relatively steep catchment in the upper reaches, becoming highly urbanised through Smithills until it reaches its confluence with Astley Brook. Model extent is approximately 4km, extending from U/S 367708, 412406 at Walker Fold Farm to D/S 370484, 411428 where it flows into Astley Brook. There are no flood defences on Dean Brook and therefore only a no defences model run is required.

c) There are ongoing culvert replacement works at Smithills Croft Road. The work is to replace the existing collapsed arched culvert with a larger box. The in-channel works are due to be completed by December 2021. Construction drawings will be provided on commencement of the modelling with as-builts to confirm culvert dimensions on project completion.

d) A hydrology assessment of Upper Dean Brook at Barrow Bridge with updated FEH calculations was completed for the Environment Agency by Capita Aecom in 2016.

Map of Study Area



3: Local Flood History

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:

3.3 The *Consultant* shall collect and evaluate data from the *Client*,

3.4 The *Consultant* shall collect and evaluate data from social media / other potential sources of information.

4: Site Visit and Topographic Survey

The *Consultant* shall:

4.1 Visit the site to understand the local flood flow pathways and flood history. The *Client* will facilitate this visit / these visits and arrange for appropriate staff to accompany the *Consultant* to provide local knowledge. The *Consultant* shall give the *Client* 10 working days' notice prior to any required visits.

4.2 The *Consultant* shall specify the survey scope in accordance with the *Client's* standard survey specification and agree this with the *Client* prior to survey procurement.

The *Consultant* shall procure and manage a survey sub-contract to deliver the required survey. The *Consultant* shall:

- Obtain 3 quotations and an outline of proposed approach from survey contractors;
- Supply the *Client* with copies of all survey tender documents for the purposes of audit;
- Review the surveyor's methodology and H&S assessment and provide prompt feedback on any areas of concern.
- Review compliance of draft survey deliverables with the specification and provide timely written feedback; and
- Supply a copy of the final survey deliverables to the *Client* upon completion of the survey.

The cost and time associated with the survey sub-contract shall be approved and accepted by the *Client* via agreement of a compensation event for a change to the Scope of the services prior to survey commencement.

5: Hydrological Assessment and 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

5.1.1 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.

5.1.2 Submit a Draft Hydrology Report to the *Client* for acceptance prior to the commencement of design simulations.

5.1.4 Submit a Final Hydrology Report to the *Client* for acceptance prior to commencement of hydraulic modelling.

Review data availability

5.2.1 Undertake a review of the hydrometric data (rainfall, levels, flow, flood extent) that are available for use 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.

5.2.2 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.

5.2.3 Review the available survey data and any existing hydraulic models to determine whether a detailed model can be updated / 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.

5.2.4 Recommend any improvements to hydrometric networks and data collection in floods

Catchment understanding

5.4.1 Schematise the catchment. Subcatchment schematisation shall represent key hydrological features (e.g. changes in catchment response, key tributaries/confluences, flood storage reservoirs). Catchment delineation must be verified including use of surface water sewer data in urbanised catchments. A GIS shape file of subcatchment 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.

5.4.2 Update subcatchment schematisation to improve delineation of urbanised areas, improve resolution of inflows, changes on the ground.

Design flow estimation - general

5.5 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

5.6.1 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).

5.6.2 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.

5.6.3 Estimates of peak flows of different annual exceedence probabilities shall also be made at the following locations: Locations to be proposed by the Consultant in their Hydrology Method Statement should include (but not be limited to) upstream and downstream model boundaries, river level gauge locations and significant confluences.

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

Design flow estimation - rainfall-runoff methods

5.7.1 Assess the applicability of rainfall-runoff methods such as ReFH1 and ReFH2.

5.7.2 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.

5.7.3 Derive design flood hydrographs (e.g. ReFH, factor ReFH to fit statistical \ accepted design peaks, Archer method).

Reconcile results and produce final design values

5.9.1 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.

5.9.2 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.

7: 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 shall 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 no defences exist: 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.

9: Model Proving, Calibration and 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.

9.1 Calibrate the new Dean Brook model through simulation of up to 3 events and verify performance through simulation of up to a further 2 events. 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. Coastal models must be calibrated using available tide gauges and wave buoys. 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.

Where a +/- 150 mm peak level fit cannot be reasonably achieved, the *Consultant* must clearly document the calibration/verification work undertaken, the reasons why the fit could not be achieved, and recommendations for further work. Verification is required where calibration is not possible.

Fluvial Models

9.4 The *Consultant s*hall undertake sensitivity analysis on the model. Sensitivity analysis shall be undertaken for the 1% AEP or AEP closest to bank top level (where the 1% AEP event is in bank), shall be submitted to the *Client* for acceptance and at a minimum shall comprise:

- ±20% flows
- ±20% roughness
- ±20% slope change in downstream boundary
- Greater and smaller grid cell size than the proposed grid cell size

10: Design Simulations & Results

10.4 Scenarios:
Fluvial no defences exist: 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.

In addition the *Consultant* shall:

Simulate structure blockage scenarios for 2 locations x 3 scenarios x 3 %AEPs.

11: Flood Warning Improvements

The *Consultant* shall deliver the following services in accordance with the guidance as referred to within the latest version of the Minimum Technical Requirements for Modelling document. 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:

11.1 Review the existing Flood Alert Area(s) and / or Flood Warning Areas extent(s) in comparison with the updated modelled outputs and advise whether modifications are required to the extent(s). Review the first impacts (out of bank), first property to flood and trigger thresholds using the updated and accepted flood maps / levels. There is / are 1 existing Flood Alert Area(s) and 1 existing Flood Warning Area(s).

11.1.1 Update the existing Flood Alert Areas and / or Flood Warning Areas extents based on the updated modelled outputs (defences removed / no defences exist 0.1% AEP plus historic flood extents, where appropriate) following the *Client's* acceptance of recommended modifications from 11.1 and provide revised extents.

11.4 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.

11.5 Produce flood extent shapefiles with associated level at Flood Warning gauge for each of 1 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.

11.6 Produce flood hazard shapefiles with associated level at the Flood Warning gauge for each of 1 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.

11.7 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.

11.8 Produce level-level correlation between the onset of flooding location and Flood Warning Gauge Site for each Flood Warning Area. Determine the frequency at which the trigger level will be exceeded. Make recommendations for improvements, explaining the benefits.

11.9 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.

Available Data - Treat as Site Information

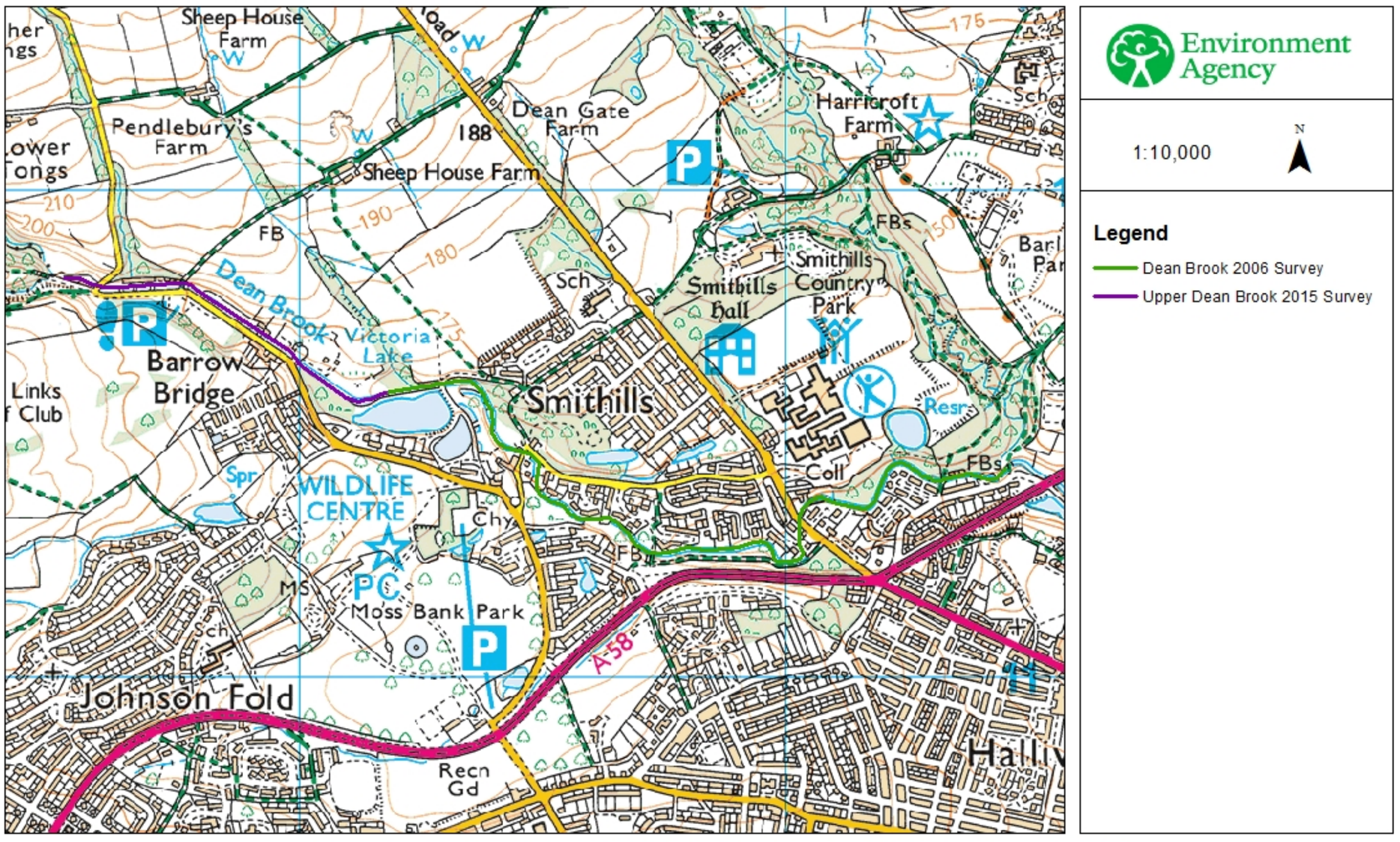
All datasets supplied for the project must be returned to the *Client* upon project completion. Datasets returned should adopt the appropriate security marking, be password protected/encrypted in accordance with the latest government guidelines. Data that will be made available to the *Consultant* include:

Hydrometric data:

Station	Location	Type (Flow / Level / Rainfall, Wind, Wave Height / Direction)	Period of record	Time interval (15 min/daily)	Fluvial/Coastal	Known data quality issues
Smithills Cross Road	SD6944311473	Surface water level			Fluvial	
562328 Dingle Reservoir TBR	369461 414420	Event raingauge (closed)	Oct 2011 - Mar 2014			
562341 Springs TBR	369463 414421	Event raingauge (closed)	Apr 2001-Oct 2011			

There are currently no operating raingauges within the Dean Brook catchment (based on FEH) but three raingauges close by at SD7095312620, SD6602014723 and SD6713111280. Data from these can be supplied to the *Consultant* if required.

Survey Coverage Map



Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Project Specific Data:

Please list any relevant existing model reports / technical notes etc.
Smithills Culvert Replacement Works (395595-MMD-XX-00-DR-C-0010-P1 and 395595-MMD-XX-00-DR-C-0011 -P1 and Location Plan)

Existing Model Summary - Fluvial Hydraulic

Model name	Date	Length of modelled watercourse (km)	Hydraulic model type	Other Type	Description	Information only or to be updated
Dean Brook 2011	2011	3.5km	Flood Modeller Pro - Tuflow		Dean Brook	Info only