1 General

The *Consultant* is

Ove Arup & Partners Ltd

Name and address etc. of *Consultant*

[redacted]

Enter email address

Insert the relevant framework tendered *fee percentage*

The *key persons* are

[redacted]

Name the *key persons* to be working on the contract

insert name	Name (3)
insert job	Job
insert responsibilities	Responsibilities
insert qualifications	Qualifications
insert experience	Experience

insert name	Name (4)
insert job	Job
insert responsibilities	Responsibilities
insert qualifications	Qualifications
insert experience	Experience

insert name	Name (5)
insert job	Job
insert responsibilities	Responsibilities
insert qualifications	Qualifications
insert experience	Experience

insert name	Name (6)
insert job	Job
insert responsibilities	Responsibilities
insert qualifications	Qualifications
insert experience	Experience

insert name	Name (7)
insert job	Job
insert responsibilities	Responsibilities
insert qualifications	Qualifications
insert experience	Experience

The following matters will be included in the Early Warning Register;

insert details
insert details
insert details
insert details
insert details
insert details
insert details
insert details

These are items which could affect the total of the Prices or delay Completion, which are known about at the time of completing this Contract Data

3 Time

to be provided within two weeks of the Contract Date	The programme identified in the Contract Data is;

This is optional and is inserted if a programme is being initially provided

5 Payment

[redacted]	forecast of the total Defined Cost plus the Fee

Resolving and avoiding disputes

The *Senior Representatives* of the *Consultant* are

[redacted]

Enter postal address

Enter email address

insert name	Name (2)

insert address	address Line 1
insert address	address Line 2
insert address	address Line 3
insert address	address Line 4
insert address	address Line 5
insert address	address Line 6

Enter postal address

insert email address	Email address for communications

Enter email address

X10: Information modelling;

The *information execution plan* identified in the Contract Data is;

to be provided within two weeks of the Contract Date.

If an *information execution plan* is to be identified in the Contract Data

X10 is always used

Framework: Collaborative Delivery Framework
Supplier: Ove Arup & Partners Ltd
Company Number: 01312453

Geographical Area:
Project Name: TWA Maintenance Reliability Study
Project Number: ENV0003340C

Contract Type: Professional Service Contract
Option: Option E

Contract Number: 32354

Revision	Status		Originator		Reviewer		Date

PROFESSIONAL SERVICE CONTRACT under the Collaborative Delivery Framework
CONTRACT DATA

Project Name TWA Maintenance Reliability Study

Project Number ENV0003340C

This contract is made on 01 February 2021
between the *Client* and the *Consultant*

- 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
  2021-05-12 Maintenance Reliability Study - Scope - v0.6_Final. Dated 12th May 2021

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 E	Option for resolving and avoiding disputes	W2

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

Z: *Additional conditions of contract*

The *service* is Assist the identification and manage business risk around the Clients ability to operate the scheme to meet water resource and navigation needs and manage Prolonged Dry Weather (PDW) and drought incidents with increased usage of the scheme envisaged as part of climate

The *Client* is Environment Agency

Address for communications [redacted]

Address for electronic communications [redacted]

The *Service Manager* is [redacted]
Address for communications

Address for electronic communications [redacted]

The Scope is in
2021-05-12 Maintenance Reliability Study - Scope - v0.6_Final. Dated 12th May 2021

The *partner contract* is

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

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 01 February 2021

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 11 November 2021

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 which the *Consultant* provides a charge for the cost of support people and office overhead are All UK Offices

6 Compensation events

These are additional compensation events

1. Managing and mitigating the impact of Covid 19 and working in accordance with Public Health England guidance, as may vary from time to time, between 1st July 2021 and 31st August 2021
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 COVER	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*	**£5,000,000** in respect of each claim, without limit to the number of claims	12 years after Completion
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	**£15,000,000** in respect of each claim, without limit to the number of claims	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	*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	**£5,000,000**	

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 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,
• 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 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

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 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* 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.
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

Z25 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 2 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 6 years after the Completion of the whole of the *service*

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 *Consultant* is
Name

Address for communications

[redacted]

Address for electronic communications

The *fee percentage* is

The *key persons* are

Name (1)
Job
Responsibilities
Qualifications
Experience

[redacted]

Name (2)
Job
Responsibilities
Qualifications
Experience

[redacted]

Name (3)
Job
Responsibilities
Qualifications
Experience

Name (4)
Job
Responsibilities
Qualifications
Experience

Name (5)
Job
Responsibilities
Qualifications
Experience

Name (6)
Job
Responsibilities

Qualifications
Experience

Name (7)
Job
Responsibilities
Qualifications
Experience

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 two weeks of the Contract Date

Resolving and avoiding disputes

The *Senior Representatives* of the *Consultant* are

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 two weeks of the Contract Date.

Contract Execution

Client **execution**

Consultant **execution**

Environment Agency

NEC4 Professional Service Contract (PSC) Scope

Project / contract information

Project name	TWA Maintenance Reliability Study
Project SOP code	ENV0003340C
Contract number	32354
Date	12/5/2021

Assurance

Reviewed	Project Manager	Date: 1/2/2021
Reviewed	Senior User	Date: 2/2/2021
Reviewed	Project Sponsor	Date: 8/2/2021
Reviewed	MEICA	Date: 27/1/2021

Revision History

Revision date	Summary of changes	Version number
17/12/20	First issue by Arup to EA project team for discussion	0.1
19/01/21	Updated based on received Project Brief and Product Description, plus comments from EA project team.	0.2
22/01/21	Alignment of language with contract (removal of ‘we’ and ‘our’).	0.3
11/02/21	Minor changes to text to reflect further EA comments received on 08/02/21. Reference to soft-start to project added to Section 6 to describe how some limited scoped activities will commence prior to the contract for the work being awarded.	0.4
26/2/21	Minor changes as recommended by the EA procurement team.	0.5
12/5/21	Amendments following review by [redacted] on 10/5/21	0.6

1 Background

The Trent Witham Ancholme (TWA) River Transfer Scheme is a significant water transfer scheme south of the River Humber, commissioned in the mid-1970s, primarily to serve the increasing water demand associated with the South Humber bank industrial area. The TWA system transfers flows from the River Trent to the River Witham and onto the River Ancholme at Toft Newton.

The scheme comprises:

- Two pumping stations (Torksey and Short Ferry).
- Over 12 miles of pipeline.
- A storage reservoir at Toft Newton.
- A separate outfall from the Short Ferry rising main to the River Ancholme, independent of the reservoir.
- Scabcroft weir on the West Drain, and
- South Ferriby Sluice and Lock, where the Ancholme drains into the Humber Estuary, is vital to the success of TWA, although does not form part of the TWA asset base (asset managed by FCRM and Waterways). Boston Grand Sluice is similar as levels in the lower Witham impact on the operation of TWA and are controlled by Boston Grand Sluice.

The TWA system has a significant asset base with in-built resilience (via a storage reservoir, and four pumps at each pumping station). Figure 1 shows the location of the principal assets.

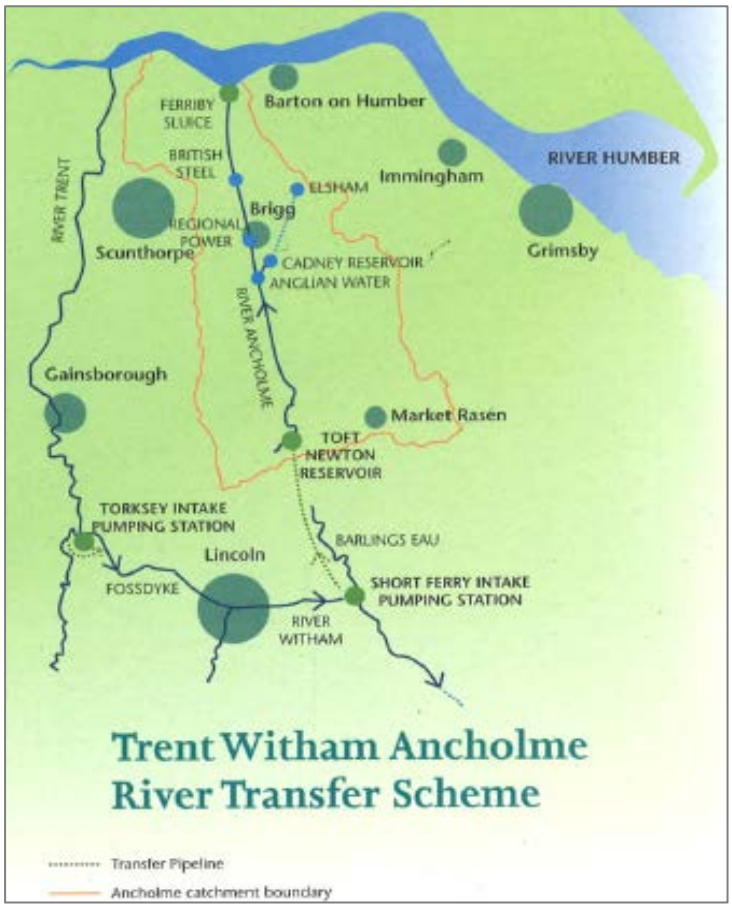

Figure 1 – Overview of location of principal assets in the TWA river transfer scheme.

There are additional FCRM and navigation interests (Canal and Rivers Trust) associated with the scheme at Boston Grand Sluice and Lock.

The scheme supports more than 100 abstraction licence holders across the agricultural and industrial sectors and is a Category A Strategically Important Asset. The TWA also supports navigation in the River Ancholme and River Witham and protects water quality and the environment. The Lincolnshire and Northamptonshire Area (LNA) Hydrology & Operations (H&O) team are responsible for making decisions on when to operate TWA and they use various hydrological tools to determine how much water to pump.

H&O have a service level agreement with the Area Field MEICA team, for the day to day operation and maintenance of TWA. Routine and small-scale non-routine maintenance is typically done by the Field MEICA team (or framework contractors). Project work (including refurbishment and replacement of parts of the asset base) is done collaboratively between H&O and Field MEICA. The H&O PM project manages, and Field MEICA team members meet contractors to ensure they are fulfilling their duties.

Field MEICA use the EA's CMMS (IDHammer) to manage the routine maintenance of the scheme although it is likely that many of the maintenance tasks generated are based on generic schedules. Maintenance is believed to be reasonably up to date however resource issues within the Field MEICA team as well as conflicting priorities do affect their ability to deliver the required workload.

Historically on average Short Ferry pumps c.6000 ML and Torksey c.2170 ML of water each year. With increasing drier summers and associated impacts upon water resources the scheme is being operated more with implications on the maintenance and asset health of the assets involved. The potential impact of climate change, which would not have been a significant factor when the scheme was designed will further affect the way the scheme is operated although this study does not consider any fundamental changes in the use of the scheme (for example additional transfers for additional abstractions etc).

The PDW Assets Recovery and Resilience Board have sanctioned this study as a priority following a breakdown in early summer 2020. Water Resource (WR) funding has been secured to deliver this reliability study in advance of potential Prolonged Dry Weather (PDW) which could occur in spring / summer in 20/21.

A combination of the aging asset and resource constraints for the delivery of maintenance have highlighted the need to fully understand the maintenance requirements of the scheme going forward to ensure a robust, risk based, maintenance plan is in place for the scheme which can in turn identify the required resource requirement. In order to develop this plan, there is a need to identify the maintenance requirements for the asset elements (currently maintenance plans are largely generic) using techniques such as failure mode effect analysis (FMEA) in order to provide a specified maintenance programme for the scheme to address the identified failure modes.

The assets include a high voltage supply at Short Ferry Pump Station. Doug Burt (Anglian Supra-area MEICA team) is the site's Senior Authorised Person (SAP). At present, maintenance of HV equipment is undertaken by a specialist contractor.

This study needs to take account of the increasing age of assets which are in the region of approximately 40 years. Service life is key and where possible there is a need to develop a maintenance regime to prolong service life.

eMission 2030 also needs to be considered, particularly achieving net zero carbon by 2030. This study should consider potential reductions in carbon associated with maintenance activities.

TWA has a SCADA system so identifying which parameters (condition monitoring, plant exercising etc.) could be monitored remotely and maintenance provided when required rather than on a regular time based approach should be included. This will need to take into account the levels of utilisation of the equipment.

2 Previous studies

Consideration will be given to the existing waterways study and associated maintenance study to enable consistent approach towards risk-based maintenance within the EA.

An asset inspection report from 2011 is available on request to be added as an appendix..

A high-level operating manual is available on request, which forms the basis for the current maintenance schedule. This will be added as an appendix.

Toft Newton reservoir has a statutory independent inspection regime. The reservoir is still to be included in this study for the maintenance activities which the field team undertake.

The *Consultant* shall review the previous studies and notify the *Client* of any deficiencies in its adequacy. Following this review, and completion of any work required to rectify the deficiencies identified, the *Consultant* shall take the risk of any deficiencies in existing data quality and quantity which have not been notified to the *Client*.

3 Objectives

The Project Brief (version 2.3 dated 04/01/21) identifies the following two objectives for the study.

The study is required to:

1. Assist the identification and manage business risk around the *Clients* ability to operate the scheme to meet water resource and navigation needs and manage Prolonged Dry Weather (PDW) and drought incidents with increased usage of the scheme envisaged as part of climate adaptation and increased demands on the scheme.
2. Provide an optimised maintenance regime for the existing TWA asset base.

4 Study extents / boundaries

The assets which are to be included in the study comprise:

- The intake works, pumping station, pipeline and outfall works at Torksey Pumping Station.
- The intake works and pumping station at Short Ferry Pumping Station.
- The pipeline from Short Ferry to Toft Newton reservoir.
- Toft Newton reservoir and outfall works at Toft Newton. Toft Newton reservoir inspection and maintenance is already covered under the Reservoir Act. However, there may be aspects of the reservoir and the TWA system that are not included in the remit of the Reservoir Act inspection and maintenance regime. This study will include the reservoir but not replicate any existing statutory provisions.
- South Ferriby and Boston Grand Sluices as well as Scabcroft Weir. Locks and sluices are to be included to the extent where new or changed maintenance could improve their reliability. It is understood that many of these assets may currently have minimal or no maintenance undertaken on them currently.
- Hydrodynamic aspects such as instrumentation and gauging will be included as these could affect the operation of the TWA system and so are a key part of the system's functionality.

The study does not include for condition assessments on existing assets to determine how close they may be to failure. The *Client* has identified Detailed Asset Inspections (DAIs) at Short Ferry Pumping Station and Torksey Pumping Station to be undertaken in 2021/2022. but the funding for this has not yet been allocated..

If there are information gaps arising from the review of existing baseline information on assets these will be filled to the extent possible by seeking additional sources of information from within the EA, from suppliers and manufacturers of the plant and equipment, archive sources of information and from site inspections. This study scope or programme does not include for undertaking or specifying additional investigative surveys to find out information on the existing assets which is not readily identifiable from visual inspections.

For the purposes of the study and FMEA similar assets may be grouped, for example the Torksey pipeline and the Short Ferry pipeline will be largely duplicating each other so it may be more efficient to combine them for FMEA purposes. However, any such decisions will be made after the initial stages of the projects when the assets are defined and understood to ensure that material differences which may exist and affect their operation or reliability are not overlooked.

5 Key tasks and outcomes

The study comprises various key tasks, each of which is summarised below, along with the proposed approach and principal outcomes.

5.1 Review of existing baseline information on assets

All available and provided information on the existing assets will be reviewed. A gap analysis document will be produced to confirm further requirements for data and information. These will be considered separately for each of the main components of the TWA. This will include the following as a minimum.

- Design and as-built drawings for the original construction and any subsequent modifications, repairs or replacement.
- All reports and documents pertaining to the assets.
- SCADA records from each pumping station.
- Data / records from any condition monitoring installed on the pumps or other critical assets.
- Existing scheduled / proactive maintenance plans.
- Records of any historic failures in the TWA assets, and any available investigations into the causes of these.
- System control philosophies.

Through this review an understanding of each individual asset and the way that they operate in conjunction with each other will be developed. Schematics of the system (such as process flow diagrams and high-level P&IDs) will be developed to facilitate the subsequent stages. Each of the assets will be visited to compare the on-ground installations against the record information. Boundaries of EA asset ownership and responsibility will be defined.

A workshop will be held with any relevant EA stakeholders to discuss the findings from this review and ensure a common and agreed baseline understanding of the assets has been developed.

Outputs from this stage will comprise:

- Summary TWA system report referencing all the identified sources of information. This will include:
    - Details of the assets and their required level of performance,
    - Any defined resilience and redundancy requirements for the assets and the overall system.
    - Comment on whether supporting information such as drawings and documents are suitably accessible, are up to date, and are effectively managed (revision control etc.). If there are any deficiencies in this regard recommendations will be made on how this can be improved.
- Identification of any significant gaps in the information that would materially affect the subsequent analysis. Where this is the case, further surveys or investigation would be required.
- Any initial comments arising on the existing maintenance strategy. This will be the start point for interventions to be developed.

5.2 Failure Mode and Effects Analysis (FMEA)

A suitable tool provided by Arup will be used to investigate each of the principal assets in the TWA individually, and then undertake an overarching system-wide assessment. The FMEA will implement a logical, bottom up and comprehensive approach to identify all envisaged failure modes and effects. This will include consideration of:

- **Process:** Each process step or step name will be defined. This will crossmatch with the process flow diagrams / P&IDs developed in Stage 1.
- **Function**: The required function of each process will be defined.
- **Requirement**: The functional requirements will be identified. A function may have one or multiple requirements.
- **Failure Mode**: The ways in which each process could potentially fails to meet the requirement will be identified. Each requirement could have one or many potential failure modes.
- **Cause:** Each failure mode will be attributed to a Cause (the reason why the failure happens). Each failure mode could have many potential causes.
- **Effects**: The potential effects of the failure mode on the function will be traced. Each failure mode may have one or multiple potential effects.

This process will provide a thorough mapping of each of the failure modes and subsequent effects on the required functionality of each of the assets. It is expected that this would identify a large number of failure modes and effects, and so a process to sift and prioritise these is needed. The next stage of the FMEA would therefore be to score each failure mode and effect for:

- **Severity (S)**: A ranking number to reflect the most severe potential effect of a failure mode.
- **Occurrence (C**): A ranking number to reflect the probability of occurrence of the failure mode.
- **Detection (D):** A ranking number to reflect the practical feasibility of detecting the potential failure in advance of each failure mode materialising.

Based on the Severity, Occurrence and Detection scores an overall Risk Priority Number / weighting will be calculated for each Failure Mode. This will allow the failure modes to be prioritised, and strategic decisions made on how the inspection, testing and maintenance plan for the TWA can optimally be undertaken, within the time and resource constraints which will exist. The final stage of the FMEA will be to identify inspection, testing and maintenance control measures which will allow the risk of failure to be reduced. This could be through:

- **Prevention Control:** Actions to prevent the potential Cause occurring (the root cause of the Failure Mode). Prevention control actions may require upfront capital investment but reduce maintenance requirements in the long-term as the asset remains in a better condition. For example, this may be improving ventilation in a control building to slow the rate of corrosion on electrical panels. This would prevent structural failure of the panels. Alternatively, other preventative controls will be undertaking maintenance at periodic intervals to limit the extent to which the asset can deteriorate and maintain it within its intended operating condition envelope.
- **Detection Control:** Actions to detect the failure or the cause of the failure as it is happening, but before it becomes critical. For example, this could be to install condition monitoring on pumps, measure the wall thickness of rising mains through non-invasive techniques at intervals, or do pump tests on the system to identify detrimental increases in pipe roughness.

The final stage of the FMEA will then be to determine the recommended action, as for each Cause or Failure Mode there may be multiple different prevention or detection controls which could be applied. In some instances, the action for each Cause or Failure Mode may involve a combination of preventative control, detection control, or allowing to run to failure. At this stage consideration will be given to the optimal way in which inspection and maintenance activities can be grouped, and interdependencies

between different actions. The extent to which each action will eliminate or reduce the probability of occurrence will be considered. The person or team best placed to take responsibility for the actions will be identified.

The FMEAs for each principal asset and the overall system will be done through a series of facilitated workshops with specialist technical input from relevant *Consultant* disciplines including civil, mechanical, electrical, control, reservoir structures etc. These will be done in conjunction with EA staff input. The workshops will be open to anyone from the EA with material knowledge on the assets and TWA system to contribute. The key findings and observations from each FMEA, and the overall integrated assessment, will be circulated for comment prior to the findings feeding into the final stage of this work.

5.3 Development of a risk-based maintenance plan for the TWA system

Within this stage, an effective, risk based, inspection, testing and maintenance plan will be developed and produced for the scheme, based on the outputs from the FMEA and specifically the identified optimal prevention and detection controls.

This will include a comparison with the existing maintenance plan identifying whether tasks are to be deleted, revised or new tasks added. Each proposed inspection, testing and maintenance task shall be clearly identified against or linked to the potential causes and failure modes in the FMEA. This will provide the justification for the proposed activities and allow intelligent review of the plan over time as improved knowledge on the assets and rates of deterioration are developed. In addition to the risk-based plan, any statutory or required routine monitoring activities will be included (such as to ensure security or public safety). Input from the existing EA teams on what these currently are will be required. Key suppliers and providers of plant and equipment will be engaged with to ascertain their latest recommendations for inspection, testing and maintenance. If this identifies differences to the proposed plan developed from the FMEA specific attention will be given to this to achieve a consensual and consistent approach.

All proposed inspection, testing and maintenance tasks will be fully documented in terms of task description, methodology, specified requirements, and outcomes. Details of required competences for those undertaking the activities will be provided where relevant.

The approach will seek to reduce risk of failure to as low as possible through an optimised maintenance regime, within the resource constraints through the proposed inspection, testing and maintenance activities. If there are any failure modes and / or causes for which planned inspection, testing and maintenance will not be sufficient to control to a sufficiently low level, these will have to be controlled through reactive maintenance. These assets / failure modes / causes will be clearly identified as they would pose a residual risk of failure to the TWA system. Any necessary measures to enable reactive maintenance will be identified – such as required resource and contingency.

The main aims of the planned inspection, testing and maintenance plan will be to:

- Keep individual assets and the system operating effectively to provide the required functionality with sufficient resilience.
- Enable appropriate information on the asset and system health to be developed and monitored over time. This will give insight into the asset and system resilience and reliability and allow more effective asset management and targeted investment in the future.

The maintenance regime guidance notes will state, where applicable, that the regime / plan should be reviewed periodically to ensure that it aligns with the long-term strategy and subsequently revised accordingly if there are changes in the operation of the assets.

6 Programme

Delivery of the study is to be completed ahead of the investment planning process in July 2021 which will establish the delivery programme for the next 6 years i.e., 2021-2027). The notional programme for this study, based on the main activities described above, is:

- Project soft-start. Team mobilisation. Initial review of existing baseline information on assets. 8 weeks starting on Monday 8th February and extending until Friday 26th March 2021.
- Phase 1 work. 5 weeks starting on Monday 29th March and extending until Friday 30th April 2021.
- Phase 2 work - Failure mode and effects analysis. 5 weeks starting on Monday 3rd May and extending until Friday 4th June 2021.
- Phase 3 work - Development of a risk-based maintenance plan for the TWA system. Roll out and discussion with EA stakeholders. Project close-down. 6 weeks from Monday 7th June and extending until Friday 16th July 2021.

7 Relevant guidance

The Consultant shall deliver the service using the following guidance:

Ref	Report Name	Where used
LIT 16559	Safety, health environment and wellbeing (SHEW) Code of Practice	Throughout
OI 120_16	Whole-life Carbon Planning Tool	Detailed design
	Project Cost and Carbon Tool	Costs
LIT 12982	Working with Others: A guide for staff	Consultation & Engagement
LIT 12280	Lessons Log template	FBC
LIT 55096	Integrated Assurance & Approval Strategy	Approvals

Additionally, it is noted that some of the *Client* MEICA technical standards address resilience issues. These will be included in FMEA through reviewing the standards applicable to the assets on the TWA system and including any / all relevant requirements into the FMEA as ‘Functions’ of assets or ‘Requirements’ of assets.

8 Services and other things provided by the *Client*

The *Consultant* will be provided with the necessary access to Environment Agency systems and resources required to enable the work including Asite, FastDraft, and the Collaborative Delivery Community SharePoint.

If required for site access, site access authorisation letter(s) will be provided.

The *Client* will provide the previous studies listed in Section 1.2, and any other available information within 2 weeks of the request.

9 COVID-19 related considerations

In relation to the ongoing COVID-19 pandemic, the *Consultant* note the following requirements in relation to the delivery of the scope defined in this document.

The *Consultant* is not liable for any delay or failure to fulfil any obligation under the Agreement to the extent any such delay or failure caused by, or is a consequence of:

> (a) cancellation, postponement or restriction of any domestic or international travel, meetings or visits to site which the *Consultant,* in its absolute discretion, considers is necessary for the health and safety and welfare of its employees, advisers, contractors and/or subcontractors; and
>
> (b) any event or circumstance outside the reasonable control of the *Consultant* including, without limitation, issues relating to the novel coronavirus (COVID-19) outbreak, whether or not those issues were known at the date of the Agreement.

The Parties agree that, notwithstanding requirements specified elsewhere in the contract, persons engaged in the performance of this contract shall not be required to travel contrary to travel advice or where it is reasonably deemed that to do so would prejudice their health, safety or wellbeing. The Parties will use reasonable endeavours to facilitate the diligent performance of their obligations. However, should the Parties be constrained from doing so for matters outside their reasonable control, the Parties shall not be liable for any delay or disruption to the performance of the Services.

In the event that performance of the Services is disrupted due to matters beyond the *Consultant's* reasonable control, the time for performance shall be adjusted by such periods as is fair and reasonable in the circumstances. In the event of such disruption, should additional resources be necessarily expended in order to diligently proceed with the Services, the *Consultant* shall (i) give notice to the *Client* that additional resources shall be expended and (ii) be entitled to a fair and reasonable additional fee.

10 Constraints

- The *Client* has identified Detailed Asset Inspections (DAIs) at Short Ferry Pumping Station and Torksey Pumping Station to be undertaken in 2021/2022. but the funding for this has not been allocated.
- Existing resource managing the scheme. A large amount of information is held with site personnel.
- Time consuming FMEA process.

11 BIM

Outputs to be produced in accordance with the BIM Protocol – Production and Delivery Table.