A proposed reservoir in Lincolnshire

Associated water infrastructure – options appraisal report

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Glossary and acronyms

Abstraction	The removal of water from any source, either permanently or temporarily.
Abstraction infrastructure	Infrastructure required to abstract water from a water source, including intake structures, pumping stations, and initial treatment.
Associated water infrastructure	The works which are required to take water from a source to a reservoir and then from a reservoir to the connection points to the existing water networks. The components of this would typically include water treatment works, transfers (pipelines, open channels or a combination of the two), abstraction infrastructure (pumping and initial treatment) and service reservoirs. Also includes the preferred discharge channel route for the water released if the reservoir needs to drawn down in an emergency situation.
Carbon costs	The calculated cost associated with the carbon emissions generated during the construction and operation of a scheme.
Component	A part of an element that does not provide the whole solution for that element on its own. Examples of components are service reservoirs, transfer routes, pumping stations or water treatment works.
Component option	An option for a partial solution to a project element, assessed in Stages B and C.
Downstream	The transfer of water from the reservoir to public water supply network.
Downstream infrastructure	Infrastructure required to transfer water from the reservoir to the reservoir supply connection point, including the water treatment works.
EIA	Environmental Impact Assessment is an assessment process which: determines the likely environmental impact of a given action or intervention; describes the mitigation to avoid or reduce these likely impacts; and identifies likely significant effects on the environment that is used to inform the decision maker before deciding whether to grant consent.
Element	The elements are the main features that combine to create a whole scheme option and comprise: upstream infrastructure; main reservoir site; downstream infrastructure; and the emergency drawdown disposal route.
Element option	An option consisting of combined components produced at the end of Stage C.
ha	Hectare
High-level carrier	Typically refers to a watercourse that is elevated or situated at a higher level relative to its surroundings.
Historic designated assets	A heritage asset which is formally protected by legal status. This includes, scheduled monuments, registered parks and gardens and listed buildings.
HRA	Habitats Regulations Assessment. There is a requirement under the Conservation of Habitats and Species Regulations 2017 (as amended) to

	determine if a plan or project may have an adverse impact on a site designated under the same (or preceding) Regulations prior to any consent or permission being determined. The process of undertaking this assessment is known as a Habitats Regulations Assessment.
Hydraulic capacity	The ability of a watercourse or channel to convey water, considering for example, volume, cross-sectional area and whether there are any obstructions.
IDB	Internal Drainage Board. A public body responsible for the management of water levels in an area. They play a fundamental part in the management of flood risk and land drainage in England.
Initial treatment	Initial treatment refers to treatment of abstracted water in proximity to the source to address concerns in respect of INNS or WFD.
INNS	Invasive Non-Native Species
Intake	A structure through which water is withdrawn from the water source, after which the water is conveyed to the associated water infrastructure.
km	Kilometre
Lincolnshire Water Partnership	Stakeholder engagement group consisting of local stakeholders. This group informed the approach taken for Options Appraisal and contributed to the findings and outcomes of the first three Options Appraisal stages.
Listed building	A building or structure designated under Chapter 1 of the Planning (Listed Buildings and Conservation Areas) Act 1990 as being of 'special architectural or historic interest'.
Low-level carrier	A watercourse that is closer to ground level or below the surrounding terrain.
LWS	Local Wildlife Sites
Mineral safeguarding area	Designated areas that provide for the safeguarding of proven mineral resources which are, or may become, of economic importance from unnecessary sterilisation by non-mineral development (such as being covered by buildings).
Ml/d	Megalitres per day. One megalitre = one million litres (1,000 cubic metres).
mm	Millimetre
National Planning Policy Framework	Sets out the government's economic, environmental and social planning policies. A revised National Planning Policy Framework was published by the Department for Levelling Up, Housing & Communities in December 2023.
NPS	National Policy Statement for Water Resources Infrastructure[1]. A document produced by the government, which sets out the need and government's

[1] Defra (2023), National Policy Statement for Water Resources Infrastructure. Retrieved from: https://assets.publishing.service.gov.uk/media/6437e3a2f4d420000cd4a1a7/E02879931_National_Policy_Statement_for_Water_Resources.pdf

	policies for development of nationally significant infrastructure projects for water resources in England under the Planning Act 2008 regime, and the decision-making framework for relevant development consent order applications to be considered against.
NPV	Net present value. The present-day financial value of costs for construction and operation calculated over a 100-year period.
Open channel transfers	The transfer of water in a natural or manmade conduit that has an open top (a free surface).
Options appraisal	Process through which options are appraised to select the best performing scheme.
Pipeline corridor	An area of land within which the pipeline could be routed. Pipeline corridors vary in width depending on the stage of the assessment and the presence of known constraints.
Polygon	The indicative area or parcel of land on which a pumping station, INNS treatment works, service reservoir, or water treatment works could be developed.
Project	The Lincolnshire reservoir project being promoted by Anglian Water including the reservoir, associated water infrastructure and other associated development.
Pumping station	A building that houses a pump to lift water, or push water along a pipeline. It can also mean the building and the pump(s) inside.
Ramsar sites	Wetland areas of international importance which have been designated under the criteria of the Ramsar Convention on Wetlands 1971 for containing representative, rare or unique wetland habitat types or for their importance in conserving biological diversity. The designation of UK Ramsar sites has generally been underpinned through prior notification of these areas as Sites of Special Scientific Interest.
RAPID	Regulators' Alliance for Progressing Infrastructure Development. An alliance of regulators made up of Water Services Regulation Authority (Ofwat), Environment Agency and Drinking Water Inspectorate, to help accelerate the development of new water infrastructure and design future regulatory frameworks.
Raw water	Water that is untreated. In terms of the Project, all water upstream of the water treatment works is considered 'raw water'. Downstream of the water treatment works it is considered 'potable water', following treatment.
rdWRMP	revised draft Water Resources Management Plan 2024
SAC	Special Areas of Conservation are European habitat sites designated under the Conservation of Habitats and Species Regulations 2017, as amended.
Scheduled monuments	Scheduled monuments are nationally important monuments that have been afforded statutory protection through their inclusion in the Schedule of monuments maintained under section 1 of the Ancient Monuments and

	Archaeological Areas Act 1979. The Secretary of State must be informed about any work that might affect a monument above or below ground, and Historic England gives advice to the government on each application. In assessing each application the Secretary of State will try to ensure that damage done to protected sites is kept to a minimum.
Sequential Test	A sequential, risk-based approach to development and flood risk set out in the NPS and the National Planning Policy Framework. It is undertaken to ensure that areas at little or no risk of flooding (from all sources) are developed in preference to areas at higher risk of flooding.
Service reservoir	A water storage facility that holds potable water after it has been treated in a water plant, and before it is piped to the end users. These storage areas are covered and are designed to keep the water safe from contamination.
Site selection	Process that identifies and assesses potential suitable locations for the purposes of identifying the preferred location for a project. For example, the site selection process undertaken to identify the preferred location for the Lincolnshire Reservoir.
Source	River or watercourse from which water will be sourced to fill the reservoir.
SPA	Special Protection Areas are protected areas for birds in the UK classified under the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales (including the adjacent territorial sea).
SSSI	Site of Special Scientific Interest
Upstream infrastructure	Infrastructure required to transfer raw water from a source towards the reservoir.
WFD	Water Framework Directive. European Directive (2000/60/EC) transposed into English and Welsh law through The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. The WFD sets out requirements to prevent the deterioration of the status of water bodies and to support the achievement of the water bodies environmental objectives.
Whole scheme	The Project as a whole, combining upstream transfers, reservoir site, downstream infrastructure and the emergency drawdown disposal route.
Whole scheme option	An option assessed in Stage D which combines options for all associated water infrastructure elements to give a holistic solution.
WRE	Water Resources East. One of five regional water resource groups (made up of different interested organisations, including water companies for that region) responsible for development of regional plans aligned with the National Framework for Water Resources.
WRMP	Water Resources Management Plan. Sets out a water company's intended approach towards water resource planning for meeting its duty to supply water for at least the next 25 years, to ensure the long-term balance

	between supply and demand is maintained; legally required to be updated every five years.
WTW	Water treatment works. A facility where raw water is treated to a standard suitable for drinking water.

Executive summary

A new storage reservoir in Lincolnshire, referred to as the Lincolnshire Reservoir, has been identified as one of several strategic resource options required to address future deficits in public water supply for this region. Following selection of, and consultation on, the best performing reservoir location in 2022, Anglian Water has undertaken a comprehensive options appraisal process to determine the most suitable options, including placement, for upstream infrastructure, downstream infrastructure and emergency drawdown of the reservoir – referred to as the associated water infrastructure.

This document provides a high level overview of the options appraisal process that has been undertaken to identify the preferred options and sites for the associated water infrastructure. This includes the four stages (Stage A to D) of the options appraisal process and an overview of the key differentiators of both the least constrained options assessed at Stage C and the whole scheme options (for the associated water infrastructure) assessed at Stage D. This is to show to consultees at this early stage of the Project development process the key differences that were considered as part of identifying the whole scheme options (for the associated water infrastructure) that are being taken forward at this stage. These whole scheme options are shown in the Phase two consultation – associated water infrastructure proposals brochure.

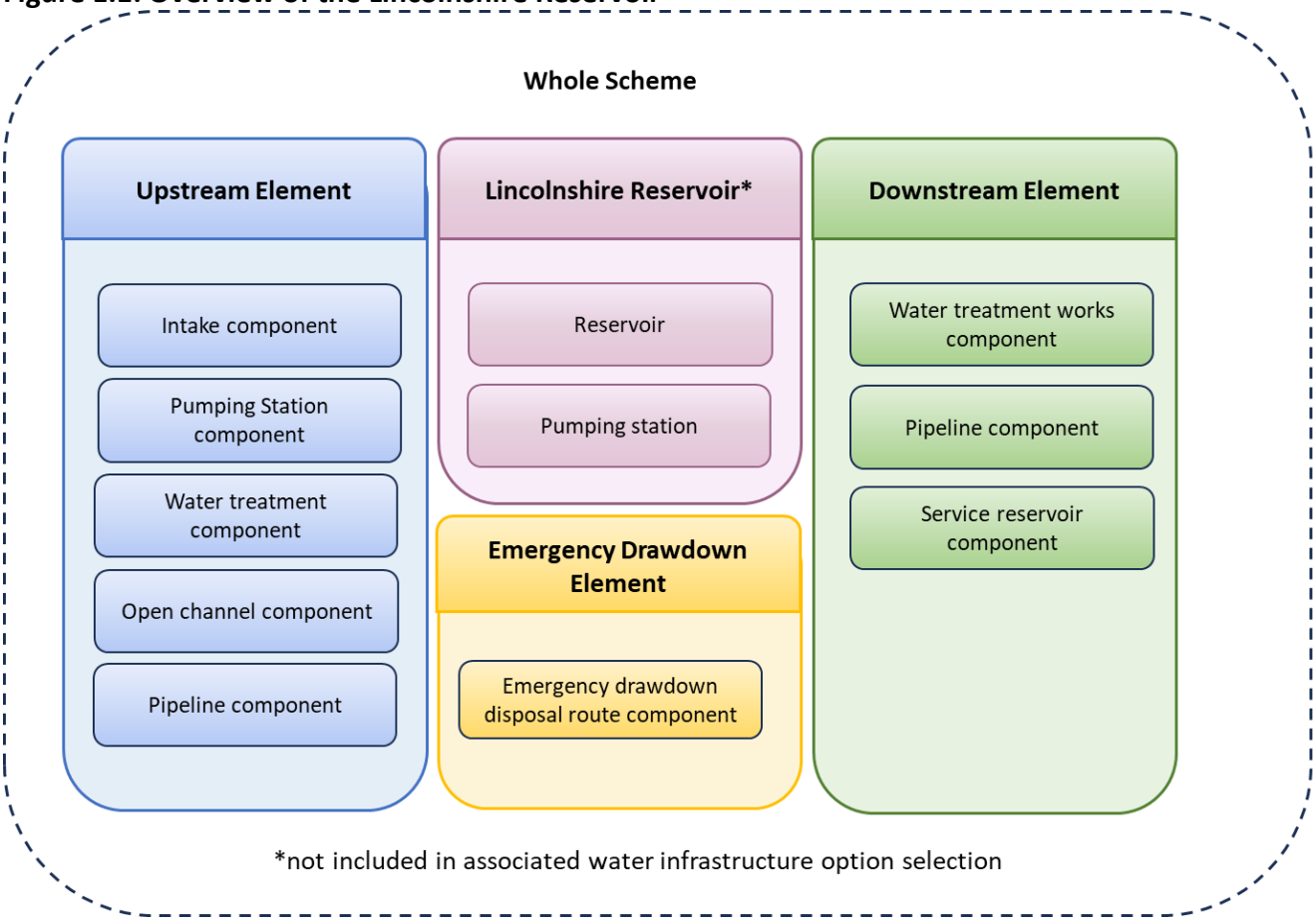
The purpose of this document is to provide consultees with information to allow them to provide a view on both the whole scheme options (for the associated water infrastructure) Anglian Water is proposing to take forward, as well as the process undertaken to get to this point. This will help to develop the proposals further in the next stage of development.

The approach to options appraisal

A four-stage options appraisal process (shown in Figure E.2) has identified and assessed potential options based upon a broad range of community, environmental, economic, and other technical criteria (constraints and opportunities). The process categorised each of the upstream infrastructure, downstream infrastructure and emergency drawdown disposal route into individual components, namely abstraction infrastructure, transfers, water treatment works and service reservoirs for consideration before combining the best performing elements to create whole scheme options for the associated water infrastructure. Figure E.1 shows how the components and elements combine to create the main elements of the Project.

The site for the Lincolnshire Reservoir forms part of the whole scheme for the Project. The location of the reservoir has been identified through a separate site selection process that was shared at the earlier consultation in October 2022 and is therefore not included as part of the associated water infrastructure options appraisal reported in this document.

Figure E.1: Overview of the Lincolnshire Reservoir



The options appraisal process and criteria used to assess options have been informed by subject matter experts across engineering, planning, environmental and land technical disciplines. Anglian Water has also engaged with stakeholders on the development of the options appraisal process and the outcomes as the appraisal process progressed. These stakeholders were engaged through two key forums: the Lincolnshire Reservoir Water Partnership and a dedicated forum, which included local planning authorities and statutory stakeholders.

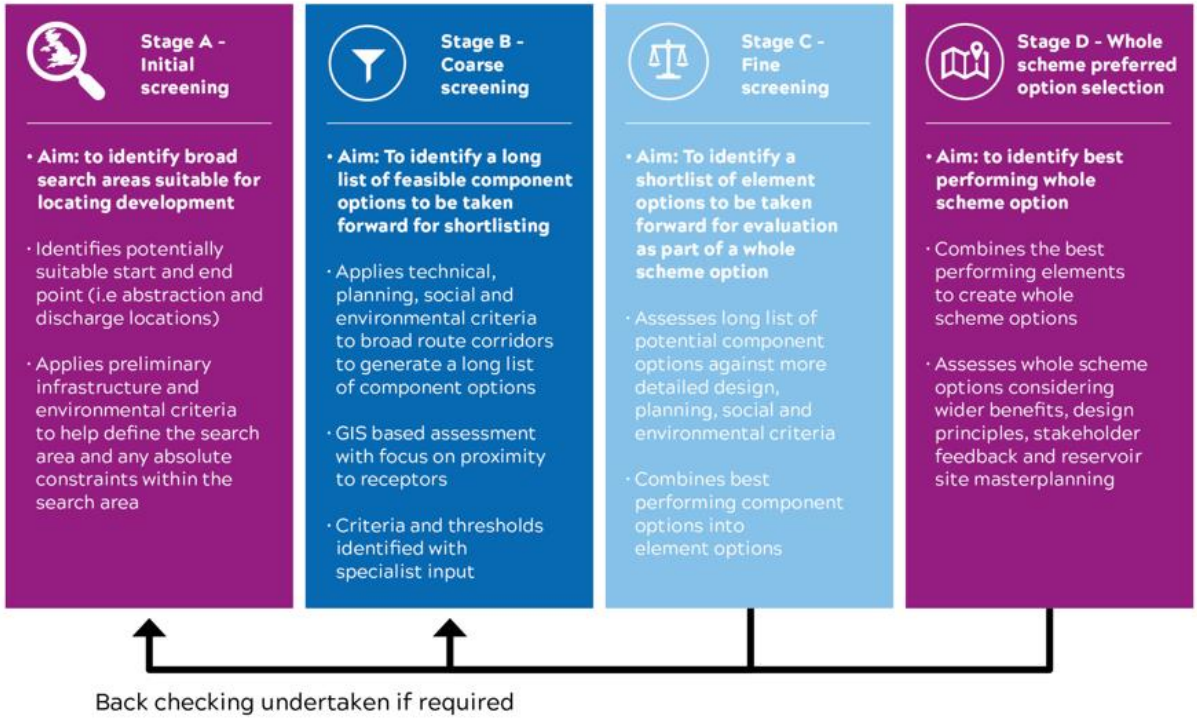
A detailed appraisal process (Figure E.2) has been applied including the following steps:

- Stage A comprised a high-level review against strategic constraints to identify broad search areas suitable for locating the associated water infrastructure.
- Stage B comprised development of a long list of options for each component (as shown in Figure E.1) required for the upstream and downstream infrastructure and emergency drawdown disposal route elements. The component options taken forward have been screened against engineering, environmental, planning, land use and social constraints.
- Stage C applied a more detailed appraisal against engineering, environmental, planning, land use and social criteria to understand how each option performs and to identify any key

differentiators between alternatives. Stakeholder feedback was also considered as part of this stage to inform the selection of the best performing components. These component options were then combined to form the wider element options.

- Stage D combined best performing elements to create whole scheme options for associated water infrastructure which were then subject to a subject matter expert-led comparative review to identify the best performing whole scheme option for the associated water infrastructure.

Figure E.2: The staged options appraisal process

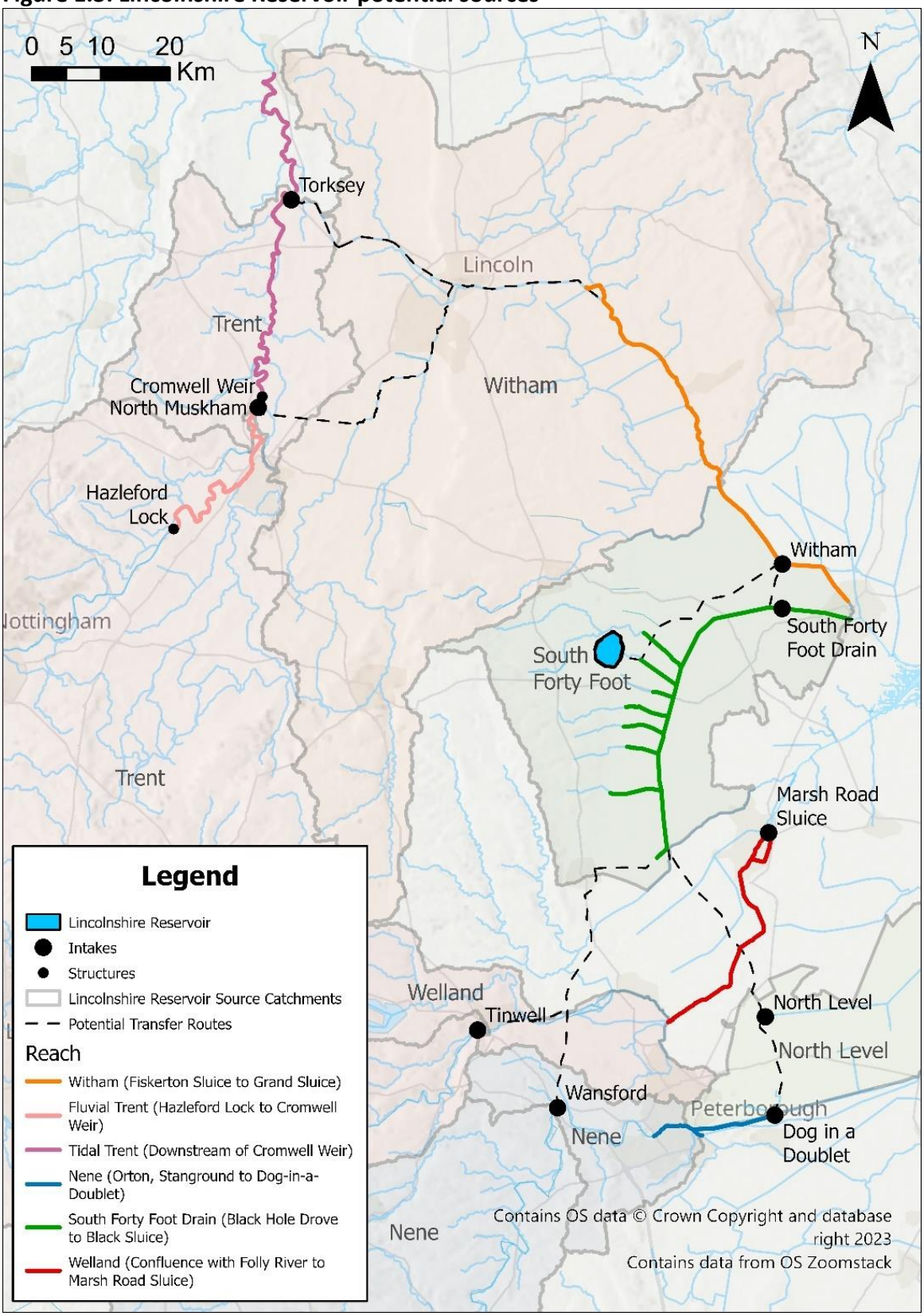


Sources of supply

The origin of the water that will be stored in the reservoir is the starting point of the appraisal process. Anglian Water's rdWRMP24 identified three potential sources of supply to fill the Lincolnshire Reservoir, the South Forty Foot Drain, the River Witham and the River Trent.

A sources of supply assessment was undertaken that used the Environment Agency's Abstraction Licensing Strategies to identify a long list of sources within a 50km radius of the proposed reservoir location. This assessment considered nine potential water sources and tested the sources in a staged process to identify a combination of potential preferred water sources. The sources of supply assessment identified that the preferred sources were the South Forty Foot Drain, the River Witham and the tidal River Trent. These are shown in Figure E.3.

Figure E.3: Lincolnshire Reservoir potential sources



Connection points

The required connections of the downstream water transfers into Anglian Water's existing supply network zones are considered and identified in Anglian Water's revised draft WRMP24 and they form the end points for the associated water infrastructure. Further consideration of specific connection points and integration with the existing Anglian Water network to refine the connection points within the zones identified in the revised draft WRMP24 was undertaken in parallel with the associated water infrastructure options appraisal process. This considered the water resource zones identified in the revised draft WRMP as receiving water from the Lincolnshire Reservoir, the location and capacity existing and planned Anglian Water assets and impacts of infrastructure failures (e.g. pipe burst) on supplies to customers. This identified that preferred connection points were:

- Wilsthorpe, near Bourne
- Chesterton, near Peterborough

Principles of associated water infrastructure options appraisal

Each step of the appraisal process was informed by desk-based information, professional opinion from relevant subject matter experts and stakeholder input to identify the preferred whole scheme option for the associated water infrastructure. National planning policy, in particular the NPS, has been a fundamental consideration in the appraisal process, as has the feedback from stakeholders at each of the four stages. An example of this is the preference for the use of open channels for the transfer of water, where alternative options performed similarly, as the use of these channels may unlock potential benefits to the environment and may also facilitate multi-agency opportunities. These potential benefits and opportunities could include the incorporation of habitat for wildlife, improvement of navigation routes and mitigation of flood risk.

The detailed process applied in the selection of component options of the associated water infrastructure is highlighted by two examples:

- **Upstream transfer routes –** open channel and pipelines, as well as a combination of the two, were explored for upstream transfer options. At Stage A the area within which the transfer corridors could be placed was identified. At Stage B a list of 50 potential transfer component options were identified and refined to 12 for more detailed assessment in Stage C. Stage C identified three preferred transfer options connecting three different sources, which were taken forward to Stage D.
- **Water Treatment Works and downstream transfer –** from the reservoir the downstream transfers transfer water are proposed to go southwards to Wilsthorpe and Chesterton connection points. Potential locations for the water treatment works were identified by considering the downstream pipeline search areas between the Lincolnshire Reservoir and the closest network connection point. Areas within Flood Zones 2 and 3 were not considered as suitable locations for the water treatment works. Eighty potential locations were

identified at Stage B and the three least constrained locations were progressed to Stage C. The more detailed Stage C assessments identified a single preferred location for the water treatment works that was taken forward to Stage D. From the water treatment works the treated water would be transferred to the two connection points. No open channel transfers were considered for the downstream transfer as the water being transferred is treated water. The assessment of the pipeline corridors followed the options appraisal process used on the upstream transfer options. Two corridor options from the Lincolnshire Reservoir to Wilsthorpe and one corridor option from Wilsthorpe to Chesterton were progressed to Stage D.

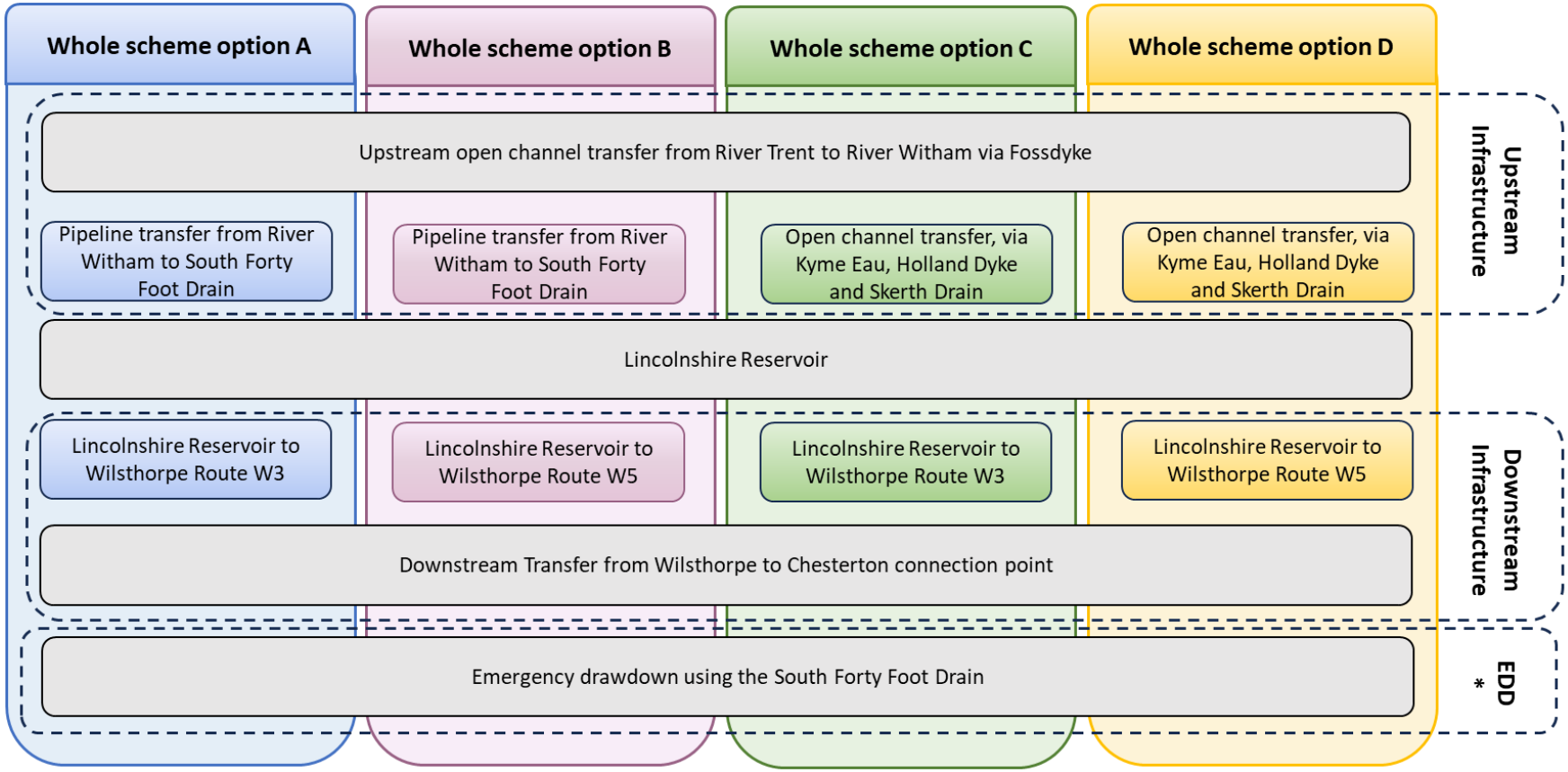
Outcome of the options appraisal process

Once each of the component and element options were considered through the staged options appraisal process (shown in Figure E.2), a comparative review of the four whole scheme options taken forward was undertaken at Stage D. These options are called whole scheme option A, whole scheme option B, whole scheme option C and whole scheme option D. The key differences between the four whole scheme options are associated with:

- the upstream transfer of water from the River Witham to the South Forty Foot Drain. Whole scheme option A and whole scheme option B transfer water through a pipeline option, whereas whole scheme option C and whole scheme option D transfer water through a combination of open channels with some pipeline sections to connect between the open channels.
- The downstream transfer of water from the Lincolnshire Reservoir to Wilsthorpe. Two downstream corridors were included in the whole scheme options. Whole scheme option A and whole scheme option C have a different pipeline corridor option to whole scheme option B and whole scheme option D.

Figure E.4 shows the different elements of the four whole scheme options.

Figure E.4: The four whole scheme options



*EDD = Emergency Drawdown

Overall, whole scheme option A was the preferred whole scheme option when considered against the wide range of assessment criteria. In particular, whole scheme option A was assessed to offer the following advantages compared to the alternative options based on the information considered at this point in the process:

- Lower whole life cost than whole scheme option C.
- Whole scheme option A (and whole scheme option B) has reduced WFD risk associated with the upstream transfer between the River Witham and the Kyme Eau, compared to whole scheme option C and whole scheme option D.
- Whole scheme option A does not directly impact on Goose and Swan Functionally Linked Land (in common with whole scheme option C).
- Whole scheme option A has less potential for impacts on the value of heritage assets for the downstream corridors (in common with whole scheme option C), in particular the risk of potential impacts on Car Dyke are reduced, when compared to whole scheme option B and whole scheme option D.
- Downstream route corridors for whole scheme option A (and whole scheme option C) are preferred from a biodiversity and habitat loss perspective.

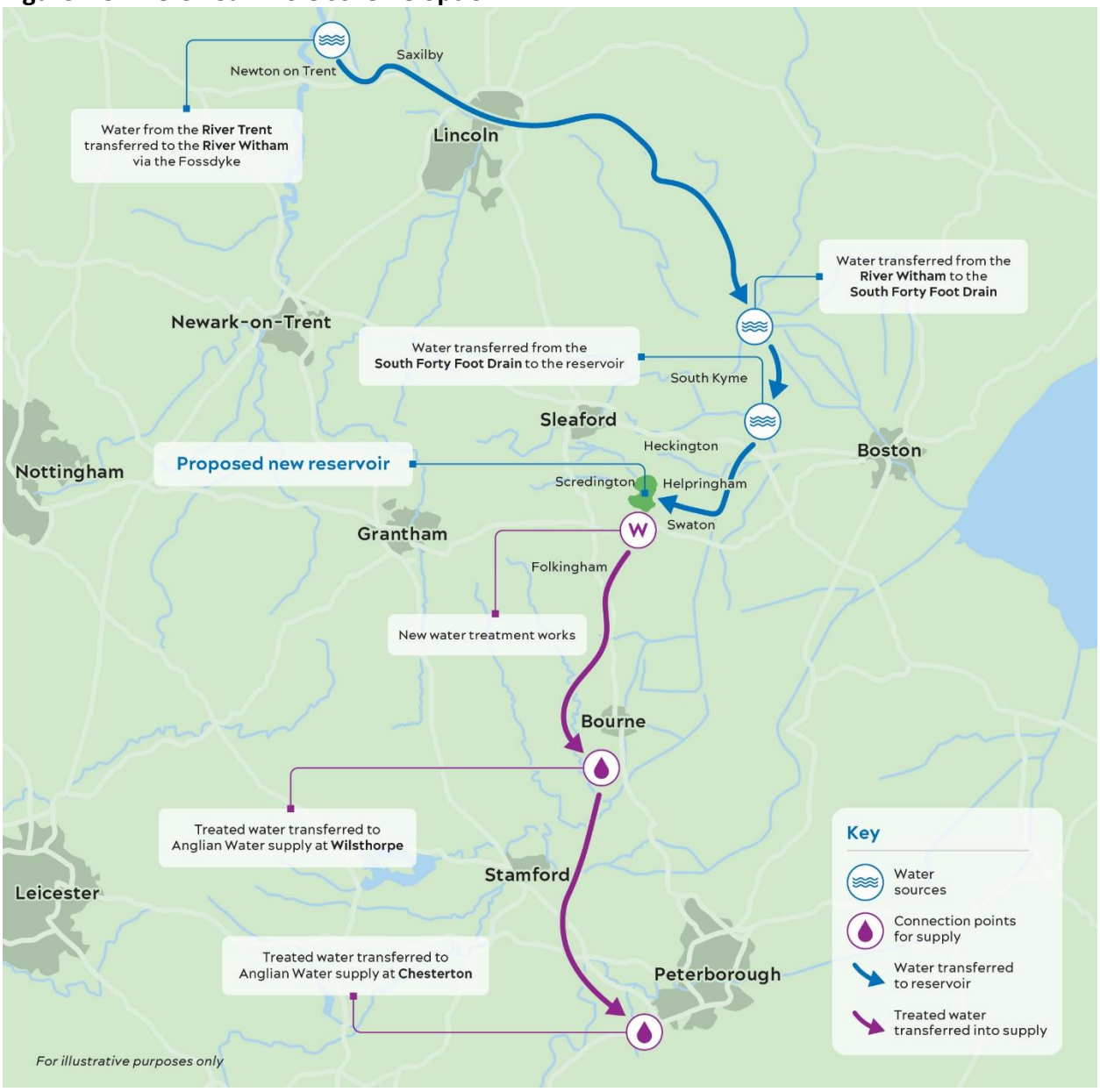
Anglian Water acknowledges the potential benefits and opportunities associated with the open channel transfer between the River Witham and South Forty Foot Drain, via the Kyme Eau, Holland Dyke and Skerth Drain (whole scheme option C and whole scheme option D).

There are two whole scheme options that could deliver these benefits. Out of these, whole scheme option C is preferred to whole scheme option D as whole scheme option C has less potential for environmental impacts associated with the downstream transfers.

Whilst the benefits and opportunities associated with the Kyme Eau open channel transfer are important to stakeholders including the Environment Agency, the higher costs of this option are not currently considered to offer the same level of value as the piped transfer. The options appraisal process has therefore identified whole scheme option A as the preferred whole scheme option when considered against whole scheme option C, as whole scheme option A has a lower whole life cost than whole scheme option C. Whole scheme option A also has lower WFD risks compared to whole scheme option C.

However, given cost is a prime differentiator between whole scheme option A and whole scheme option C and the strength of support for whole scheme option C from stakeholders in the region, Anglian Water is considering if alternative funding source(s) to progress whole scheme option C could be secured to meet the additional costs required. As such, both whole scheme option A and whole scheme option C are being considered at this stage of the process. However, to meet the overall project programme and achieve the planned DCO submission dates, the additional funding source(s) would need to be confirmed at the earliest opportunity to retain consideration of this option.

Figure E.5: Preferred whole scheme option



Supporting information

A series of documents has been published for the consultation. All of these can be viewed online at **www.lincsreservoir.co.uk/documents** and are available by contacting the project team.

Supporting Information	
Document Name	**Detail**
A guide to our proposals and phase two consultation	An overview of the phase two consultation, with more information about what is being consulting on, where to find out more about the proposals and how you can have your say.
Project fact sheets	Supporting information about the approach to a range of topics and important themes.
Reservoir	
Document Name	**Detail**
Phase two consultation – main site design brochure	Information on the emerging design for the main reservoir site and the factors considered to reach this point. This provides information about the initial opportunities for the features it could include, and how it is likely to operate.
Main site design report	An explanation of the emerging design for the reservoir site, and how this was developed.
Associated Water Infrastructure	
Document Name	**Detail**
Phase two consultation – associated water infrastructure proposals	Information about the proposals for drawing available water from the sources that have been identified, transferring the water to the reservoir, treating it, and supplying it to customers. This explains the infrastructure that may be needed, and the preferred options identified at this stage.
Options appraisal report	**This report –** An overview of the options appraisal process that has been carried out to identify the preferred options and sites for the associated water infrastructure. This explains the four stages (Stage A to D) of the appraisal process, how the options that were progressed for detailed assessment compared to one another, and the different combinations assessed to identify the proposals being taken forward at this stage.

1 Introduction

1.1 Introduction

1.1.1 This associated water infrastructure options appraisal report summarises the options appraisal process used to identify the best performing location for water infrastructure associated with the proposed Lincolnshire Reservoir. This chapter introduces the proposed Lincolnshire Reservoir and associated water infrastructure, outlines the strategic need for the reservoir, and describes the four-staged options appraisal process undertaken to identify the most suitable location and routing for associated water infrastructure required for operation of the reservoir.

1.1.2 This document provides a high level overview of the options appraisal process that has been undertaken to identify the preferred options and sites for the associated water infrastructure. This includes the four stages (Stage A to D) of the options appraisal process and an overview of the key differentiators of both the least constrained options assessed at Stage C and the whole scheme options (for the associated water infrastructure) assessed at Stage D. This is to show to consultees at this early stage of the Project development process the key differences that were considered as part of identifying the whole scheme options (for the associated water infrastructure) that are being taken forward at this stage. These whole scheme options are shown in the Associated Infrastructure Consultation Brochure.

1.1.3 The purpose of this document is to provide consultees with information to allow them to provide a view on both the whole scheme options (for the associated water infrastructure) Anglian Water is proposing to take forward, as well as the process undertaken to get to this point. This will help to develop the proposals further in the next stage of development.

1.1.4 A new storage reservoir in Lincolnshire, referred to as the Lincolnshire Reservoir, has been identified as one of several strategic resource options required to address increasing deficits in future public water supply. The reservoir, promoted by Anglian Water, is being progressed through the delivery framework overseen by the Regulators' Alliance for Progressing Infrastructure Development (RAPID) and is a Nationally Significant Infrastructure Project seeking consent through the Development Consent Order regime[2].

1.1.5 A comprehensive site selection process has been undertaken to determine the preferred location for this reservoir, which is proposed approximately 7km south-east of the town of Sleaford, within the North Kesteven District Council area (see Figure 1.1). It is located between a number of smaller villages and is approximately 1.2km north-west of Swaton, approximately 1km east of Scredington and approximately 1km

[2] https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/WA010003

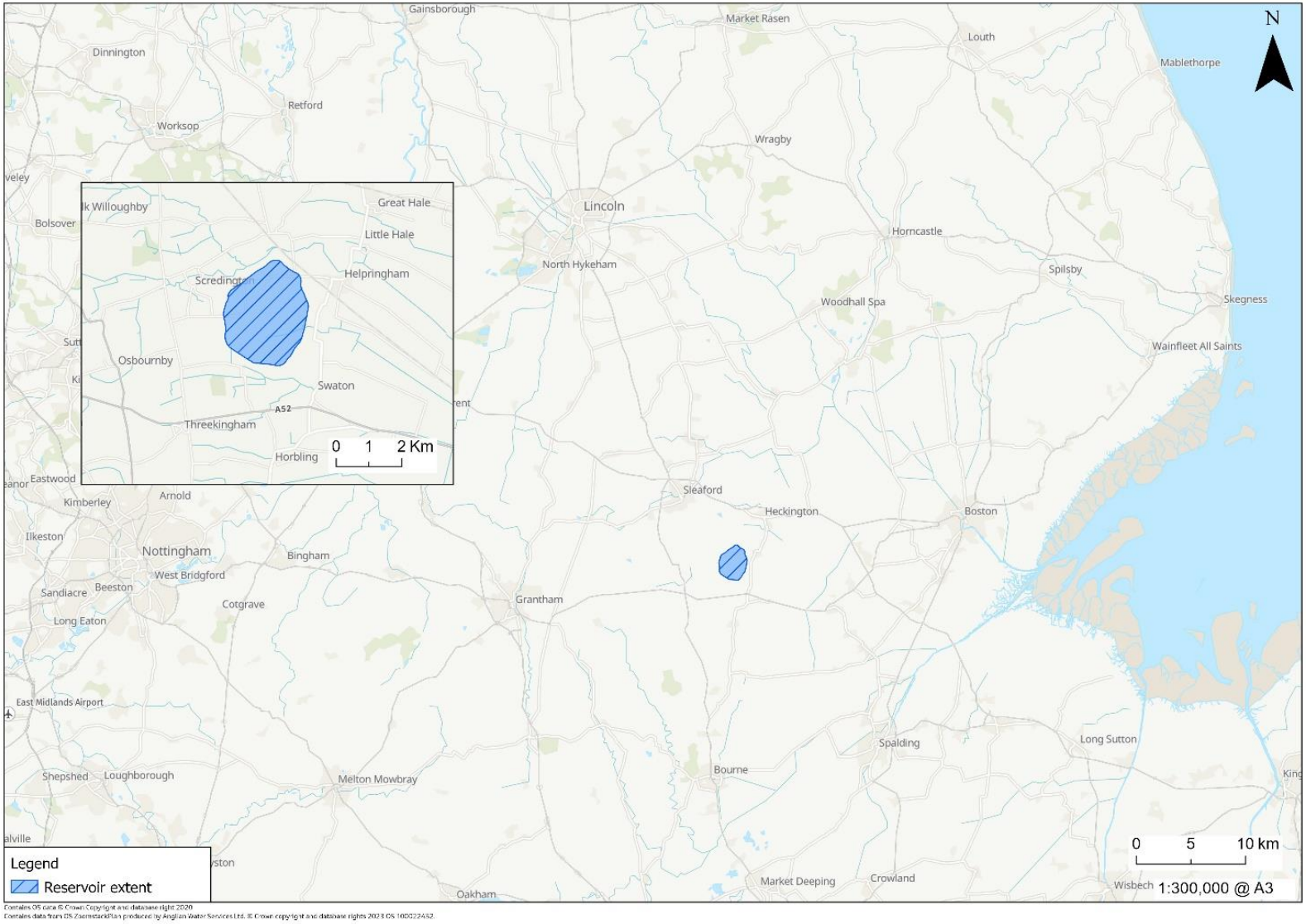
west of Helpringham. Further detail on the reservoir site selection process is set out in the site selection report for the Lincolnshire Reservoir[3], which was consulted on in phase one of the Project's consultation between October and December 2022.

1.1.6 Figure 1.1 shows the best performing site identified in the Lincolnshire Reservoir site selection process.

1.1.7 Following selection of the best-performing reservoir location, a comprehensive options appraisal process has been undertaken to identify the preferred options, including locations and corridors, for upstream infrastructure, and downstream infrastructure associated with the reservoir and disposal route for flows from an emergency drawdown event. This is referred to as the associated water infrastructure options appraisal. Further details on this process are set out in this report including the criteria applied, how stakeholders have inputted into the process and the engineering principles used to define the land required for the associated water infrastructure. This process sought to avoid or minimise potential adverse environmental, economic or social impacts and maximise potential benefits and potential opportunities that the associated water infrastructure may enable or facilitate.

[3] Anglian Water (2022), Site Selection Report for a Reservoir in Lincolnshire. Retrieved from: https://www.lincsreservoir.co.uk/assets/images/downloads/Site-Selection-Repor-Lincolnshire-Reservoir-phase-one-consultation-2022.pdf

Figure 1.1: The best performing site for the Lincolnshire Reservoir



1.2 Strategic need

1.2.1 The East of England is the driest and fastest-growing region in the country and is home to many unique and precious landscapes that rely on water. This creates particular challenges for Anglian Water. Weather is becoming more extreme and an increasing population and ambitious growth strategies place greater emphasis on the need for water supply resilience during extreme drought. Water abstraction from environmentally sensitive areas also needs to be reduced as set out in the National Framework for Water Resources[4].

1.2.2 The Water Resources East (WRE) Regional Water Resources Plan[5] and Anglian Water's revised draft Water Resources Management Plan 2024 (rdWRMP24)[6] set out a best value plan for meeting these challenges. Both plans have considered options to reduce demand for water, such as leakage reduction, and options to provide additional water. The scale of the challenge is such that it cannot be met through demand management solutions alone. The WRMP, as well as the WRE Regional Water Resources Plan, is supported by water resources modelling that has identified the need for two new strategic raw water reservoirs in the region to address part of the supply deficit – the Fens Reservoir and Lincolnshire Reservoir.

1.2.3 Modelling and analysis undertaken to inform the above-mentioned WRE regional plan and rdWRMP24 has shown that the reservoirs continue to be selected as low-regret, robust options. The reservoirs need to be delivered alongside a number of other solutions and policies, including desalination and other infrastructure projects, as well as reducing leakage and demand on water supplies, which are a key part of the plans for this region. Through delivering the reservoirs first, any required desalination plants could be delivered at a later stage, providing opportunity for technological developments that may increase the efficiency of these plants and reduce their energy requirements.

1.2.4 Whilst these reservoirs are a fundamental component to the long-term water resource plans in the region, providing a safe and resilient supply of drinking water, the reservoirs and their associated water infrastructure could also provide environmental, socio-economic and recreational benefits for surrounding communities.

1.2.5 For the Lincolnshire Reservoir, water resources modelling has confirmed in the WRE Regional Plan 2023 that the required reservoir capacity to meet public water supply

[4] Environment Agency (2020), Meeting Our Future Water Needs: a National Framework for Water Resources. Retrieved from: https://www.gov.uk/government/publications/meeting-our-future-water-needs-a-national-framework-for-water-resources

[5] WRE (2023), Regional Water Resources Plan for Eastern England. Retrieved from: https://wre.org.uk/wp-content/uploads/2023/12/WRE-Regional-Water-Resources-Plan-for-Eastern-England.pdf

[6] Anglian Water (2023), Our Water Resources Management Plan 2024, Revised Draft WRMP24, Main Document. Retrieved from: https://www.anglianwater.co.uk/siteassets/household/about-us/wrmp/revised_draft_wrmp24_main_report.pdf

requirements should be 55 million cubic metres (55,000 megalitres) to provide a supply of up to 169 megalitres per day (Ml/d) to Anglian Water.

1.3 The new storage reservoir and associated water infrastructure

1.3.1 In order to operate the Lincolnshire Reservoir to provide the resilient water supply identified, associated water infrastructure is required. This associated water infrastructure has been the focus of the options appraisal process set out in this document. The key features of the Lincolnshire Reservoir associated water infrastructure are illustrated in Figure 1.2 and comprise the following elements:

- **Upstream infrastructure** is required to abstract and transfer water from each identified source of water supply (see below) into the Lincolnshire Reservoir. This includes abstraction infrastructure for intakes, pumping stations and water treatment, including measures to prevent the spread of invasive species, where required, and raw water transfers, which could be utilising existing open channel transfers, building new pipelines, or a combination of both. Upstream infrastructure requirements are described in more detail in section 3.1.
- **Downstream infrastructure** is required to treat and transfer water from the Lincolnshire Reservoir into the identified connection points for the existing supply network. This includes water treatment works, treated water pipelines and service reservoirs. Downstream infrastructure requirements are described in more detail in section 4.1.
- **Emergency drawdown disposal route** element provides a route for the safe disposal of reservoir water in the event of an emergency which threatens the integrity of the reservoir embankment. The emergency drawdown disposal route is described in more detail in section 5.1.

1.3.2 The rdWRMP24 identified the following three possible sources of water supply for the Lincolnshire Reservoir:

- River Trent
- River Witham
- South Forty Foot Drain

1.3.3 These sources of supply are the required starting points of the upstream infrastructure for abstracted water to then be transferred to the end point at the Lincolnshire Reservoir. Further detail regarding the sources of supply is provided in Chapter 2.

1.3.4 The Lincolnshire Reservoir (which would store the abstracted water) is then the starting point for both the downstream infrastructure and the emergency drawdown disposal route.

1.3.5 Water from the reservoir will be used to meet public water supply requirements for Anglian Water's existing supply network. The rdWRMP24 identified that the water from Lincolnshire Reservoir would be transferred to the Ruthamford North water resource zone but did not identify specific connection points. The associated water infrastructure options appraisal process has considered connecting to the existing network at two existing Anglian Water distribution hubs within Ruthamford North during Stage A and Stage B: Etton and Chesterton, near Peterborough.

1.3.6 The rdWRMP24 also included a transfer from Ruthamford North water resource zone to Bourne water resource zone. An additional connection point at Wilsthorpe (an existing distribution hub in the Bourne water resource zone) was included in the associated water infrastructure options appraisal. Wilsthorpe is located between the Lincolnshire Reservoir and Ruthamford North and therefore this connection is an alternative to taking water to Ruthamford North and pumping it back to Bourne water resource zone.

1.3.7 Further consideration of specific connection points and integration with the existing Anglian Water network was undertaken in parallel with the options appraisal process to identify the points in the network for the associated water infrastructure to connect into. This concluded during Stage C of the associated water infrastructure options appraisal and identified two required connection points at (Etton was therefore not progressed as a connection point in Stage C):

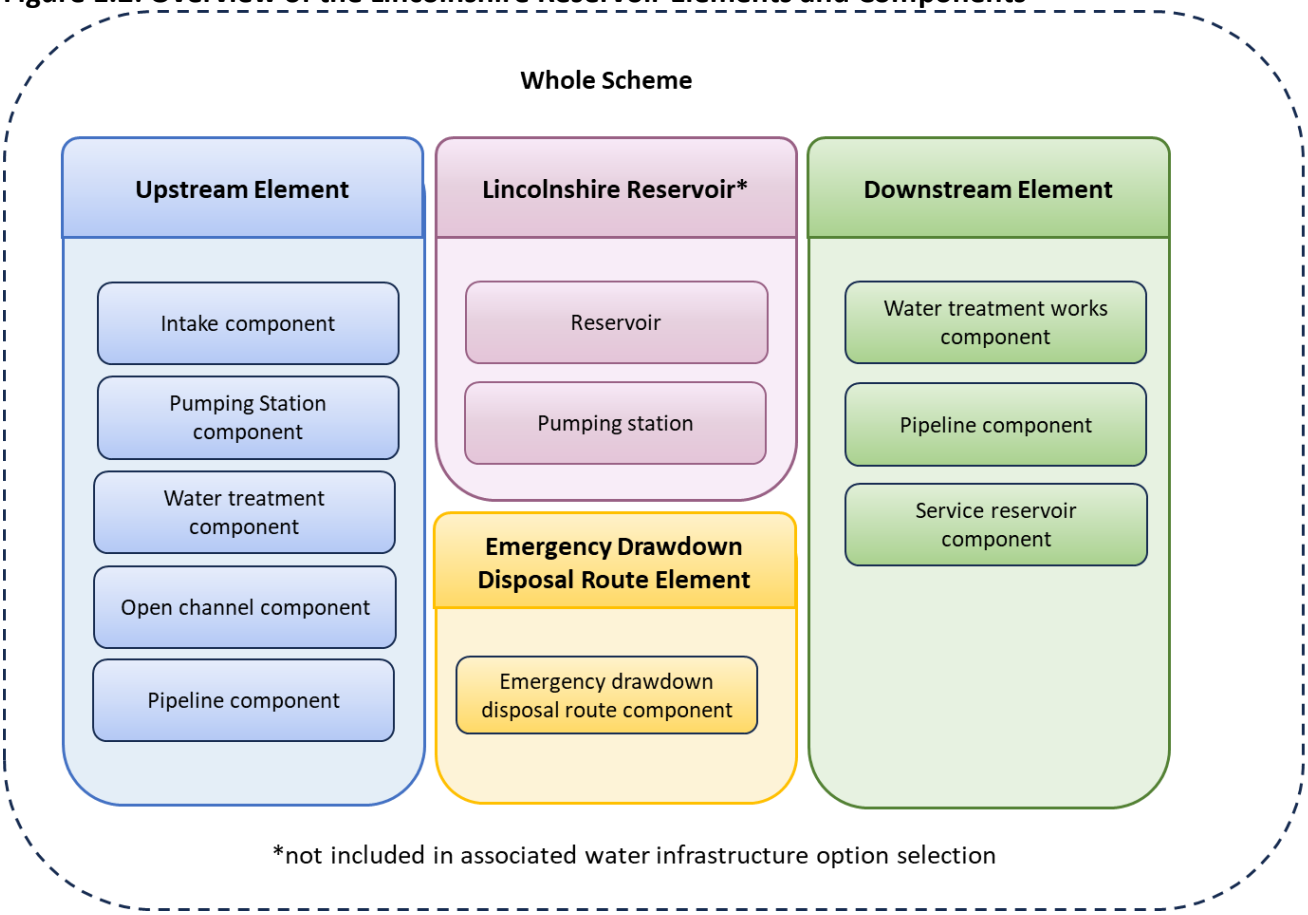
- Wilsthorpe
- Chesterton.

1.3.8 These connection points are the required end points of the downstream infrastructure for treated water originating from the Lincolnshire Reservoir.

1.3.9 For the purposes of the options appraisal process the above-detailed associated water infrastructure has been categorised as components and elements; see Figure 1.2.

- A component is a necessary part of an element that does not provide the whole solution for that element on its own. Examples of components are service reservoirs, transfer routes, pumping stations and water treatment works.
- Elements are the main features that combine to create a whole scheme and comprise upstream infrastructure, main reservoir site, downstream infrastructure, and the emergency drawdown disposal route.

Figure 1.2: Overview of the Lincolnshire Reservoir Elements and Components



1.3.10 The options appraisal process for associated water infrastructure that is the subject of this document is limited to the assessment of the upstream infrastructure, downstream infrastructure and the emergency drawdown disposal route elements.

1.4 The options appraisal process

1.4.1 Anglian Water has undertaken a four-stage options appraisal process to identify and assess potential options for the associated water infrastructure based on a broad range of community, planning, economic, environmental, and other technical criteria. This included looking at both constraints and potential benefits and opportunities. The list of criteria and at what stage in the process they were considered is set out in Appendix A.

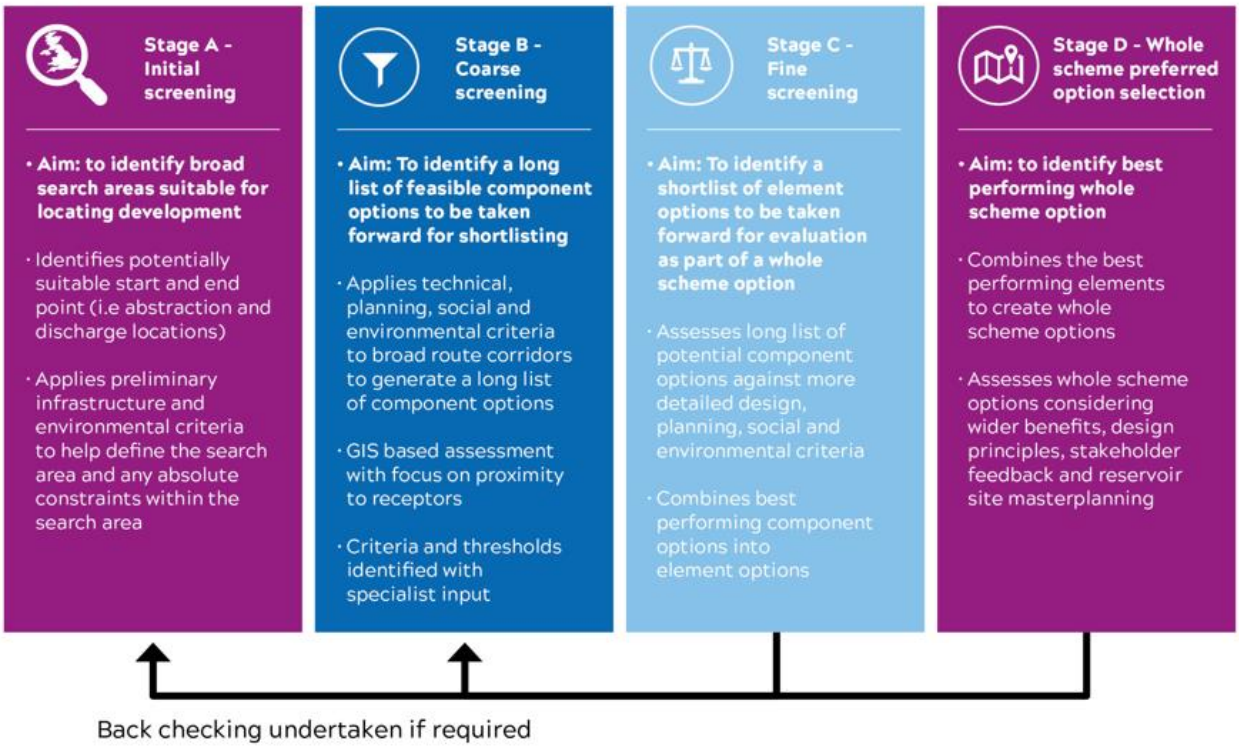
1.4.2 The criteria were selected as they would allow a robust technical, engineering and consenting appraisal to be completed against core legislative and policy requirements that would be factors in the future consenting and decision-making processes. These criteria were developed using Government policy and regulations, including:

- National Policy Statement (NPS) for Water Resources Infrastructure (April 2023)

- Infrastructure Planning (Environmental Impact Assessment) Regulations 2017
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2017
- The Conservation of Habitats and Species Regulations 2017 (as amended).

1.4.3 National Planning Policy Framework (2023). The process has been aligned with the site selection process undertaken for the reservoir. This comprehensive, staged options appraisal process is summarised in Figure 1.3.

Figure 1.3: Staged options appraisal process for the Lincolnshire Reservoir and associated water infrastructure



1.4.4 A fundamental aspect of the options appraisal process has been the consideration of relevant national policy and in particular, the NPS for Water Resources Infrastructure[7].

1.4.5 The four stages of the options appraisal process were as follows.

1.4.6 **Stage A – initial screening** comprised a high-level review of specific strategic constraints to identify broad search areas suitable for the siting of the associated water infrastructure.

[7] Defra (2023), National Policy Statement for Water Resources Infrastructure. Retrieved from: National Policy Statement for Water Resources Infrastructure (publishing.service.gov.uk)

1.4.7 **Stage B – coarse screening** comprised the identification of suitable locations to accommodate the upstream infrastructure component options, downstream infrastructure component options and emergency drawdown disposal route component options within the broad search areas identified at Stage A. The listed component options were screened against a range of environmental, engineering, planning, land use and social constraints. The Sequential Test for flood risk was carried out to identify suitable areas for above-ground infrastructure taking account of the components flood risk vulnerability. Component options that were least constrained were recommended to be taken forward to the next stage. However, some of the options progressed have potential consenting risk that needed more detailed consideration at Stage C in the context of the alternative options also being considered at that stage.

1.4.8 At **Stage C – fine screening**, the list of component options was subject to more detailed assessments against engineering, environmental, social, planning and land use criteria, to understand potential constraints, and benefits for each option and to identify any key differentiators between the options. Best performing component options were identified based on performance against these criteria and stakeholder feedback received on individual component options was also considered at this stage. The best performing component options were combined to form element options. These element options were then considered, with the best performing element options being taken forward to Stage D.

1.4.9 **Stage D – preferred whole scheme options appraisal** combined the best-performing element options identified at Stage C to create whole scheme options for the associated water infrastructure[8]. A comparative review was then undertaken taking into consideration the appraisals undertaken at Stage C. This allowed the multiple strengths and weaknesses of the whole scheme options to be weighed up against one another in a subject matter expert-led comparative review to identify the best performing whole scheme option for the associated water infrastructure.

1.4.10 The identification of broad search areas (Stage A) and component options (Stage B) was undertaken using geospatial data and mapping software. Readily available datasets for Stage A and B constraints, as listed in Appendix A were considered alongside component-specific requirements and professional judgement to identify the search areas and component options.

1.4.11 Further detail about each stage of the associated water infrastructure options appraisal process is provided in the following chapters.

[8] The Lincolnshire Reservoir forms part of the whole scheme. The location of the reservoir has been the subject of a separate options appraisal process and is therefore not included as part of the associated water infrastructure options appraisal.

1.5 Stakeholder engagement

1.5.1 Throughout the options appraisal process, stakeholders were invited to comment on the process and outcomes of the four stages of the process. The stakeholders that were engaged with, included:

- A dedicated forum comprising the following statutory bodies, engaged with owing to the statutory function of the organisation and technical knowledge: Natural England, Historic England, Environment Agency, the Black Sluice Internal Drainage Board and the relevant local planning authorities.
- Members of the pre-existing Lincolnshire Reservoir Water Partnership group comprising statutory bodies and local non-statutory groups with interests and technical expertise including in local nature conservation, heritage and water resources. The Lincolnshire Reservoir Water Partnership also played a valuable peer review role.

1.5.2 The dedicated forum and the Lincolnshire Reservoir Water Partnership were engaged from early 2023 on the approach to the options appraisal process (Stage A to D), the criteria used at Stage B and Stage C, and the emerging results as the Project progressed through the process. Feedback was invited following each engagement, and this was used to inform the options appraisal process. Specifically:

- In June 2023, a briefing was held with the dedicated forum and the Lincolnshire Reservoir Water Partnership outlining the options appraisal approach. Details of the criteria to be used during Stages B and C of the options appraisal were circulated to the members of the dedicated forum and the Lincolnshire Reservoir Water Partnership at this time.
- In August 2023 the results of Stage A were presented to the dedicated forum and the Lincolnshire Reservoir Water Partnership, along with an early indication of the progress of the Stage B options identification.
- In September 2023 the results of Stage B were presented.
- In October 2023 a workshop was held with the dedicated forum and the Lincolnshire Reservoir Water Partnership to capture benefits and opportunities relating to the associated water infrastructure options so that they could be considered during Stage C and D of the options appraisal.
- In January 2024 the results of Stage C were presented.
- In early May 2024 the results of Stage D were presented.

1.5.3 At the conclusion of Stage C of the options selection process, the relevant local planning authorities could be identified with respect to the emerging best performing

element options. These newly identified local planning authorities were invited to the Stage C dedicated forum to provide their feedback.

1.5.4 Feedback to each stage of the options appraisal process was requested within two weeks of the presentation of each stage to enable comments to be considered in the subsequent stage of the options appraisal process. All feedback was captured in agreed meetings records and recorded by the Project team for response. This enabled the options appraisal process to be meaningfully influenced by the stakeholder feedback and stakeholders were made aware of the regard to their feedback in writing and through subsequent meetings.

1.5.5 The iterative engagement allowed a check and review process to be applied with stakeholder input informing the selection of the best performing associated water infrastructure options.

1.5.6 Feedback from stakeholders focussed on key constraints and sensitivities that could be considered, including the identification of designated assets and sites and the need to properly assess and understand potential impacts on those designations to inform decision making. This feedback has been considered as the options appraisal process has progressed, including considering these key constraints and sensitivities at Stage B to identify least constrained options and in Stage C assessments to understand potential risks based on the information available at this early stage in the process. More detailed environmental assessments will be undertaken on the preferred option(s) at the next stage of the development process.

1.6 Supporting Information

1.6.1 A series of documents has been published for the consultation. All of these can be viewed online at **www.lincsreservoir.co.uk/documents** and are available by contacting the project team.

Supporting Information	
Document Name	**Detail**
A guide to our proposals and phase two consultation	An overview of the phase two consultation, with more information about what is being consulting on, where to find out more about the proposals and how you can have your say.
Project fact sheets	Supporting information about the approach to a range of topics and important themes.
Reservoir	
Document Name	**Detail**
Phase two consultation – main site design brochure	Information on the emerging design for the main reservoir site and the factors considered to reach this point. This provides information about the initial opportunities for the features it could include, and how it is likely to operate.

Supporting Information	
Document Name	**Detail**
Main site design report	An explanation of the emerging design for the reservoir site, and how this was developed.
Associated Water Infrastructure	
Document Name	**Detail**
Phase two consultation – associated water infrastructure proposals	Information about the proposals for drawing available water from the sources that have been identified, transferring the water to the reservoir, treating it, and supplying it to customers. This explains the infrastructure that may be needed, and the preferred options identified at this stage.
Options appraisal report	**This report –** An overview of the options appraisal process that has been carried out to identify the preferred options and sites for the associated water infrastructure. This explains the four stages (Stage A to D) of the appraisal process, how the options that were progressed for detailed assessment compared to one another, and the different combinations assessed to identify the proposals being taken forward at this stage.

2 Sources of supply assessment

2.1.1 This chapter outlines the approach and results of the process undertaken to confirm the preferred sources of supply for the Lincolnshire Reservoir.

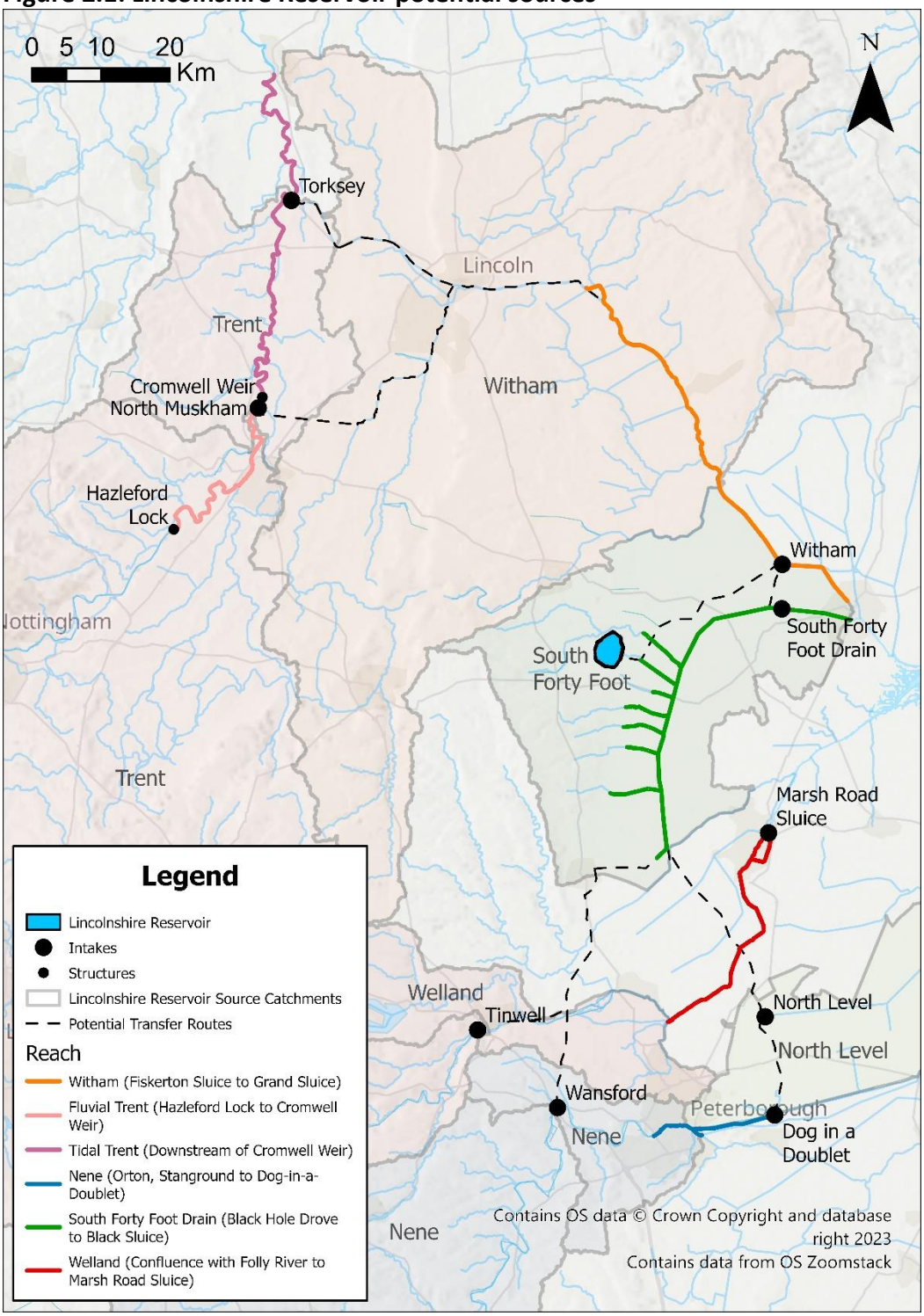
2.1.2 Anglian Water's rdWRMP24[9] identified three potential sources of supply to fill the Lincolnshire Reservoir, as described below:

- **South Forty Foot Drain** is being considered as a potential source to supply the reservoir given its proximity to the reservoir site and as its potential function as a transfer route for bringing water from the River Witham to the reservoir.
- **River Witham** catchment serves as an important source in its own right, in addition to its function as a transfer route to bring water from the Trent towards the reservoir. It is proposed to transfer water from the Witham at times when it is not possible to abstract the required supply from the South Forty Foot Drain
- **River Trent** which has significant water availability and provides a resilient source for the Lincolnshire Reservoir. This can help supplement the River Witham source. It is proposed to transfer, either by pipeline, open channel transfer, or a combination of both, water from the River Trent to the River Witham at times when it is not possible to abstract the required supply from just the River Witham or the South Forty Foot Drain.

2.1.3 A sources of supply assessment was undertaken that used the Environment Agency's Abstraction Licensing Strategies[10] to identify a long list of sources within a 50km radius of the proposed reservoir location. The 50km radius was considered a practical limit based on professional judgement due to the complexity, cost and carbon emissions which increase significantly the further the water needs to be transferred from source to reservoir. In addition to the sources of supply identified in the rdWRMP24 set out in paragraph 2.1.2, these additional potential sources include the River Nene, the River Welland, North Level IDB, Welland and Deepings IDB and the River Glen.

[9] https://www.anglianwater.co.uk/siteassets/household/about-us/wrmp/revised_draft_wrmp24_main_report.pdf
[10] Environment Agency (2023), Abstraction licensing strategies (CAMS process). Retrieved from: https://www.gov.uk/government/collections/water-abstraction-licensing-strategies-cams-process

Figure 2.1: Lincolnshire Reservoir potential sources



2.1.4 A staged process was followed to appraise the potential sources identified. Initially, the reservoir yield from each individual potential source was considered, under climate

change conditions with a 1 in 500-year drought[11] (in accordance with Water Resources Planning Guideline[12]). The Welland and Deepings IDB and the River Glen did not provide a reliable yield and so did not progress, the remaining potential sources are shown in Figure 2.1.

2.1.5 Source combinations were then assessed to identify the preferred source of supply options for the Lincolnshire Reservoir.

- All options that include the River Trent also include the River Witham, which is required to transfer water to the reservoir. There is an existing connection between the tidal River Trent and the River Witham via the Fossdyke Canal.
- The River Trent is essential in order to realise the required reservoir yield as set out in the rdWRMP24.
- Abstracting from the tidal River Trent provides a higher estimated reservoir yield compared to abstracting from the fluvial River Trent, due to greater water availability in the tidal River Trent.
- When combined, several source options provided minimal additional yield and were not progressed. These were the River Nene, River Welland and North Level IDB.

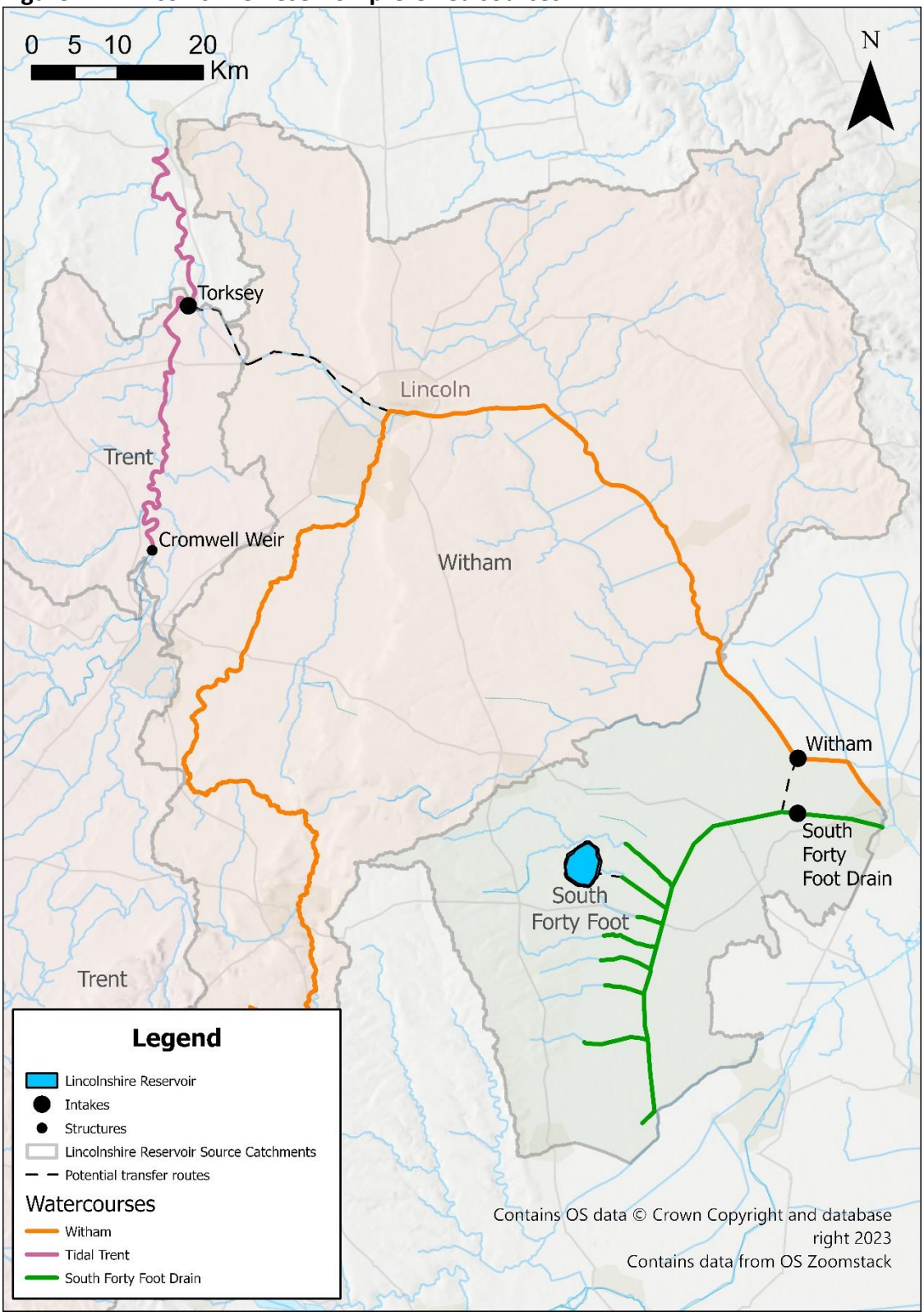
2.1.6 The sources of supply assessment concluded that the preferred sources were the South Forty Foot Drain, River Witham and the tidal River Trent. The sources of supply assessment also considered the presence of water level management structures, such as weirs and sluices, and inflows of water from tributaries to define the abstraction reach for each of the sources, as listed below and on Figure 2.1:

- The tidal River Trent, defined as the reach downstream of Cromwell Weir.
- The River Witham, defined as the reach from Fiskerton Sluice to Grand Sluice.
- South Forty Foot Drain, defined as the reach from Black Hole Drove to Black Sluice.

2.1.7 At Stage A associated water infrastructure options were considered for both the fluvial River Trent (upstream of Cromwell Weir) and the tidal River Trent (downstream of Cromwell Weir). The sources of supply assessment, which occurred in parallel to the options appraisal process, concluded during Stage B that the South Forty Foot Drain, the River Witham and tidal River Trent is the preferred combination of sources. As a result, the transfer options from the fluvial River Trent (upstream of Cromwell Weir) were not progressed through the Stage B assessments.

[11] Climate change assessments have mirrored those adopted in the rdWRMP24, considering the most robust level of assessment (Tier 3 in the WRPG supporting guidance).
[12] Water resources planning guideline - GOV.UK (www.gov.uk)

Figure 2.2: Lincolnshire Reservoir preferred sources



3 Upstream infrastructure

3.1 Introduction

3.1.1 This chapter outlines the approach and results of the first three stages of the options appraisal process (initial screening, coarse screening and fine screening) for the upstream infrastructure. This included identifying the broad search areas (Stage A), defining feasible upstream component options and undertaking initial assessment (Stage B) and undertaking further component option assessments and determining the preferred component options and element options (Stage C) for progression to Stage D for identifying the best-performing whole scheme option (associated water infrastructure).

3.1.2 Upstream infrastructure is required to abstract raw water from the preferred sources and transfer this water to the Lincolnshire Reservoir. The start of each transfer is therefore defined by the source, and the end of the transfers is the reservoir.

3.1.3 Upstream infrastructure elements were identified for each source of supply:

- River Trent to the Lincolnshire Reservoir.
- River Witham to the Lincolnshire Reservoir.
- South Forty Foot Drain to the Lincolnshire Reservoir.

3.1.4 There are no existing facilities for transferring water between the identified sources and the Lincolnshire Reservoir location and therefore some form of new transfer infrastructure is required.

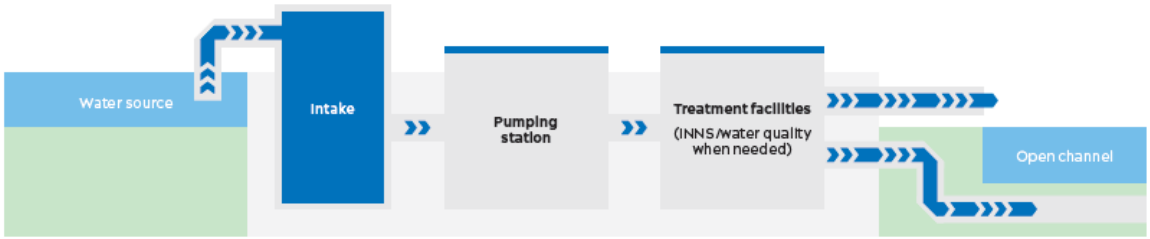
3.1.5 The upstream infrastructure elements include the following components, as shown in Figure 3.1.

- **Abstraction infrastructure** is required to collect the water from the source watercourse, and where necessary treat it, so that it can be transferred to the reservoir. The abstraction infrastructure can be either all on the same site or split over multiple sites in relation to the same source. For example multiple sites may be required in order to locate treatment works outside of Flood Zone 3b (see paragraph 3.3.15). Abstraction infrastructure may include the following, depending on the particular source/circumstances:
  - River intakes – this is a structure built into the bank of the river or channel. It would include a screen to exclude any debris, such as branches or leaves, from being collected.

- Raw water pumping stations, which would lift the water either into the transfer infrastructure (see below) or to a treatment works if the river water needs treatment before being transferred.
- Treatment works may be required in some cases to remove any invasive non-native species (INNS) present (see paragraph 3.1.7) and/or to achieve the required water quality when moving water between river catchments (see paragraph 3.1.6).

- **Upstream transfer**, which would convey water from the required abstraction infrastructure to the reservoir.
  - Existing rivers and channels that flow in the direction needed for the transfers could be used as part of the transfer, a map of the major watercourses around the Lincolnshire Reservoir is included in Appendix B.
  - New pipelines have also been considered for transferring water and could be used in combination with rivers and channels, or on their own.
  - Development of new open channel transfers covering the full distance from sources to the reservoir have been excluded from the associated water infrastructure options appraisal process due to the potential environmental impact, land requirements, likely carbon emissions and cost considerations of an infrastructure pipeline solution for the full distance, compared to utilising existing open channel transfers where practicable.

Figure 3.1: Indicative arrangement of upstream infrastructure



3.1.6 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (WFD) sets out requirements to prevent the deterioration of the status of water bodies (e.g. rivers, lakes and groundwater) and to support the achievement of the environmental objectives for water bodies. WFD water bodies in the UK have been allocated a specific status based on water quality and ability to support wildlife. Within Lincolnshire the different water bodies (shown in Appendix C) have different statuses and different justification for their respective status. Where water is transferred from one WFD water body to another, care must be taken not to reduce the water quality of the receiving WFD water body. In such cases, water quality treatment may be required before discharging the water into the receiving WFD water body. This may be required

either where the receiving water body is of higher water quality than the water being introduced or where there is a water body objective to improve the quality of the receiving water.

3.1.7 The transfer of water creates a risk of either introducing INNS or encouraging the spread of INNS present in one water body or catchment to another. This can have implications for biodiversity, ecosystems and operation of the associated water infrastructure. This is generally a risk where new transfers are proposed between different water bodies and catchments, especially where these are not already connected. Conversely, where these water bodies are already connected, the proposed change to INNS risk may yet be sufficiently low to not warrant such treatment. Further engagement and investigation would therefore be required to identify the risk of spread and associated level of INNS prevention, mitigation and/or treatment required.

3.2 Stage A – Initial screening

3.2.1 Initial screening was completed to identify broad search areas (in which the abstraction infrastructure and upstream transfers could be feasibly sited) for each of the identified potential sources of supply, other than the South Forty Foot Drain. These broad search areas are shown in Figure 3.7.

3.2.2 The reason that no search area was defined for the South Forty Foot Drain is that it is close to the Lincolnshire Reservoir site (approximately 5km east) and furthermore it is also the identified flow route for discharging water from the reservoir during emergency drawdown (see Section 5). A transfer route is needed between the reservoir and the South Forty Foot Drain and this was considered as part of the emergency drawdown disposal route options appraisal. The same transfer, between the South Forty Foot Drain and the reservoir, would be used for both emergency drawdown disposal and upstream transfer.

3.2.3 Water arriving at the Lincolnshire Reservoir by open channel will require further pumping to transfer water from the channel to the reservoir. This final pumping station would be at the reservoir site, close to the transfer channel, and therefore the exact location is being identified as part of the reservoir site masterplanning and design process, to allow the pumping station to be integrated into the overall reservoir site design. The location of this final pumping station is therefore not considered as part of the associated water infrastructure options appraisal.

3.2.4 As part of identifying broad search areas, component-specific requirements were considered. For example:

- Intakes and raw water pumping stations would need to be sited close to the source water body in order to facilitate the abstraction of water.

- Water quality and INNS treatment should preferably be located close to the source and within the same source catchment so that operational discharges from the treatment works would remain within the source catchment. This would reduce the risk of introducing invasive species or poorer quality water into a different catchment, as well as reducing the risk of INNS impacting the operability of the associated water infrastructure.

Identification of existing open channels with potential to be used for upstream transfers

3.2.5 Potential upstream existing open channel route options that could enable water transfer, or part of a transfer, have been identified by identifying main river and high-level carriers that could be used to convey water between the abstraction and discharge locations and through engagement with the Lincolnshire Reservoir Water Partnership.

3.2.6 In principle, transfers that utilise existing open channels are considered preferable to pipeline transfers, where alternative options performed similarly, as they could unlock potential benefits to the environment, and also may facilitate multi-sector opportunities. These potential benefits and opportunities could include the incorporation of habitat for wildlife, improvement of navigation routes and mitigation of flood risk.

3.2.7 Existing open channels may not be able to facilitate a transfer from the source of supply to the reservoir, as they may not pass close to both a source and the reservoir site. Short sections of new open channel or pipelines may therefore be required to complete the transfer from source to the reservoir. These sections new open channel or pipeline as part of the longer transfer route have been considered in Stage B of the options appraisal process.

3.2.8 Existing open channel transfer options were identified that could convey raw water from the sources towards the Lincolnshire Reservoir in combination with either each other or with pipelines:

- River Trent to River Witham
  - Fossdyke (from the Trent to the Witham).
  - River Till, a tributary of the Fossdyke.
  - Boultham Catchwater, a tributary of the River Witham.
- River Witham to Lincolnshire Reservoir
  - South Forty Foot Drain.
  - Kyme Eau and Skerth Drain.

Pipeline infrastructure search areas

3.2.9 Pipeline corridor search areas have been identified from each of the sources and these are shown in Figure 3.7 and are listed below:

- River Trent to River Witham
  - Fluvial River Trent to River Witham search area. (Note that options from the fluvial River Trent were not progressed through Stage B as the sources of supply assessment did not identify this as a preferred source.)
  - Tidal River Trent to River Witham search area.
  - Tidal River Trent to River Till search area.
  - Tidal River Trent to Fossdyke search area.
- River Witham to Lincolnshire Reservoir
  - River Witham to the Lincolnshire Reservoir search area.
  - River Witham to the South Forty Foot Drain search area.
  - South Kyme Eau to Skerth Drain search area.

3.2.10 Search areas for pipeline corridors have been identified by firstly measuring the shortest, direct distance between the start and end of the potential transfers listed in paragraph 3.2.9. The search area was then defined based on limiting the maximum direct route between the start and end of the potential transfers to 1.5 times the shortest direct route. This limit was applied to avoid excessively long pipeline routes, taking account of environmental, carbon, resource use and cost factors for both construction and operational phases of delivery that increase with the length of any pipeline. The multiplier of 1.5 was used to define the extent of the search area as professional judgement suggested this would provide a practical limit, whereby pipelines extending beyond these bounds were likely to be prohibitively long. The search areas were not allowed to extend beyond the limits of the abstraction reaches defined by the sources of supply assessment, see paragraph 2.1.6. The search areas for pipelines from the fluvial River Trent to River Witham is shown in Figure 3.2 and the search area for the pipelines from the tidal River Trent to the River Witham are shown in Figure 3.3.

Figure 3.2: Stage A search area for fluvial River Trent to River Witham pipeline routes

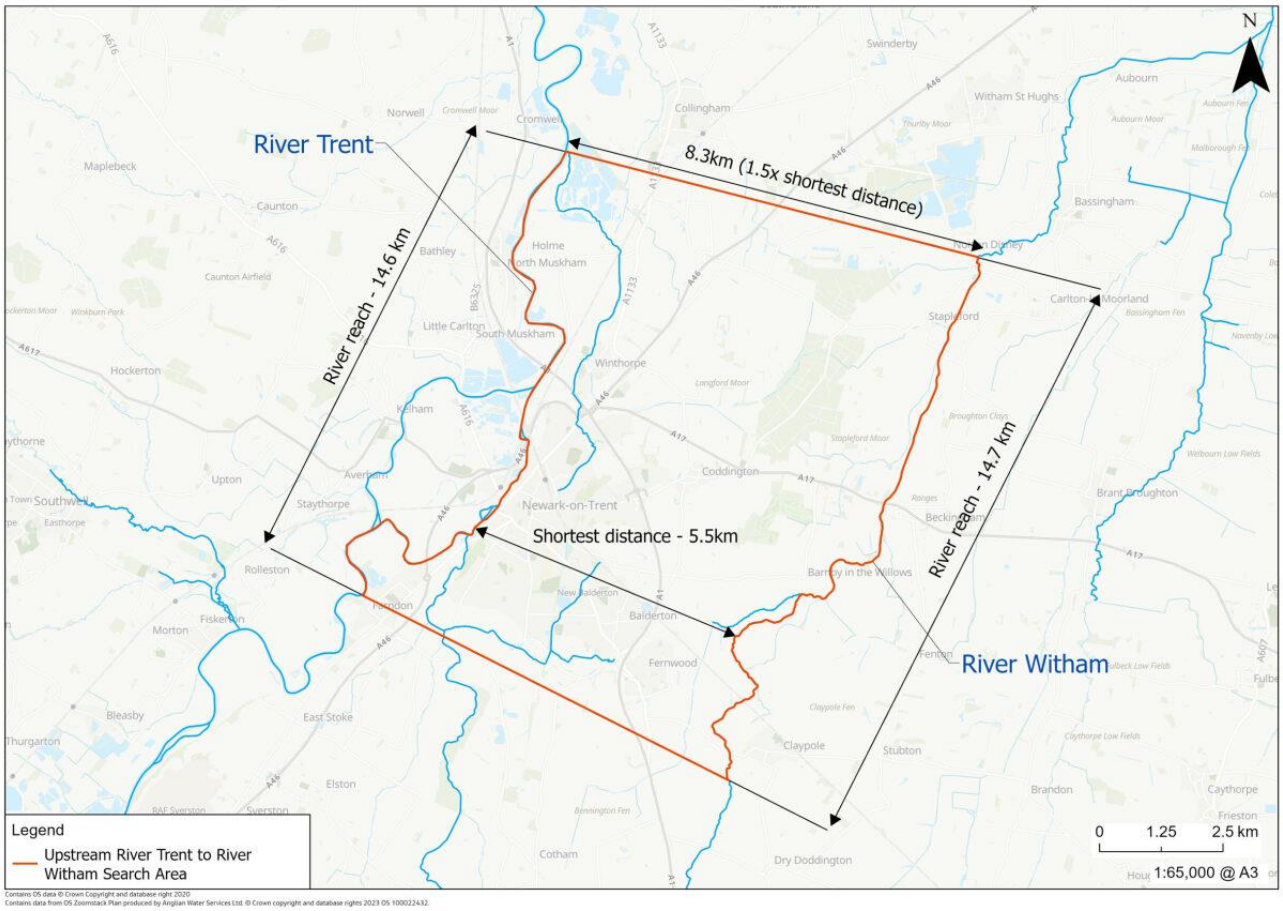
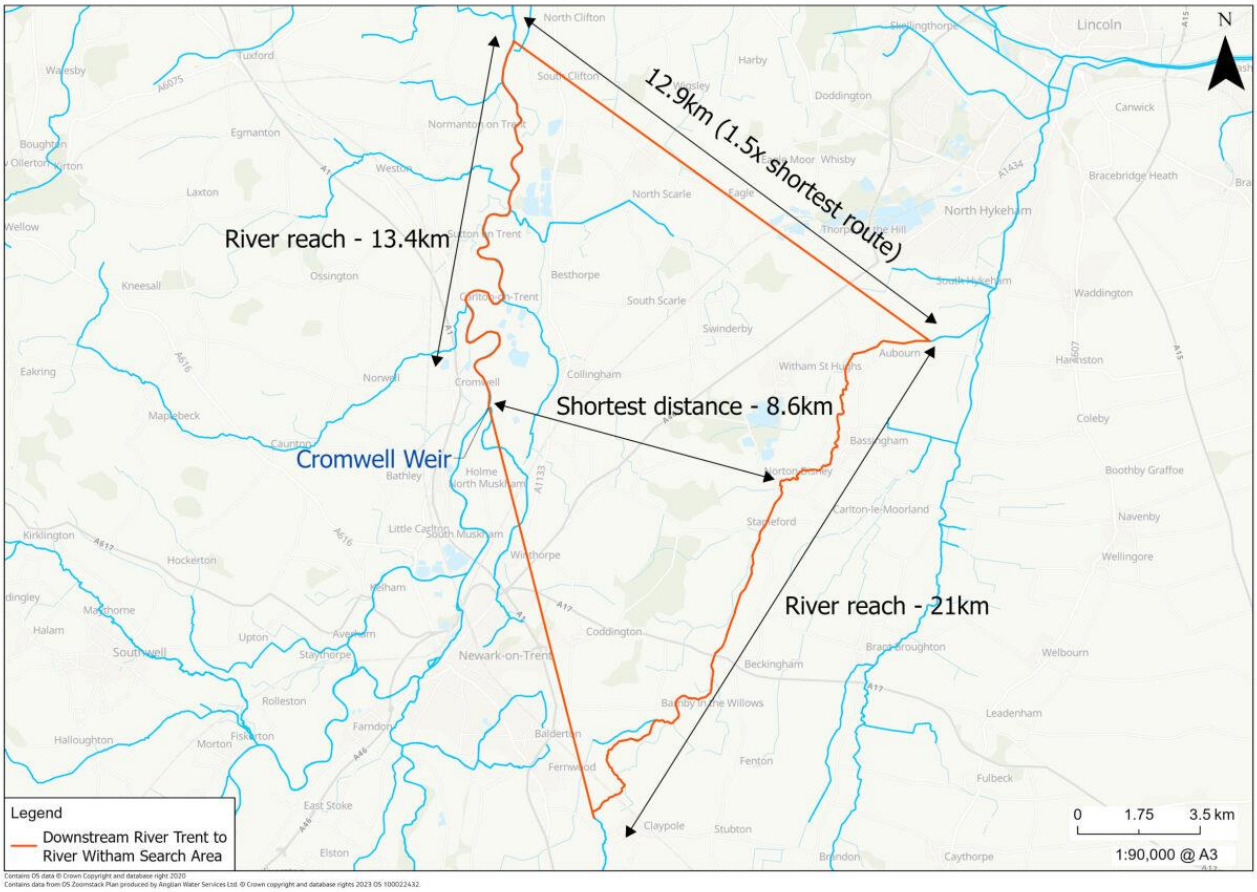


Figure 3.3: Stage A search area for tidal River Trent to River Witham pipeline routes



3.2.11 For some of the potential transfers this approach was adapted to better suit the specific transfer, as described below.

- The River Trent and the Fossdyke meet at Torksey Lock and therefore it is not possible to define a shortest direct distance between. In order to define the search area for the River Trent to Fossdyke pipeline options, the minimum length of 10km reach of river was measured along the Fossdyke, as well as north and south along the River Trent from Torksey Lock. A distance of 10km was used based on professional judgement to provide a practical limit to define the search area, see Figure 3.4.
- For the River Trent to River Till transfer the discharge reach on the River Till was defined as between the upstream end of the Main River stretch of the River Till and the confluence of the River Till with the Fossdyke. The search area for the River Trent to River Till pipeline options was the defined such that the maximum direct route from the River Trent to each end of the discharge reach was 1.5 times shortest direct route from the River Trent to the River Till, see Figure 3.5.

- The River Witham and the South Forty Foot Drain meet at Black Sluice Lock and therefore it is not possible to define the shortest direst distance between them. In order to define the search area for River Witham and the South Forty Foot Drain pipeline options, the minimum length of 10km reach of river was measured along the River Witham and the South Forty Foot Drain, see Figure 3.6.
- The western boundary of the Kyme Eau to Skerth Drain search area was defined as Clay Bank Road based on the hydrological restrictions it imposes on both the Kyme Eau and Skerth Drain.

Figure 3.4: Stage A search area for River Trent to Fossdyke pipeline routes

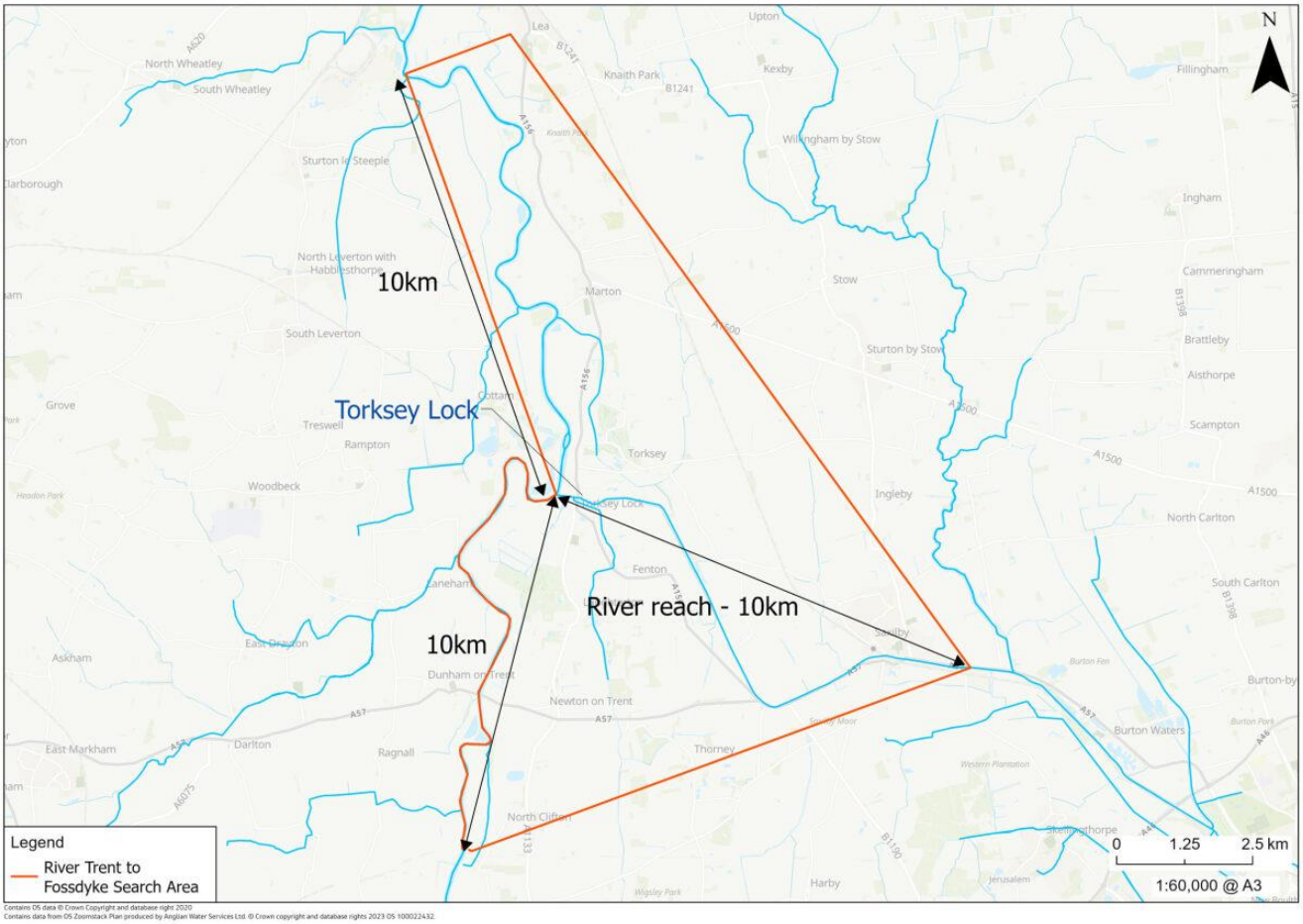


Figure 3.5: Stage A search area for River Trent to River Till pipeline routes

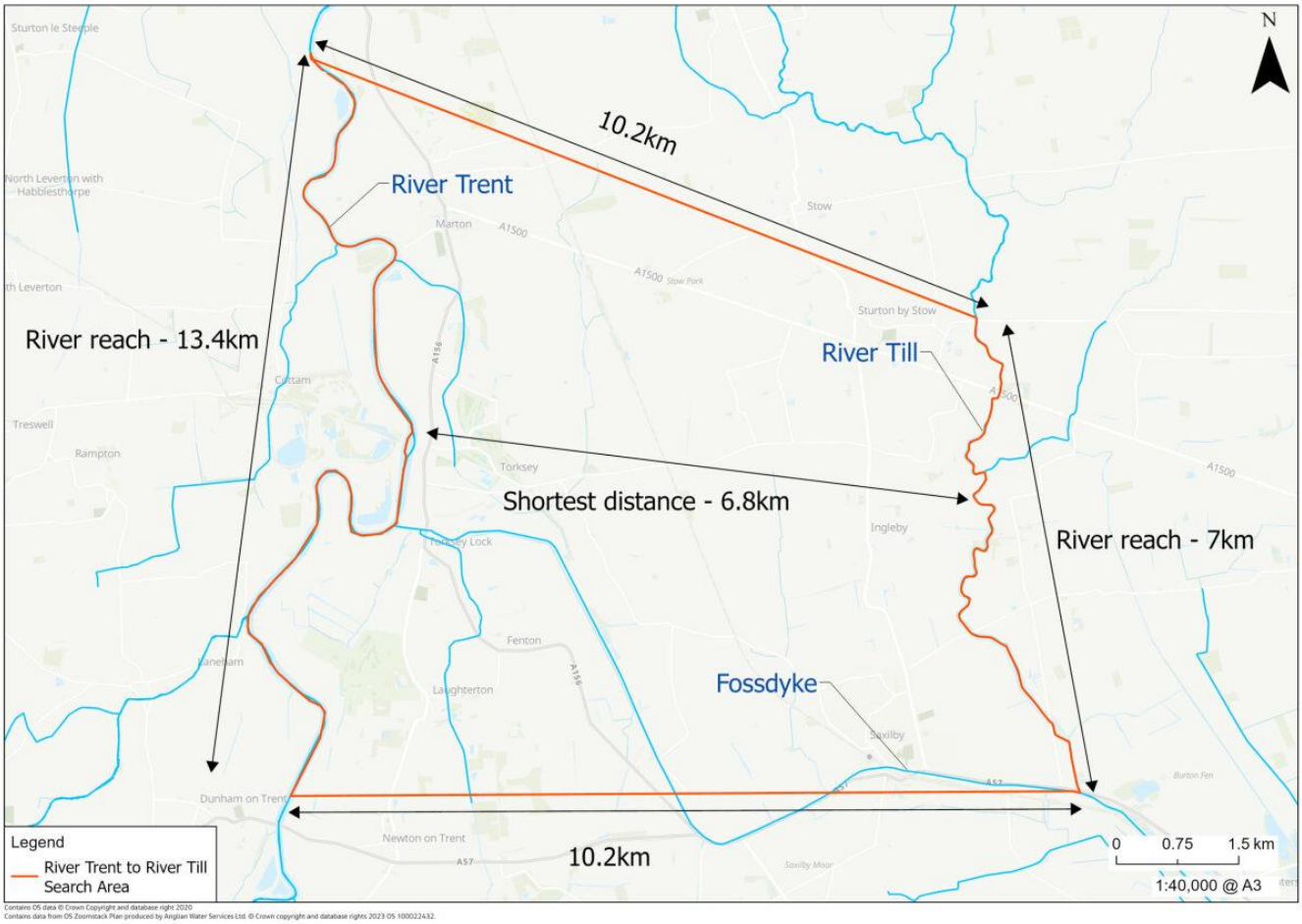
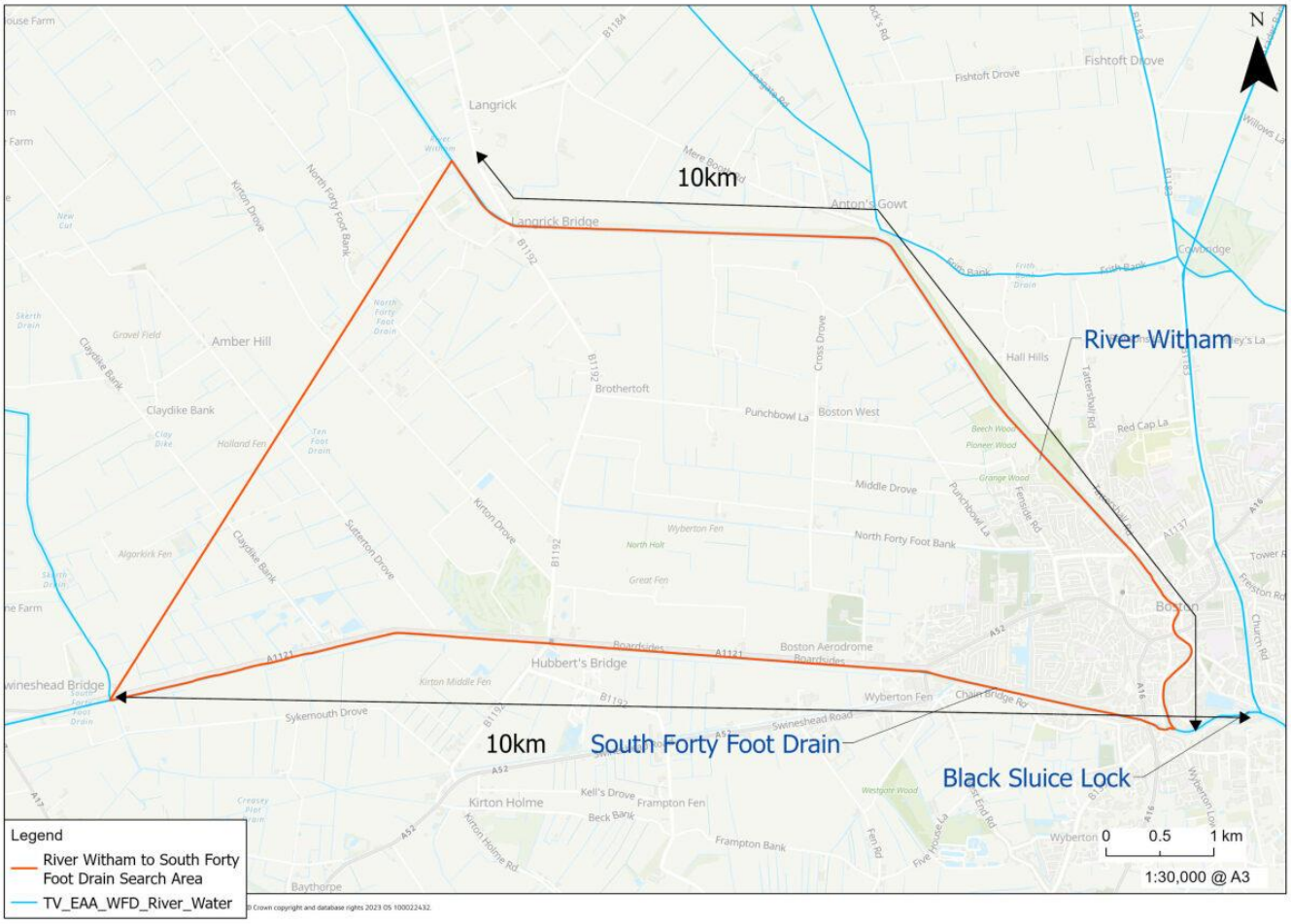


Figure 3.6: Stage A search area for River Witham to South Forty Foot pipeline routes



3.2.12 No search area was developed for a pipeline transfer direct from the River Trent to the Lincolnshire Reservoir. The shortest direct distance between the River Trent and the Lincolnshire Reservoir is at least four times greater than the shortest direct transfer between the River Trent and the River Witham, which has already been identified as the preferred transfer route for this part of the upstream transfer. The longer pipeline would have a higher cost and carbon emissions and impact on a greater area of land. Transfers from the River Trent via the River Witham have the benefit of unlocking several potential benefits to the environment and may also facilitate multi-sector opportunities and were therefore preferred to direct pipeline transfers.

3.2.13 The engineering, environmental, planning, and social and community constraints mapping (See Appendix A) was not applied at Stage A to the pipeline search areas as they would be below ground assets and constraints can be avoided, or impacts mitigated by routing the pipeline around constraints or using trenchless crossing techniques.

Abstraction infrastructure search areas

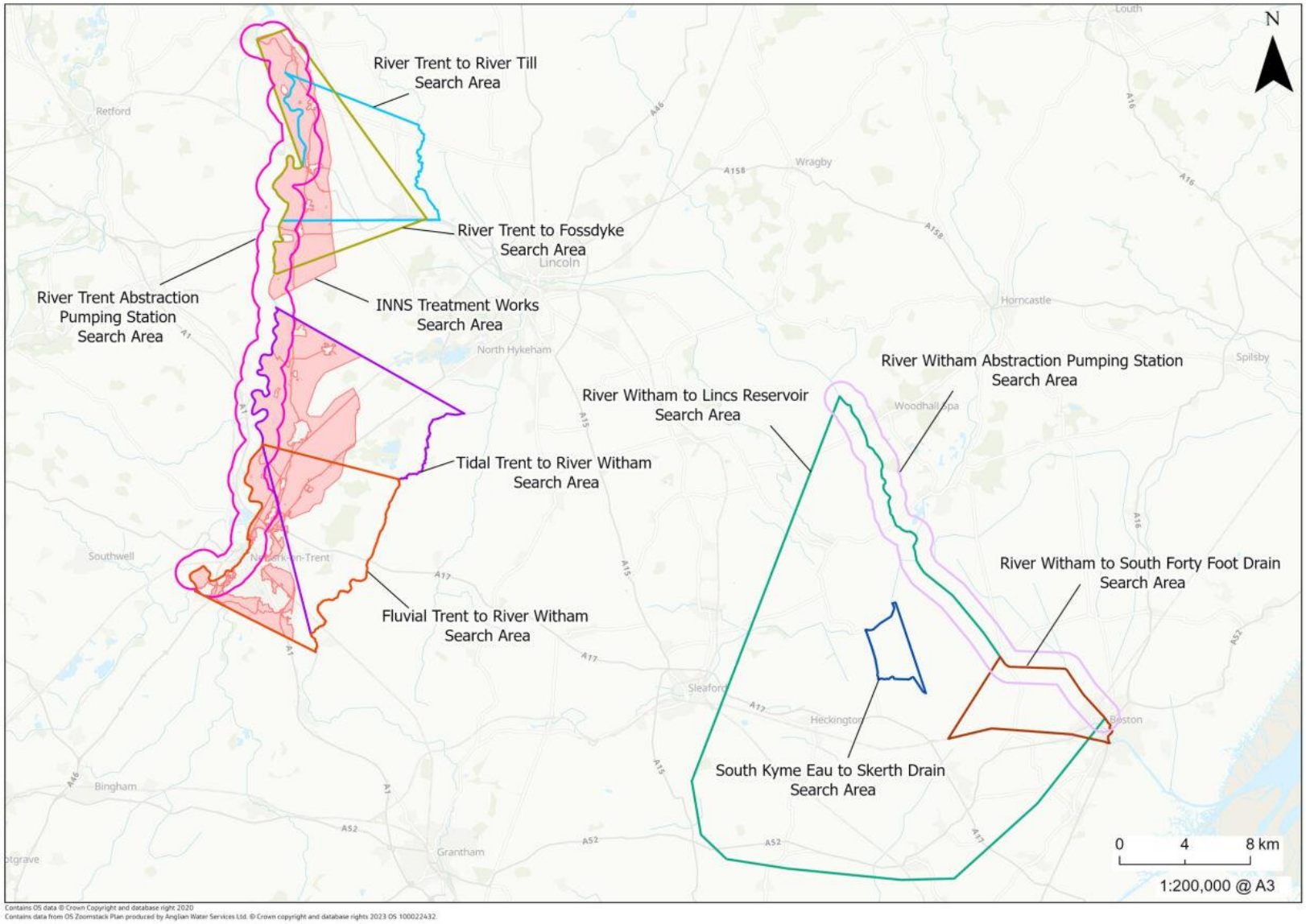
3.2.14 The Stage A search areas for abstraction infrastructure were defined by creating a 1km ellipse around the abstraction reach of the source river used to define the pipeline search areas. A distance of 1km was considered as a practical limit based on professional judgement as the complexity, cost, and carbon emissions associated with the intake and pumping station increase significantly the further away it is located from the source, due to the need to maintain positive pressure on the suction side of the pumps.

3.2.15 The Stage A search areas for INNS/water quality treatment works have been defined by the boundary of the associated pipeline search areas, and by the ridge line/watershed between the catchments. The INNS treatment works should be located on the source water body side of the watershed. This is because during any flood event, flood water should return to the source water body to prevent the potential transfer of INNS.

3.2.16 Engineering, environmental, planning and social and community constraints (see Appendix A) were applied to the broad search areas identified in Stage A for abstraction infrastructure to identify exclusion areas. This refers to areas within the broad search areas where existing constraints (e.g. built up areas) would prevent the placement of abstraction infrastructure.

3.2.17 The engineering, environmental, planning and social and community constraints mapping was not applied at Stage A to the pipeline search areas as they are below ground assets and constraints can be avoided, or impacts mitigated by routing the pipeline around constraints or using trenchless crossing techniques.

Figure 3.7: Stage A upstream transfer search areas



3.3 Stage B – Coarse screening

3.3.1 The purpose of Stage B was to identify component options within the search areas identified in Stage A and to screen the components against the Stage B options appraisal criteria (see Appendix A).

3.3.2 Component options were screened against the environmental, planning, engineering, land use, social and community criteria set out in Appendix A identified as being considered at Stage B. These criteria were selected to allow key constraints to be identified for each option identified in the search areas to understand the likely feasibility of each option and potential consenting risks. This was used to inform decision making on which those options to take forward for Stage C fine screening for more detailed assessment against the Stage C criteria. The component options with the least constraints, which as a result are likely to carry the lowest risk to project delivery, were carried forward to Stage C for fine screening and a more detailed assessment against criteria.

3.3.3 Within the identified search areas, potential routings for upstream water transfers and locations for the abstraction infrastructure were identified, as set out below.

River Trent source

3.3.4 At Stage A associated water infrastructure options were considered for both the fluvial River Trent (upstream of Cromwell Weir) and the tidal River Trent (downstream of Cromwell Weir).

3.3.5 During Stage B, the sources of supply assessment (refer to Chapter 2), which occurred in parallel to the options appraisal process, concluded that the South Forty Foot Drain, the River Witham and tidal River Trent is the preferred combination of sources. **As a result, the transfer options from the fluvial River Trent (upstream of Cromwell Weir) were not progressed through the Stage B assessments and were not taken forward to Stage C. The associated abstraction infrastructure components were also not taken forward.**

Upstream water transfers – pipeline and open channel transfers

3.3.6 Options for open channel transfer, pipeline transfer and combinations of both were identified for upstream transfers of raw water from source water bodies to the reservoir. At Stage B the upstream pipeline transfers were assumed to end in the centre of the reservoir, as the reservoir emerging design and illustrative master plan were still under development. Open channel transfers to the reservoir were assumed to end adjacent to the reservoir. These endpoints were refined at Stage C.

3.3.7 The hydraulic capacity of existing open channels identified at Stage A (see paragraphs 3.2.5 to 3.2.8) was assessed to understand their suitability for transfer of raw water to

the reservoir. Those channels with sufficient hydraulic capacity were then screened against Stage B criteria to identify the least constrained options.

3.3.8 Where an open channel does not extend all the way from source to reservoir, or levels do not facilitate the transfer by gravity, supplementary components were identified to enable the transfer from source to reservoir. These supplementary components included new open channel sections and pipeline transfers.

3.3.9 As a starting point, pipeline corridor options were identified with the aim of minimising the overall length of the route, as far as this is practicable, in order to minimise the likely carbon impacts and costs for the infrastructure, as well as minimising, the extent of land that would be required or impacted. A 1km wide pipeline corridor was developed for each option to provide sufficient flexibility to refine the corridor route during the Stage C fine screening. The corridors avoided constrained land where practicable. Generally, the preferred construction method for a pipeline is installing it using an open cut trench. However, for some sections of the pipeline route there will be critical crossings that will not be generally suited to open cut excavation and so a different construction method is required using trenchless construction techniques. For the purpose of this assessment, trenchless techniques have been assumed to be used to cross the following physical constraints where open cut would be unlikely to be approved:

- A-Roads.
- Motorways.
- Railways.
- High pressure gas pipelines.
- Buried high voltage electrical lines.
- Main rivers.
- Strategic Anglian Water pipelines.

3.3.10 At Stage B the pipeline corridors were 1km wide and were not narrowed to avoid known constraints. A 1km corridor is much wider than will actually be required for construction and operation of the pipeline and therefore there is flexibility to align the route within the corridor to avoid constraints at the stage in the process where the pipeline route is identified within the preferred corridor. If constraints cannot reasonably be avoided, measures such as trenchless construction could be adopted to avoid, reduce or mitigate impacts on particularly sensitive constraints. Further scheme development and assessments are required to identify potential impacts and risks to inform the construction methodology for any pipeline routes.

3.3.11 This process identified 50 potential transfer component options, 36 for the River Trent to River Witham transfer (see Figure 3.8) and 14 for the River Witham to the Lincolnshire Reservoir transfer (see Figure 3.9):

- **Fluvial River Trent (upstream of Cromwell Weir) to River Witham**[13]: Eight pipeline component options.
- **Tidal River Trent (downstream of Cromwell Weir) to River Witham**: 12 pipeline options.
- **Tidal River Trent to River Witham via the Fossdyke, near Torksey**: Seven pipeline component options and one open channel component option.
- **Tidal River Trent to River Till (a tributary of the Fossdyke)**: Six pipeline component options and one open channel transfer component option.
- **Tidal River Trent to River Witham via Boultham Catchwater**: One open channel transfer component option.
- **River Witham to Lincolnshire Reservoir**: Seven pipeline component options.
- **River Witham to South Forty Foot Drain**: Four pipeline component options.
- **River Witham to South Forty Foot Drain via Kyme Eau**: Two pipeline component options and one open channel component option.

[13] Further work has shown that the River Witham, tidal River Trent and South Forty Foot Drain is the preferred combination of sources and so transfer options from the fluvial River Trent (upstream of Cromwell Weir) were not taken forward at a later stage in the appraisal process. Where associated water infrastructure options were developed for the fluvial River Trent, they have been retained in this report for completeness up until the stage where it was no longer progressed as a source.

Figure 3.8: River Trent to River Witham transfer component options considered at Stage B

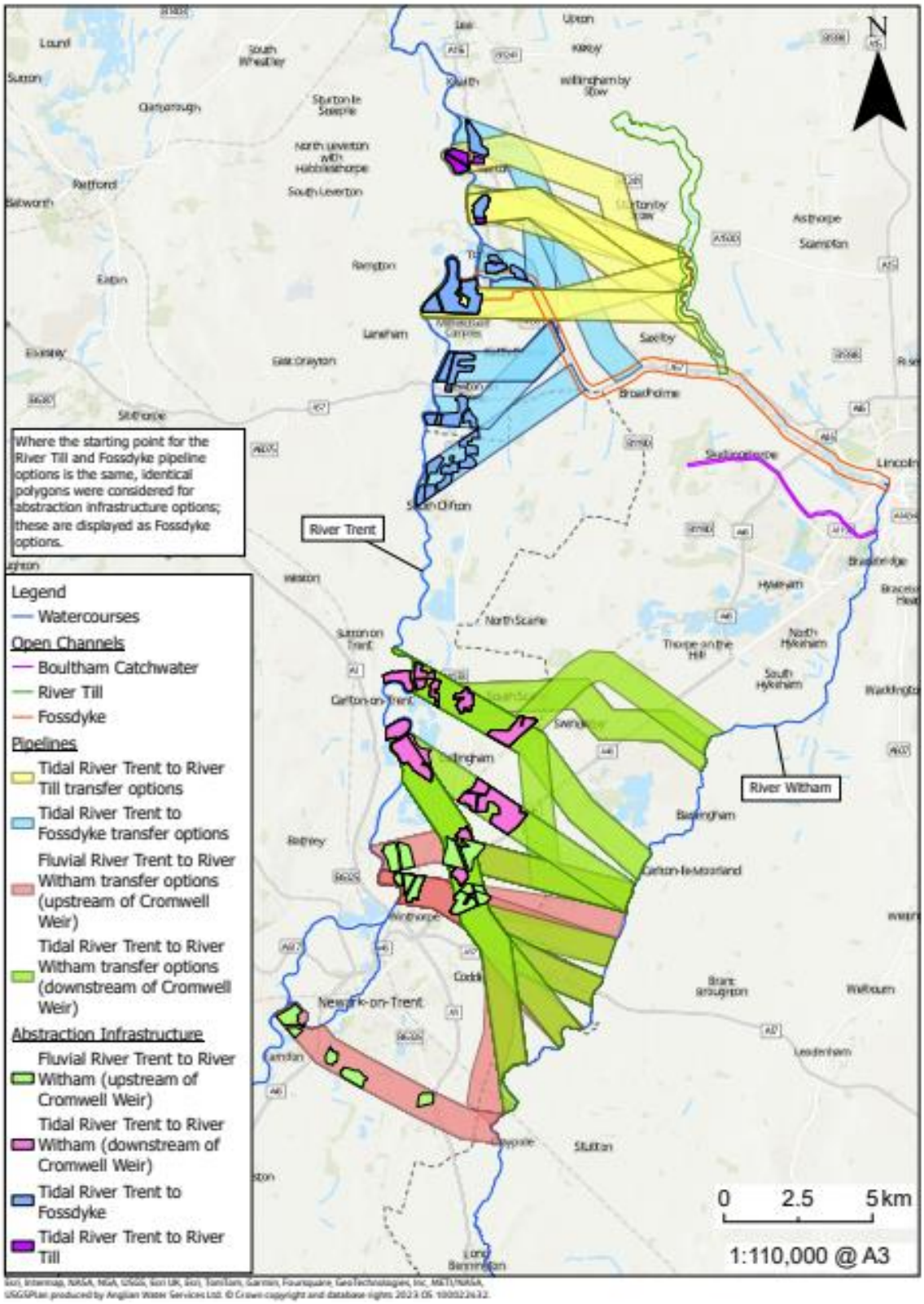
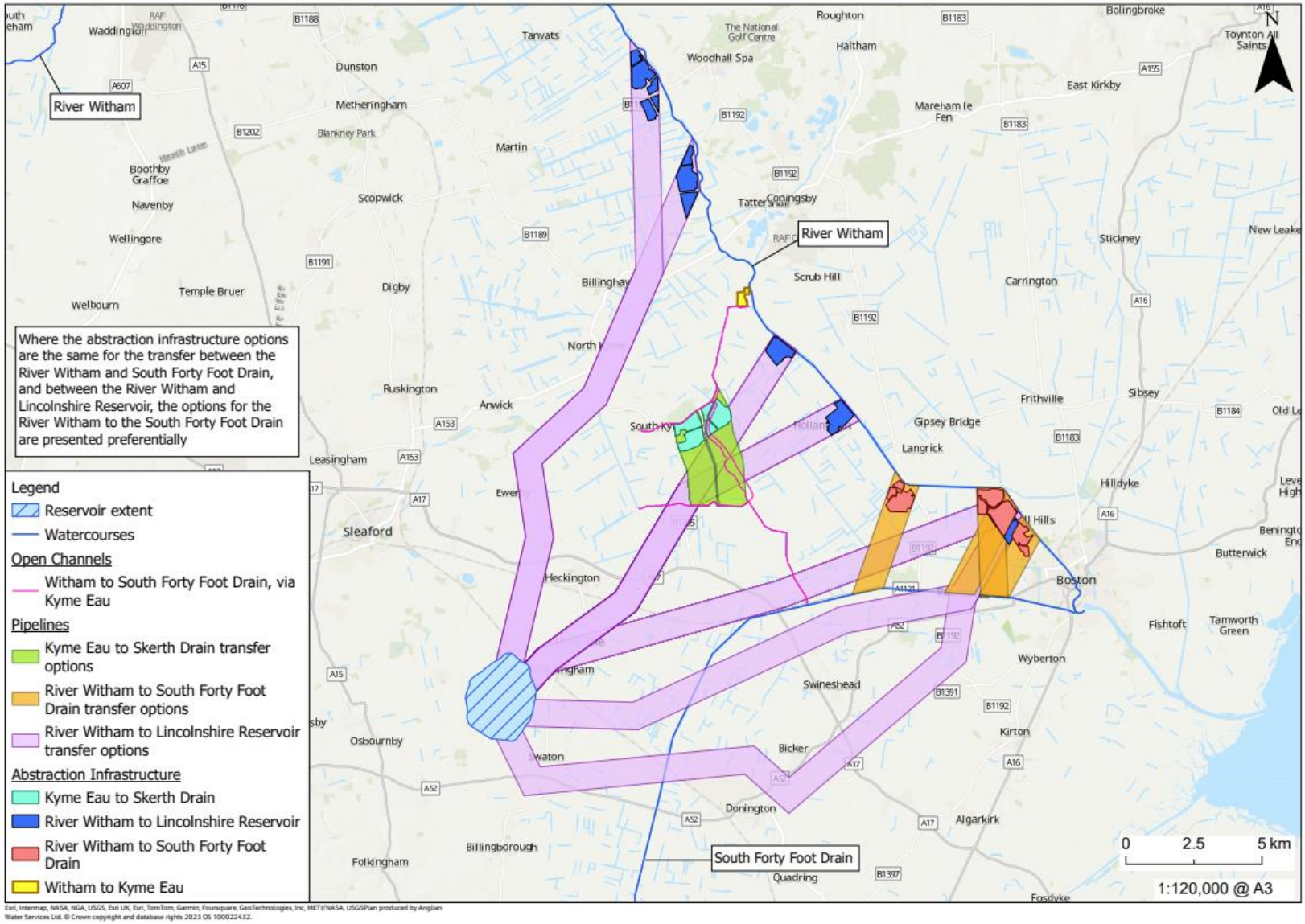


Figure 3.9: River Witham to the Lincolnshire Reservoir transfer component options considered at Stage B



Abstraction infrastructure

3.3.12 Polygons for abstraction infrastructure were delineated close to the source water bodies, using geospatial data and mapping software to avoid the most sensitive environmental, heritage, developed land use and infrastructure constraints. The minimum area of land required for a polygon was assessed based on being able to accommodate the pumping station or INNS treatment works footprint and the temporary space (based on early, indicative work of likely infrastructure size) needed during construction, 2.7ha and 8.5ha respectively.

3.3.13 Land adjacent to the source water body may often be in the floodplain and vulnerable to flooding due to the nature of being close to a water body. The flood vulnerability classification of the abstraction infrastructure was therefore assessed to understand suitability for it being located within flood zones, in accordance with the Flood Sequential Test[14]. Flood Risk vulnerability classifications[15] are essential infrastructure, highly vulnerable, more vulnerable, less vulnerable and water compatible.

- Water compatible infrastructure is compatible with all Flood Zones including the Functional Floodplain, also known as Flood Zone 3b.
- Less vulnerable infrastructure is compatible with Flood Zones 1, 2 and 3a but is not permitted within the Functional Floodplain/Flood Zone 3b.
- More vulnerable infrastructure is compatible with Flood Zones 1 and 2 but requires an Exception Test to be permitted within Flood Zone 3a and is not permitted within Flood Zone 3b.
- Highly vulnerable infrastructure is compatible with Flood Zone 1 but requires an Exception Test to be permitted within Flood Zone 2 and is not permitted within Flood Zones 3a and 3b.
- Essential infrastructure is compatible with Flood Zones 1 and 2 but requires an Exception Test to be permitted with Zone 3a or 3b.

3.3.14 The intakes and raw water pumping stations were assessed to be 'water-compatible'[16] and therefore suitable for location in Flood Zone 3b. However, the water quality and INNS treatment facilities were assessed to be 'less vulnerable' to flood risk and therefore recommended to be located outside the functional floodplain/Flood Zone 3b.

3.3.15 Where feasible, the abstraction infrastructure polygons have been sized to incorporate both the pumping station and any potential water quality and/or INNS

[14] https://www.gov.uk/guidance/flood-risk-and-coastal-change#the-sequential-approach-to-the-location-of-development
[15] Flood risk and coastal change - GOV.UK (www.gov.uk)
[16] Annex 3

mitigation/treatment, if required. Where the pumping stations' polygons were identified in the Flood Zone 3b, separate polygons were identified outside of the Flood Zone 3b for potential water quality and/or INNS mitigation/treatment works.

3.3.16 This process identified 104 potential locations for abstraction infrastructure component options, 75 for the River Trent to River Witham transfer (see Figure 3.8) and 29 for the River Witham to the Lincolnshire reservoir transfer (see Figure 3.9). These comprised:

- **Fluvial River Trent (upstream of Cromwell Weir) to River Witham**[17]: Seven pumping station polygons and ten water quality and INNS treatment works polygons.
- **Tidal River Trent (downstream of Cromwell Weir) to River Witham**: Seven pumping station polygons and eight water quality/INNS treatment works polygons.
- **Tidal River Trent to River Witham via the Fossdyke**: Sixteen pumping station polygons and 11 water quality and INNS treatment works polygons.
- **Tidal River Trent to River Till** (a tributary of the Fossdyke): Ten pumping station polygons and six water quality/ INNS treatment works polygons.
- **Tidal River Trent to River Witham via Boultham Catchwater**: No abstraction infrastructure polygons were identified.
- **River Witham to Lincolnshire Reservoir**: Thirteen abstraction infrastructure polygons.
- **River Witham to South Forty Foot Drain**: Ten abstraction infrastructure polygons.
- **River Witham to South Forty Foot Drain via Kyme Eau**: One abstraction infrastructure polygon for pumping between River Witham and Kyme Eau and five abstraction infrastructure polygons for pumping between Kyme Eau and Holland Dyke.

Stage B screening

3.3.17 At Stage B the component options identified above were assessed against engineering, environmental, planning, land use and social criteria, as listed in Appendix A. These criteria were selected to identify the most significant constraints, taking account of the requirements of the NPS and other relevant legislation and policy requirements. The

[17] Further work has shown that the River Witham, tidal River Trent and South Forty Foot Drain is the preferred combination of sources and so transfer options from the fluvial River Trent (upstream of Cromwell Weir) were not taken forward at a later stage in the appraisal process. Where associated water infrastructure options were developed for the fluvial River Trent, they have been retained in this report for completeness up until the stage where it was no longer progressed as a source.

assessments were carried out using geospatial data and mapping software. Desktop datasets for Stage B criteria were considered alongside component-specific requirements and professional judgement of the subject matter experts to identify and assess component options.

3.3.18 The Stage B options were considered against the Stage B criteria to identify potential constraints that may affect the feasibility of the component or introduce consenting risk compared to the alternative options available. Preference was given to options with less constrained land on the basis that those options were likely to carry the overall lowest risk to consenting and project delivery. These options were taken forward to Stage C fine screening for more detailed assessment against the Stage C criteria.

3.3.19 Different criteria have differing level of protection given to them under the NPS and so this has been considered as part of the Stage B screening process. For example, an internationally designated habitats site is considered more sensitive and afforded a higher level of protection than a site with a local or regional wildlife designation under the NPS for Water Resources Infrastructure which is national planning policy. Judging the subtle differences and weighing the balance of respective constraints was undertaken in workshops attended by multidisciplinary subject matter experts.

3.3.20 In some cases it was not feasible to locate infrastructure away from sensitive receptors due to the geographical extent of some constraints and some of the water sources being designated biodiversity sites (including Ramsar sites, SAC, SPA, SSSI). As a result, in these circumstances options identified at Stage B may extend into these areas that would otherwise be avoided, with any direct and indirect effects on constraints and designations being considered further in the more detailed assessments at the in later stages of the options appraisal process.

3.3.21 The pipeline corridors did in some instances overlap with identified Stage B constraints; however, as the assessment was undertaken on a 1km corridor, it is much wider than will actually be required for construction and operation of the pipeline. There is therefore flexibility to align the pipeline route within the corridor to avoid or reduce impacts on constraints, where possible. Measures such as trenchless construction could be adopted to avoid, reduce or mitigate impacts on particularly sensitive constraints.

3.3.22 The least constrained component options from an environmental perspective were the options that avoid or minimise impacts on internationally or nationally designated habitats sites, although this hasn't been possible in all cases, and that avoid or minimise the potential for impacts on designated heritage assets, such as scheduled monuments. The preferred pipeline corridor options from an engineering perspective were generally the shortest routes, making them preferable in comparison to longer corridors due to the lower associated production of carbon and the cost of construction and maintenance, with reduced disturbance to existing land use; and

routes with the fewest crossings, making them less technically complex than other options.

3.3.23 Polygons for above-ground infrastructure including pumping stations, water treatment works and INNS treatment, were identified to avoid the most sensitive constraints. Where the search areas included land with sensitive constraints, such as environmental and planning policy designations like common land or Green Belt, these were not excluded from the polygon at Stage B as there could be an overriding case for locating infrastructure within the designated land areas when considered against the alternative options and subject to compliance with any relevant legislative or policy tests. Where polygons performed well against Stage B criteria generally, but are within or close to a designated site or asset, these were carried forward to Stage C for further consideration against any alternative options to understand if any alternative options would avoid or reduce the impact on the designation.

3.3.24 The least constrained component options at Stage B, recommended for progression to Stage C, were shared with the Lincolnshire Reservoir Working Partnership in order to gather any feedback. The feedback received was taken into account during the Stage C option assessments. Component options taken forward to Stage C were:

- River Trent to River Witham
  - **Tidal River Trent (downstream of Cromwell Weir) to River Witham**: Four pipeline component options and four abstraction infrastructure polygon options.
  - **Tidal River Trent (near Torksey) to River Witham via the Fossdyke**: Two pipeline component options, one open channel component option and six abstraction infrastructure polygon options.
- River Witham to Lincolnshire Reservoir
  - **River Witham to South Forty Foot Drain**: Two pipeline component options and two abstraction infrastructure polygon options.
  - **River Witham to South Forty Foot Drain via Kyme Eau**: Two pipeline component options, one open channel transfer component option, one abstraction infrastructure polygon option for pumping between River Witham and Kyme Eau and three abstraction infrastructure polygon options for pumping between Kyme Eau and Holland Dyke.

3.4 Stage C – Fine screening

3.4.1 Fine screening incorporated four steps to support and inform decision-making on the options (from Stage B) for progression to Stage D – preferred whole scheme options appraisal for the associated water infrastructure elements. These were the following:

- Refinement of components taking into account the Stage B appraisals.
- The Stage C technical appraisals (including technical, environmental, social and planning criteria)) to assess options against more detailed criteria and stakeholder engagement on individual components.
- Combination of the best-performing component options into elements, and review of the combinations to ensure that when considered as part of an element, the best-performing component options remained the best-performing component options.
- Where more than one element option was created from the best-performing component options, these were compared against each other to identify the best-performing element options for progression to Stage D.

Design refinement

3.4.2 Design refinement primarily involved amendment of pipeline corridors and above-ground infrastructure polygons to minimise encroachment on key constraints and maximise distance from sensitive receptors. Design refinement was based on the outcomes of the consideration of the criteria considered at Stage A and Stage B (as set out in Appendix A) which identified constraints, so that opportunities to refine the design could be identified to avoid these constraints, where reasonably practicable at this early stage in the process.

3.4.3 The polygons for abstraction infrastructure identified at Stage B were not reduced in size to more closely match the expected land requirements, keeping the full polygons at this stage gives greater flexibility for siting of the infrastructure within the polygon to avoid, reduce or mitigate any potential impacts. The preferred siting of the infrastructure within the polygons will identified at a later stage of the Project.

3.4.4 At this stage, pipeline corridor options were reduced from 1km to 500m. A corridor width of 500m is still many times wider than the actual width of the pipeline route that would be required for construction; however, it allows for flexibility for the detailed routing of the pipeline at a later stage within the wider area of land being considered in the corridor. At some places, the corridor was narrowed to less than 500m or its alignment was altered at specific points along the route in order to avoid or minimise potential impacts on particular environmental sensitivities and engineering constraints.

3.4.5 Open channel transfer options were refined using hydraulic models and calculations to determine constraints and their extents. Analysis of the route and the hydraulic results informed the development of the components and the infrastructure or improvements required to provide the transfer.

3.4.6 Initial hydraulic assessments of existing structures along the open channels were undertaken in order to assess whether or not the structures are a constraint to the

capacity of the channel. Where constraints to the capacity of the channel were identified, options were considered to overcome the constraint, such as bypasses or channel widening.

Stage C technical appraisals

3.4.7 Desk-based technical appraisals were undertaken by subject matter experts to assess each component option against the more detailed Stage C criteria to identify potential risks to the feasibility of each option and consenting risks to inform the identification of the preferred elements to be taken forward into the Stage D. The Stage C technical appraisal considered the criteria set out as being used in Stage C in Appendix A and covers a wide range of technical and engineering, environmental, planning and land criteria.

3.4.8 Decision-making throughout Stage C was based on understanding how each of the options performed against the Stage C engineering, environmental, land use and planning criteria set out in Appendix A and through the lens of the NPS consenting tests for water resources infrastructure, and then the comparison of the alternative options against each other to identify the best performing options.

3.4.9 Some criteria are informed by specific policy or legislative consenting tests that must be considered at the decision-making stage. Examples of these include the Conservation of Habitats and Species Regulations 2017 (as amended) (known as the Habitats Regulations) and Green Belt land (protected through Chapter 13 of the National Planning Policy Framework[18]). The development of the Stage C fine screening appraisal process considers the options against these consenting tests to inform decision making on what tests need to be met for an option to progress.

3.4.10 A collaborative workshop was held with the dedicated forum and the Lincolnshire Reservoir Working Partnership to capture potential benefits and opportunities for each of the associated water infrastructure options under consideration. The outcomes of this workshop were considered as part of the Stage C assessments.

3.4.11 The following sections present the outcomes of the assessments for the upstream infrastructure options, focussing on aspects that are key differentiators between options or where there are potential consenting risks.

River Trent to River Witham

3.4.12 Component options were brought forward from Stage B for either a pipeline transfer from the tidal River Trent (downstream of Cromwell Weir) or a hybrid option that is a combination of pipeline to the Fossdyke, which is used as an open channel transfer.

[18] Department for Levelling Up, Housing & Communities (2023), National Planning Policy Framework. Retrieved from: https://assets.publishing.service.gov.uk/media/65a11af7e8f5ec000f1f8c46/NPPF_December_2023.pdf

3.4.13 A pipeline only transfer option from the tidal River Trent (downstream of Cromwell Weir) to the River Witham would require:

- Abstraction infrastructure polygon for an intake and pumping station.
- Abstraction infrastructure polygon for any required water quality or INNS treatment, which could be co-located with the pumping station.
- Pipeline corridor for the transfer from the River Trent to the River Witham.

3.4.14 A hybrid transfer of a pipeline and an open channel transfer via the Fossdyke would require:

- Abstraction infrastructure polygon for an intake and pumping station.
- Abstraction infrastructure polygon for any required water quality or INNS treatment, which could be co-located with the pumping station.
- Pipeline corridor to transfer water from the River Trent to the Fossdyke.
- Open channel transfer via the Fossdyke, with upgrades to the Fossdyke potentially being required to enable the transfer.

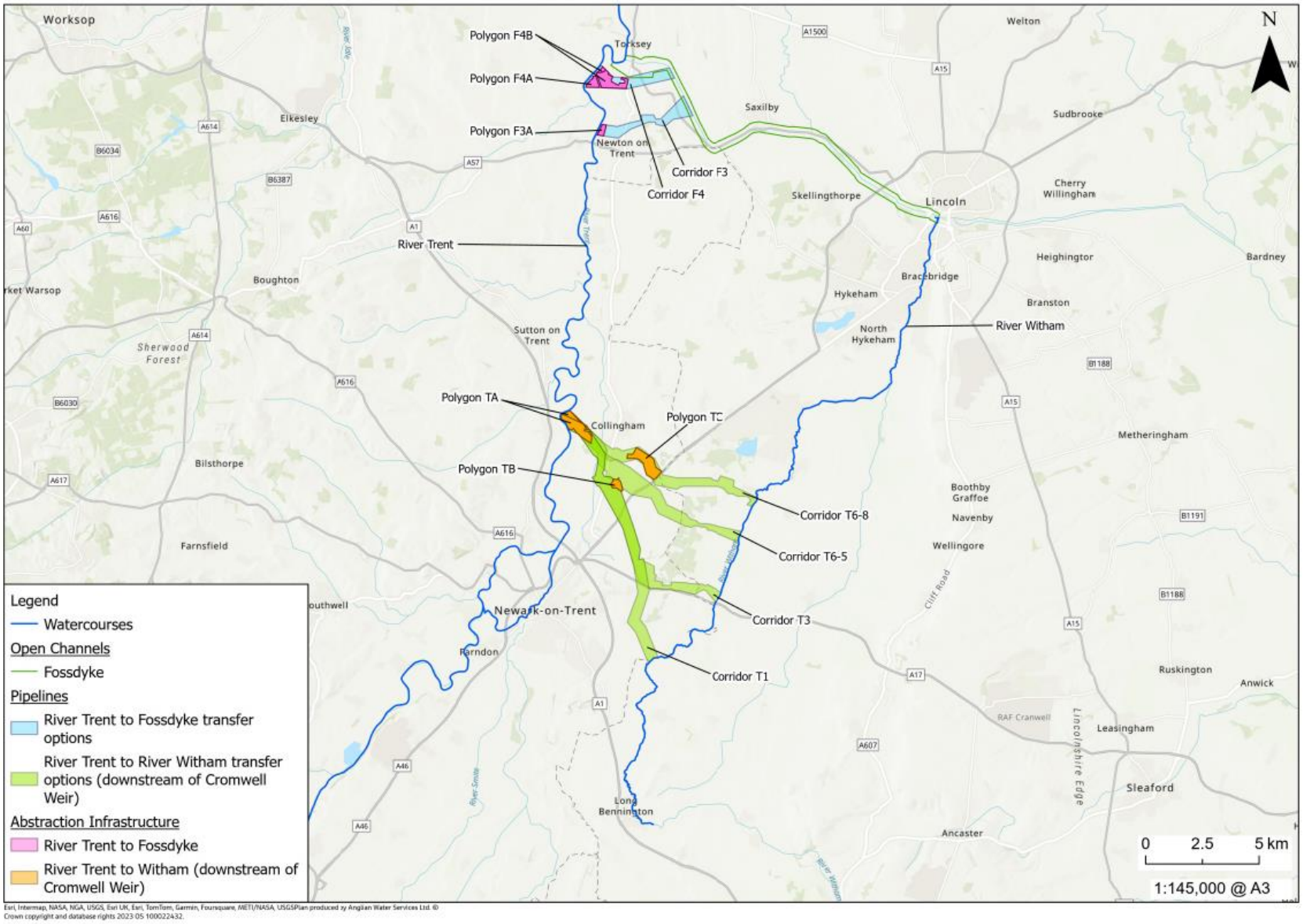
Upstream water transfers

3.4.15 The components brought forward from Stage B to Stage C are summarised in Table 3-1. The location of each of the components are shown in Figure 3.10.

Table 3-1: Upstream component options for River Trent to River Witham transfers progressed to Stage C

Transfer component	Associated abstraction infrastructure polygons
Pipeline only transfer option from the tidal River Trent (downstream of Cromwell Weir)	
Pipeline Corridor T1	Polygon TA, Polygon TB
Pipeline Corridor T3	Polygon TA, Polygon TB
Pipeline Corridor T6-5	Polygon TA, Polygon TB
Pipeline Corridor T6-8	Polygon TA, Polygon TC
Hybrid from tidal River Trent (near Torksey) to River Witham via the Fossdyke	
Pipeline Corridor F3 and open channel transfer through Fossdyke	Polygon F3A
Pipeline Corridor F4 and open channel transfer through Fossdyke	Polygon F4A, Polygon F4B

Figure 3.10: River Trent to River Witham transfer component options considered at Stage C



3.4.16 Four pipeline corridor options labelled T1, T3, T6-5, and T6-8 for the transfer from the tidal River Trent (downstream of Cromwell Weir) to the River Witham and two hybrid transfer options via the Fossdyke were assessed at Stage C. The hybrid options via the Fossdyke include a short pipeline section between the River Trent and the Fossdyke and the Fossdyke is then used as the open channel transfer to the River Witham.

Pipeline Transfers from tidal River Trent (downstream of Cromwell Weir) to River Witham

3.4.17 All four pipeline corridors leave the River Trent west of Collingham in a south-easterly direction and then all diverge before they reach the A1133 to the south of Collingham Village.

3.4.18 Corridor T1 heads south and crosses the A1133 to the north of Langford, then continues south to cross the A46 to the south of Brough. The corridor passes the west of Danethorpe before crossing the A17 to the east of Coddington Village. It then continues in a southerly direction before reaching the River Witham, south-west of Barnby.

3.4.19 Corridor T3 follows the same alignment of Corridor T1 until it reaches Coddington Village where Corridor T3 takes an easterly turn and runs adjacent and parallel along the northern side of the A17, before reaching the River Witham, near Beckingham.

3.4.20 Corridor T6-5 crosses the A1133 and continues in a south-easterly direction crossing the A46 near Brough. The corridor continues in this direction until it passes the south of Stapleford and reaches the River Witham, south-west of Stapleford.

3.4.21 Corridor T6-8 crosses the A1133 and continues in a westerly direction crossing the A46 to the north of Brough. It continues in an easterly direction until it passes the south of Norton Disney and reaches the River Witham.

3.4.22 Corridor T1 is at 12km in length and is the longest option and so it correspondingly has the highest likely cost and carbon emissions. It also has the largest number of sensitive crossings that have been assessed on the basis of assuming trenchless construction techniques (see paragraph 3.3.9). Corridor T3 has a common alignment as Corridor T1 for much of its length but is slightly shorter and therefore is expected to be lower cost and carbon emissions. Corridors T6-5 and T6-8 are similar in length to each other and approximately 20% shorter than Corridors T1 and T3, which is reflected in the cost and carbon assessments as they are expected to have lower cost and carbon compared to Corridors T1 and T3.

3.4.23 There are no differentiators from a HRA perspective between the corridors. All the corridors cross watercourses that drain to The Wash so there are potential impact pathways on the hydrologically connected designated sites of The Wash SPA and Ramsar site and The Wash and North Norfolk Coast SAC. Initial consideration is that these impacts would be mitigable through the implementation of measures which

would likely include standard good practice construction techniques, such as pollution prevention measures and fish-friendly pumps and sediment control, where applicable. Further hydrological modelling and assessment is required to determine any potential operational impacts on the qualifying features or their supporting habitats within the designated sites and to identify appropriate mitigation, if required.

3.4.24 Corridors T1 and T3 are considered to be worse performing as they have a higher risk of significant impact upon the value of Scheduled Monuments Langford medieval village (approximately 60m south-west of T1 and 50m south-west of T3) and Crococalana Roman Town (approximately 70m east of T1 and T3). There is potential for archaeological remains associated with these assets to extend into both corridors. These remains could be considered to be part or of similar value to the Scheduled Monuments.

3.4.25 All the River Trent to River Witham pipeline corridors have potential to impact on the value of regionally important prehistoric and Roman archaeological assets during construction. This is because the Trent Valley has formed a focus for dense settlement throughout these periods.

3.4.26 All pipeline corridors options have listed buildings within them, it is expected that direct impacts on these can be avoided through sensitively routing the pipeline away from the designated asset within the wider corridor area, wherever practicable. There is a potential risk for temporary impacts on the setting of these designated heritage assets and other nearby designated assets, such as Collingham Conservation Area, during the construction on the pipeline, however, as the works are temporary and with appropriate mitigation, including sensitively siting the works, there is not considered to be a risk of substantial harm.

3.4.27 Corridor T1 and Corridor T3 include part of Langford Lowfields RSPB reserve which is a Local Wildlife Site and avoiding this site is unlikely to be possible, so there are likely to be temporary habitat impacts and potential for disturbance during construction in adjoining parts of the reserve. Corridor T6-5 is partly within the RSPB reserve, but there is potential to route the pipeline within the wider corridor area to avoid direct impacts on the Local Wildlife Site; however there is still potential for indirect impacts such as disturbance during construction. Corridor T6-8 avoids the Local Wildlife Site.

3.4.28 All corridor options performed equally from a materials and waste perspective. There are large areas of land identified in the local plans as Minerals Safeguarding Areas between the River Trent and the River Witham and all of the corridors pass through Minerals Safeguarding Areas. As part of the assessment of the Project any impacts on mineral safeguarded areas will be assessed and Anglian Water will engage with the Mineral Planning Authority as part of this process. As required in the NPS, appropriate mitigation or compensation measures to safeguard the mineral resources will be considered, if required.

3.4.29 Water quality in the River Trent is poorer than in the upper River Witham where the pipeline transfers would discharge and therefore discharging further downstream is preferable for reducing WFD and INNS risks. Corridors T6-5 and T6-8 discharge to the River Witham in the area around Stapleford, which is further downstream than Corridors T1 and T3 which discharge in the area around Barnby and Beckingham, making Corridors T6-5 and T6-8 preferred from a WFD perspective.

3.4.30 In summary, **Corridors T6-5 and T6-8 are preferred over Corridors T1 and T3** as:

- Corridors T6-5 and T6-8 are shorter in length and so have correspondingly lower likely cost and carbon emissions. The shorter lengths also means that less land will be required for the pipeline route which will likely reduce the number of land interests impacted by this part of the Project.
- Corridors T6-5 and T6-8 discharge to the River Witham further downstream than Corridors T1 and T3 making Corridors T6-5 and T6-8 preferred from a WFD perspective.
- Corridors T6-5 and T6-8 also have lower heritage risks as they are further away from the Scheduled Monuments in the area compared to Corridors T1 and T3. The closest Scheduled Monument, Crococalana Roman town, is located approximately 215m south of Corridor T6-5. Subject matter experts consider that it is unlikely any associated remains extend into the corridor. There are no Scheduled Monuments in close proximity to Corridor T6-8.

3.4.31 Corridor T6-5 and Corridor T6-8 perform similarly against the criteria considered at Stage C, with both corridors having the potential for adverse impacts on the value of the Collingham Conservation Area. However, Corridor T6-5 is slightly worse performing for heritage when compared to Corridor T6-8 as it has the potential for adverse impacts on the value of six Listed Buildings, compared to five Listed Buildings for T6-8. Whilst both corridors are in proximity to designated heritage assets, it is expected that any impacts would result in less than substantial harm on the value of these designated built heritage assets and that any impacts would be mitigated, including through the routing of the pipeline within the wider corridor area.

3.4.32 Both Corridors T6-5 and T6-8 have constrained areas where the pipeline corridors have been reduced to narrower than 500m width and there is limited or no opportunity for selecting a pipeline alignment to reduce impacts on receptors. This is particularly challenging for Corridor T6-8 where at the constrained section the corridor width is less than the space normally required for construction. There is a specialist education facility at this location that will be sensitive to disruption from construction and it is expected that the pipeline would need to pass through the education facility's grounds. In comparison, the constrained section on Corridor T6-5 still leaves sufficient space for the required construction working width.

3.4.33 Overall, Corridor T6-5 is preferred over Corridor T6-8, as although Corridor T6-8 is shorter and is likely to have a correspondingly lower cost and carbon emissions, there are significant technical challenges of constructing a pipeline through the constrained section of Corridor T6-8 due to the specialist education facility at this location. Accordingly, it is considered unlikely that direct impacts can be avoided without causing significant disruption and so Corridor T6-5 is preferred as it avoids direct impacts both on the specialist education facility and an overall greater number of sensitive receptors than Corridor T6-8.

3.4.34 **Corridor T6-5 is therefore the preferred pipeline corridor for the pipeline transfer option from the River Trent to the River Witham**.

Transfers from tidal River Trent (near Torksey) to River Witham via the Fossdyke

3.4.35 Two hybrid options have been assessed at Stage C, both of which use the Fossdyke to transfer water between the River Trent near Torksey to the River Witham near Lincoln. A short section of pipeline is needed between the River Trent and the Fossdyke and an area of land is required for the abstraction infrastructure needed to pump the transfer flows into the Fossdyke. The two hybrid options use the same open channel transfer along the Fossdyke, but each option has a different pipeline corridor option, Corridor F3 and Corridor F4, as well as different associated abstraction infrastructure polygons.

3.4.36 Corridor F3 leaves the River Trent in an easterly direction crossing the A1133 between Laughterton and Newton on Trent. It then continues east past the south of Kettlethorpe before crossing the A156 and reaching the Fossdyke.

3.4.37 Corridor F4 leaves the River Trent in an easterly direction. The corridor crosses the A1133 and the A156 to the north of Fenton, before reaching the Fossdyke.

3.4.38 The two pipeline corridors are similar in length and are expected to have a similar cost. Corridor F4 is further downstream and closer to Torksey, which is where the existing Fossdyke and River Trent connection is. The Environment Agency has an existing intake and abstraction pumping station for the Trent – Witham – Ancholme transfer within Corridor F4 and there is a potential opportunity to optimise the pumping infrastructure between the two schemes at this location. The Environment Agency is supportive of exploring this opportunity.

3.4.39 The channel of the River Trent has a steeper profile in Corridor F4 than Corridor F3, making it more suited to siting an intake. Furthermore, the abstraction infrastructure polygon on Corridor F3 is wholly within Flood Zone 3b and therefore not suitable for siting any water treatment infrastructure that may be required. Corridor F4 offers the potential opportunity to optimise the existing Trent – Witham – Ancholme intake and abstraction pumping station and the Lincolnshire Reservoir upstream transfer, as noted above. **Corridor F4 is preferred over Corridor F3 for transfer from the River Trent to the Fossdyke.**

3.4.40 Some engineering works may be required on the Fossdyke to facilitate the transfer flows. These are at locations such as bridges, where the modelling has indicated that there may be existing constraints on the Fossdyke capacity that may result in velocities being too high for navigation purposes. Potential engineering solutions have been identified, but further investigation and assessments are needed to understand these potential capacity constraints and whether or not engineering works are needed. Any works that may potentially be required along the Fossdyke are the same for both options and therefore are not a differentiator when considering the two options.

Comparison of pipeline transfer and transfer via the Fossdyke

3.4.41 From a WFD and INNS perspective the options that transfer water via the Fossdyke are preferred over the pipeline options, as the pipeline options discharge into the upper River Witham upstream of the connection between the Fossdyke and the River Witham. The risk of WFD and INNS impacts for the pipeline options would cover three receiving water bodies for the River Witham whereas the risk for the hybrid options via the Fossdyke would cover one receiving water body for the River Witham. Water quality in the River Trent is poorer than in the upper River Witham where the pipeline transfer options would discharge. In comparison, there is an existing connection between the River Trent and the Fossdyke and water is regularly transferred through the Fossdyke as part of the Environment Agency's Trent – Witham – Ancholme transfer (although it is noted that transfer volumes may be higher under the proposed transfer option compared to the existing transfers). The hybrid transfer options via the Fossdyke are therefore preferred to pipeline transfer options between the River Trent and the River Witham from both WFD and INNS risk perspective.

3.4.42 An open channel transfer via the Fossdyke is expected to have lower cost and carbon emissions compared to the pipeline transfers from the River Trent to the River Witham. A transfer via the Fossdyke also offers the potential opportunity of optimising with the existing Trent – Witham – Ancholme transfer which is being explored with the relevant stakeholders.

3.4.43 There are complexities associated with the use of the Fossdyke for transferring water and further investigations and assessments are required. Initial discussions have been undertaken with both the Canal and River Trust and the Environment Agency, and they are supportive of working with Anglian Water to establish how these might be resolved. Any transfer using, or works to, the Fossdyke will need to be developed to avoid or minimise potential impacts to navigation, which will require further assessment and engagement with relevant stakeholders.

3.4.44 **Abstraction from the River Trent and transfer along pipeline Corridor F4 to the Fossdyke for transfer to the River Witham is the preferred option and was progressed to Stage D**.

Abstraction infrastructure

Pipeline Transfers from tidal River Trent (downstream of Cromwell Weir) to River Witham

3.4.45 All the pipeline transfer corridor options for the tidal River Trent to River Witham (downstream of Cromwell Weir) that were considered at Stage C start at the same stretch of the River Trent, to the west of Collingham, and therefore the abstraction location is not a differentiator. Corridors with abstraction locations further north along the tidal River Trent performed poorly against the Stage B criteria and were not progressed to Stage C.

3.4.46 Infrastructure associated with the abstraction includes an intake and a pumping station. There may also be a requirement for water treatment to address INNS and/or water quality risks. The intake and pumping station need to be close to the river for the abstraction. Any required water treatment could either be co-located with the pumping station or at a separate location further from the river. Abstraction infrastructure polygons have been identified both close to the River Trent and away from the River Trent. Locations within Flood Zone 3b are not suitable for siting any required treatment and locations distant from the river are not suitable for intakes and pumping stations, refer to paragraphs 3.3.12 to 3.3.15.

3.4.47 Polygon TA was identified as the preferred abstraction infrastructure polygon close to the River Trent. This polygon sits within Corridors T1, T3, T6-5 and T6-8 and is therefore suitable for any of these pipeline corridors. This polygon is within Flood Zone 3b and therefore is only suitable for water-compatible development, in accordance with the Flood Risk Sequential Test. Any required INNS or water treatment would therefore need to be located separately from the intake and pumping station.

3.4.48 Two additional polygons, Polygons TB and TC, have been considered. These polygons are further from the River Trent. Polygon TB sits within pipeline corridors T1, T3 and T6-5 and Polygon TC sits within pipeline Corridor T6-8. These polygons are within Flood Zone 1 and are therefore suitable for infrastructure less vulnerable to flood risk, such as water treatment. There are no significant differentiators between Polygons TB and TC that would alter the preference for Corridor T6-5 over Corridor T6-8.

3.4.49 None of the polygons associated with the pipeline transfers were taken forward to Stage D as the hybrid option of a transfer via the Fossdyke was preferred to a pipeline transfer from the River Trent to the River Witham.

Transfers from tidal River Trent (near Torksey) to the Fossdyke for the transfer to the River Witham

3.4.50 One polygon, Polygon F3A, was identified on Corridor F3 for abstraction infrastructure. This is adjacent to the River Trent and in Flood Zone 3b. It is therefore suitable for the

intake and abstraction pumping station but not for any INNS or water quality treatment, if required.

3.4.51 For Corridor F4 two polygons, Polygon F4A and Polygon F4B were considered at Stage C. The larger polygon, Polygon F4B, was identified for abstraction infrastructure, which allows for siting of the intake and abstraction pumping station near the river and for siting any water treatment outside of Flood Zone 3b. Polygon F4A is entirely within Polygon F4B and also within Flood Zone 3b and therefore would not be suitable for siting any water treatment that may be required. **Polygon F4B was progressed to Stage D as the preferred abstraction infrastructure polygons associated with Corridor F4 as it includes an area suitable for location of any required water treatment**.

River Witham to South Forty Foot Drain

3.4.52 For the transfer of water from the River Witham to the South Forty Foot Drain, component options were brought forward from Stage B for three different types of transfer. These were:

- A pipeline transfer.
- A hybrid transfer that involves a combination of a pipeline and use of the existing Kyme Eau and other open channels.
- A fully open channel transfer via the Kyme Eau and other open channels.

3.4.53 A **pipeline transfer** option from the River Witham to the South Forty Foot Drain would require:

- Abstraction infrastructure polygon for an intake and pumping station.
- Abstraction infrastructure polygon for any required water quality or INNS treatment, which could be co-located with the pumping station if a suitable single polygon of sufficient size was identified.
- Pipeline corridor from the River Witham to the South Forty Foot Drain.

3.4.54 A **hybrid transfer** via the Kyme Eau and other open channels would require:

- Abstraction infrastructure polygon for an intake and pumping station on the River Witham.
- Pipeline corridor from the River Witham to the Kyme Eau.
- Open channel transfer via the Kyme Eau. Improvements to the banks of the Kyme Eau may be required to enable the transfer.
- Abstraction infrastructure polygon for an intake and pumping station on the Kyme Eau.

- Abstraction infrastructure polygon for any required water quality or INNS treatment, which could be co-located with the pumping station if a suitable single polygon of sufficient size was identified.
- Pipeline corridor from the Kyme Eau to the Skerth Drain.
- Open channel transfer via the Skerth Drain.

3.4.55 An **open channel transfer** via the Kyme Eau would require:

- Abstraction infrastructure polygon for an intake and pumping station on the River Witham.
- Pipeline corridor from the River Witham to the Kyme Eau.
- Open channel transfer via the Kyme Eau. Upgrades to the Kyme Eau to enable the transfer.
- One of the following:
  - If water quality or INNS treatment is required: abstraction infrastructure polygon for an intake and pumping station on the Kyme Eau and an abstraction infrastructure polygon for water quality or INNS treatment could be co-located with the pumping station. A pipeline corridor between the Kyme Eau and Holland Dyke, via the treatment works.
  - If water quality or INNS treatment is not required, an open channel connection between Kyme Eau and Holland Dyke.
- Open channel transfer via Holland Dyke. Upgrades to the Holland Dyke to enable the transfer.
- Open channel transfer via the Skerth Drain.

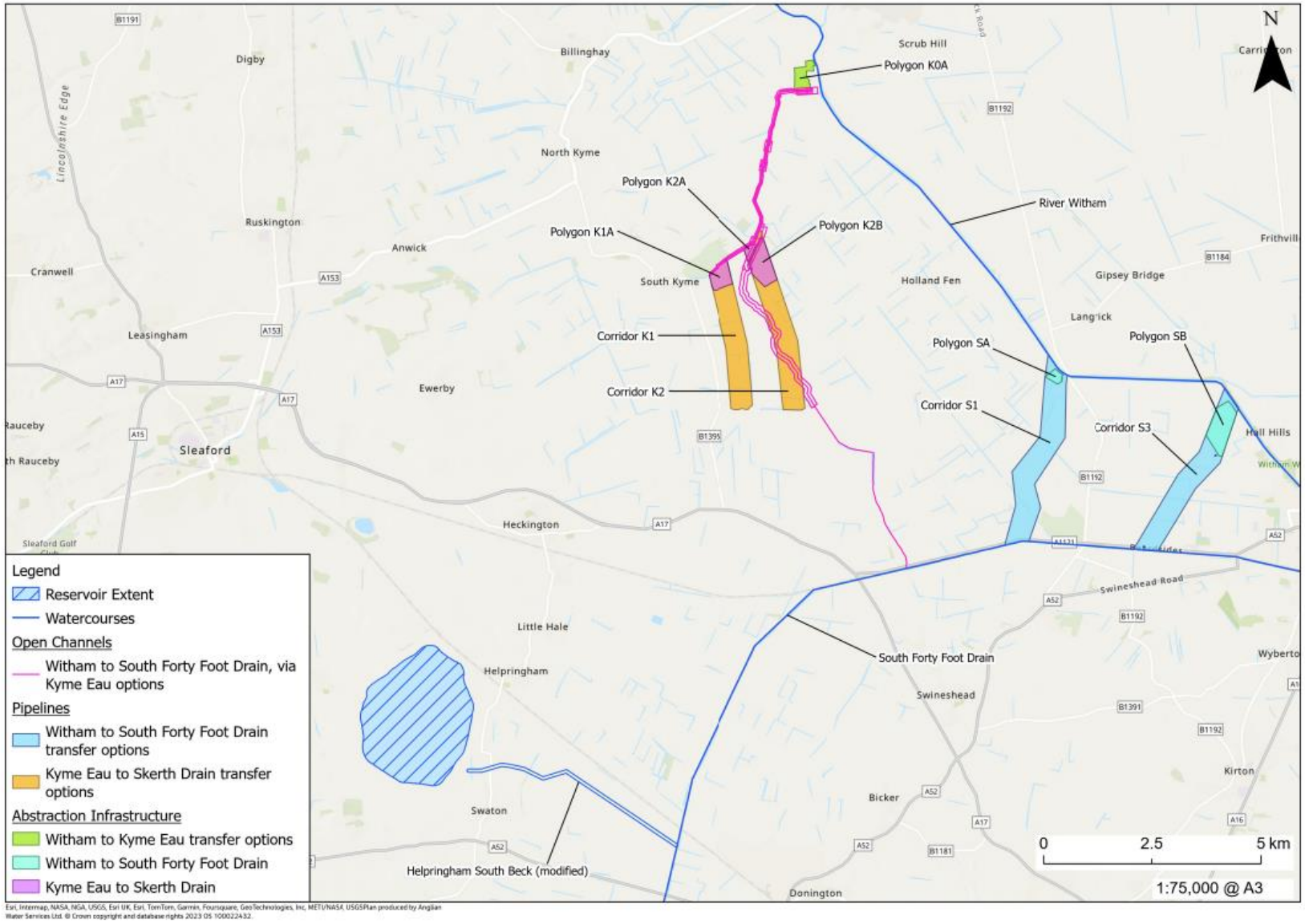
3.4.56 The components brought forward from Stage B to Stage C are summarised in Table 3-2 and shown in Figure 3.11.

Table 3-2: Upstream component options for River Witham to South Forty Foot Drain transfers progressed to Stage C

Transfer component	Associated abstraction infrastructure polygons
Pipeline transfer option from the River Witham to the South Forty Foot Drain : S1	
Pipeline Corridor S1	Polygon SA
Pipeline transfer option from the River Witham to the South Forty Foot Drain : S3	
Pipeline Corridor S3	Polygon SB
Hybrid transfer via the Kyme Eau : KH1	
Open channel transfer through Kyme Eau	Polygon K0A
Pipeline Corridor K1	Polygon K1A

Transfer component	Associated abstraction infrastructure polygons
Open channel transfer through Skerth Drain	n/a
Hybrid transfer via the Kyme Eau : KH2	
Open channel transfer through Kyme Eau	Polygon K0A
Pipeline Corridor K2	Polygon K2A, Polygon K2B
Open channel transfer through Skerth Drain	n/a
Open Channel transfer via the Kyme Eau : KO	
Open channel transfer through Kyme Eau	Polygon K0A
Open channel transfer through Holland Dyke	Polygon K2A, Polygon K2B
Open channel transfer through Skerth Drain	n/a

Figure 3.11: River Witham to the Lincolnshire Reservoir transfer component options considered at Stage C



Upstream water transfers

3.4.57 Two pipeline transfer options labelled Corridor S1 and Corridor S3, two hybrid transfer options, KH1 and KH2, and one open channel transfer option, KO, for transferring water from the River Witham to the South Forty Foot Drain were assessed at Stage C fine screening. The open channel and hybrid options are via Kyme Eau and Skerth Drain, which would be connected either by a pipeline or an open channel.

Pipeline transfer options from the River Witham to the South Forty Foot Drain

3.4.58 Both pipeline options, Corridor S1 and Corridor S3, abstract water from the River Witham near Langrick to the west of Boston, and discharge into the South Forty Foot Drain near Hubberts Bridge.

3.4.59 Corridor S1 is approximately 4.4km and leaves the River Witham in a southerly direction until it crosses the North Forty Foot Bank west of Brothertoft, where it takes a south-westerly direction. After crossing Kirton Drove, the corridor turns south until it is in line with Boston West Golf Centre where the corridor takes a south-westerly direction, passing to the west of the Boston West Golf Centre until it reaches the South Forty Foot Drain to the west of Hubberts Bridge.

3.4.60 Corridor S3 is approximately 3.9km and leaves the River Witham north of Boston West in a south-westerly direction, crossing the North Forty Foot Bank to the south-east of Brothertoft, and reaching the South Forty Foot Drain to the east of Hubberts Bridge.

3.4.61 Both pipeline options include:

- A new intake on the River Witham and pumping station.
- Provision for INNS and/or water quality treatment, if required.
- A pipeline.
- Outfall into the South Forty Foot Drain.

3.4.62 Corridor S3 is the shortest corridor and is therefore expected to have the corresponding lowest cost and carbon emissions. The intake location for Corridor S3 is preferred to the intake for Corridor S1 from a geomorphology perspective.

3.4.63 The WFD considerations for the two pipeline corridors are similar and are therefore not a differentiator. Both have a risk of WFD deterioration due to a deterioration in water quality. WFD water quality status in the Lower Witham has a lower status for ammonia and potentially phosphate and PFOS compared to the Black Sluice water body.

3.4.64 There are no designated heritage assets within either Corridor S1 or Corridor S3, however, there have been more archaeological finds within Corridor S1 than in Corridor S3, and stakeholder feedback (Historic England) noted particular concern around Corridor S1.

3.4.65 There are more noise sensitive receptors that may be impacted if the pipeline was constructed in Corridor S1 than Corridor S3. These sensitive receptors include residential properties.

3.4.66 There is a slight preference from a biodiversity perspective for Corridor S1 compared with Corridor S3 due to potential for direct impact on two priority habitats located within the S3 corridor. However, it is likely that potential risk of impact can be reduced or mitigated to prevent significant effects, for example by routing the pipeline within the wider corridor area to avoid the priority habitat, and so this is not considered a significant consenting risk at this stage.

Transfers from River Witham to South Forty Foot Drain via the Kyme Eau

3.4.67 The two hybrid transfer options (KH1 and KH2) and one open channel transfer option (KO) between River Witham and the South Forty Foot Drain all utilise the Kyme Eau, a tributary of the River Witham, and Skerth Drain, a tributary of the South Forty Foot Drain. The Kyme Eau and Skerth Drain are not currently hydraulically connected and therefore works are required to connect the two watercourses. Three options were considered for providing connectivity: upgrading the Holland Dyke, and two pipeline options, Corridors K1 and K2. Both pipeline corridors follow a similar alignment to Holland Dyke. Corridor K2 overlaps with the existing Holland Dyke channel, whereas Corridor K1 is west of Holland Dyke and east of Clay Bank. The components required for each of the options are shown in Table 3-2.

3.4.68 To allow transfer via the Kyme Eau, a new control structure would be needed at the downstream end of the Kyme Eau to allow water levels within the Kyme Eau to be raised. Water would be pumped from the River Witham into the Kyme Eau. Information available on the condition of the Kyme Eau banks indicates that they would need to be improved to facilitate the transfer. The following works are required for all of options KH1, KH2 and KO via the Kyme Eau:

- Improvements to up to 5.6km of the banks of the existing open channel in the Kyme Eau.
- New locks and sluice gates at the downstream end of the Kyme Eau.
- A new intake on the River Witham and pumping station to pump water into the Kyme Eau.
- Provision for INNS and/or water quality treatment, if required.

3.4.69 Options KH1, KH2 and KO all utilise approximately 4.75km of the Skerth Drain for open channel transfer. An initial capacity check indicates that the existing Skerth Drain has sufficient capacity to convey abstraction flows and therefore no works are required, further hydraulic modelling will be required to assess this further.

3.4.70 The hybrid options KH1 and KH2 require an additional intake and pumping station to pump water from the Kyme Eau and into the pipeline for transfer to Skerth Drain.

3.4.71 Option KO requires widening and raising of the banks along Holland Dyke to increase its capacity and change it from a low-level carrier to a high-level carrier. It is expected that the existing South Kyme pumping station would need to be replaced with a new pumping station to provide sufficient space for the Holland Dyke channel upgrades.

3.4.72 Option KO is a higher cost option than the two hybrid options, KH1 and KH2, that include a pipeline to connect the Kyme Eau and Skerth Drain, but it is expected to have lower embodied carbon. The lower carbon emissions are reflective of the different construction techniques and materials associated with constructing new banks compared to an underground pipeline which has higher embodied carbon. The hybrid option KH2 with pipeline Corridor K2 has a longer pipeline section and is therefore expected to have a higher cost and carbon emissions than the hybrid option KH1 using pipeline Corridor K1.

3.4.73 All of the options via the Kyme Eau have a risk of WFD deterioration due to a deterioration in water quality. In common with the pipeline transfers from the River Witham to the South Forty Foot Drain, options via the Kyme Eau have a WFD risk as the water quality status in the Lower Witham has a lower status for ammonia and potentially phosphate and PFOS[19] compared to the Black Sluice water body. There are additional WFD risks associated with options via the Kyme Eau as the Kyme Eau has a lower status for dissolved oxygen than the Black Sluice water body and in addition, the Lower Witham has a lower status for ammonia and potentially phosphate than the Kyme Eau.

3.4.74 Raising water levels in the Kyme Eau could also have WFD impacts as it changes the hydrology and morphology of the lower Kyme Eau. The current understanding is that this could be mitigable, but further technical assessment is required and so it remains a risk at this stage.

3.4.75 The conversion of Holland Dyke from a low-level carrier to a high-level carrier (option KO) isolates it from the floodplain which has a WFD risk. The current understanding is that this could be mitigable, but further technical assessment is required and so it remains a risk at this stage.

3.4.76 All of the options via the Kyme Eau could result in less than substantial harm on the value of the listed buildings, through temporary alterations to setting. The permanent raising of banks is unlikely to result in harm on the value of these assets. There is also the possible medieval settlement near South Kyme and therefore there is potential for archaeological remains of regional importance for all options, again this is common to all three options via the Kyme Eau (options KH1, KH2 and KO).

[19] perfluorooctane sulfonate

3.4.77 There are no major environmental, land or planning differentiators between the two hybrid pipeline options KH1 and KH2.

3.4.78 The works on the Kyme Eau and Holland Dyke have potential for WFD opportunities, including habitat improvements, habitat creation and some water quality improvements. The hybrid pipeline options KH1 and KH2 have the same potential for opportunities linked to the Kyme Eau but not for Holland Dyke.

3.4.79 The Kyme Eau forms part of the Sleaford Navigation, a partially restored navigation route between the River Witham and Sleaford. The provision of new locks and sluice gates at the downstream end of the Kyme Eau as part of the options KO, KH1 and KH2 could improve water level control which may bring navigational benefits.

3.4.80 The open channel transfer option KO from the Kyme Eau at South Kyme to the South Forty Foot Drain may offer potential flood risk benefits to the Kyme Eau in fluvial floods due to the increased storage created and channel upgrade works.

3.4.81 If a Kyme Eau transfer option is taken forward, further technical work and engagement with stakeholders would be required to understand what potential benefits and opportunities may be delivered.

Comparison of pipeline transfers and transfers via the Kyme Eau

3.4.82 The pipeline corridors S1 and S3 between the River Witham and the South Forty Foot Drain are a similar length to the pipeline sections of the hybrid options KH1 and KH2 via the Kyme Eau, however they do not require the rest of the works associated with the channel upgrades that are needed for the open channel part of the Kyme Eau hybrid options. The River Witham to South Forty Foot Drain pipeline options S1 and S3 are therefore expected to be lower cost and carbon emissions than the Kyme Eau hybrid options KH1 and KH2 and they also have lower WFD risk. **The River Witham to South Forty Foot Drain pipeline options are therefore preferred to the Kyme Eau hybrid options KH1 and KH2.**

3.4.83 Of the two River Witham to South Forty Foot Drain pipeline options, Corridor S3 is the shorter option and is therefore expected to have a correspondingly lower cost and carbon emissions. Corridor S3 intake location is preferred to the Corridor S1 location for geomorphology. There is also a preference for Corridor S3 from an environmental perspective as there are less recorded archaeological finds and less sensitive receptors that may be impacted during construction and the potential for impacts on protected species is considered to be mitigatable. **River Witham to South Forty Foot Drain pipeline option Corridor S3 has therefore been taken forward to Stage D**.

3.4.84 **The open channel transfer option KO via Kyme Eau, Holland Dyke and Skerth Drain has also been taken forward to Stage D** as, although it is the highest cost solution, and has higher WFD risks, there is potential for benefits and opportunities (see paragraphs 3.4.78 to 3.4.80) associated with the open channel transfer that would not be

delivered by a pipeline or hybrid option. It is apparent from stakeholder engagement undertaken that there is a strong sentiment from statutory bodies for this option to be further investigated (including in respect of funding and the ability to mitigate the WFD risks preliminarily identified).

Abstraction infrastructure

Pipeline transfer options from the River Witham to the South Forty Foot Drain

3.4.85 If INNS or water quality treatment is required for transfer between the River Witham and the South Forty Foot Drain, this would be co-located with the pumping station from the River Witham for the pipeline transfers. Polygon SA is the abstraction infrastructure polygon for Corridor S1 and Polygon SB is the abstraction infrastructure polygon for Corridor S3.

3.4.86 There are more sensitive receptors near Polygon SA that could be impacted by construction activities than near Polygon SB, including a potential for impact on a Grade II listed building and, as with Corridor S1 (the associated pipeline corridor), it has a higher likelihood of archaeological finds. Polygon SB is therefore preferred over Polygon SA.

3.4.87 **Polygon SB has been taken forward to Stage D as it is associated with the preferred pipeline corridor S3**.

Transfers from River Witham to South Forty Foot Drain via the Kyme Eau

3.4.88 All transfer options via the Kyme Eau (options K0, KH1 and KH2) would require water to be pumped from the River Witham to the Kyme Eau. A single abstraction infrastructure polygon, Polygon K0A, for the pumping station from the River Witham to the Kyme Eau was considered at Stage C. There were no risks, potential benefits or opportunities identified for this polygon that would influence preference for the River Witham to South Forty Foot Drain pipeline options over the Kyme Eau hybrid (options KH1 and KH2) or open channel (option KO) options.

3.4.89 For transfer via the Kyme Eau (options KO, KH1 and KH2) any required INNS or water quality treatment would be provided between the Kyme Eau and Skerth Drain, which is where the water moves from the River Witham catchment into the South Forty Foot Drain catchment. The treatment would be co-located with the pumping station from the Kyme Eau.

3.4.90 Three abstraction infrastructure polygons were considered for the abstraction infrastructure between Kyme Eau and Skerth Drain at Stage C, Polygon K1A for pipeline corridor K1 and Polygons K2A and K2B for both pipeline corridor K2 and open channel transfer via Holland Dyke.

3.4.91 There were no risks, benefits or opportunities identified for the abstraction infrastructure polygons that would influence the preference for the River Witham to

South Forty Foot Drain pipeline options over the Kyme Eau hybrid or open channel options.

3.4.92 **Polygons K0A, K2A and K2B have been taken forward to Stage D associated with the open channel option via Kyme Eau, Holland Dyke and Skerth Drain**.

3.5 Element identification

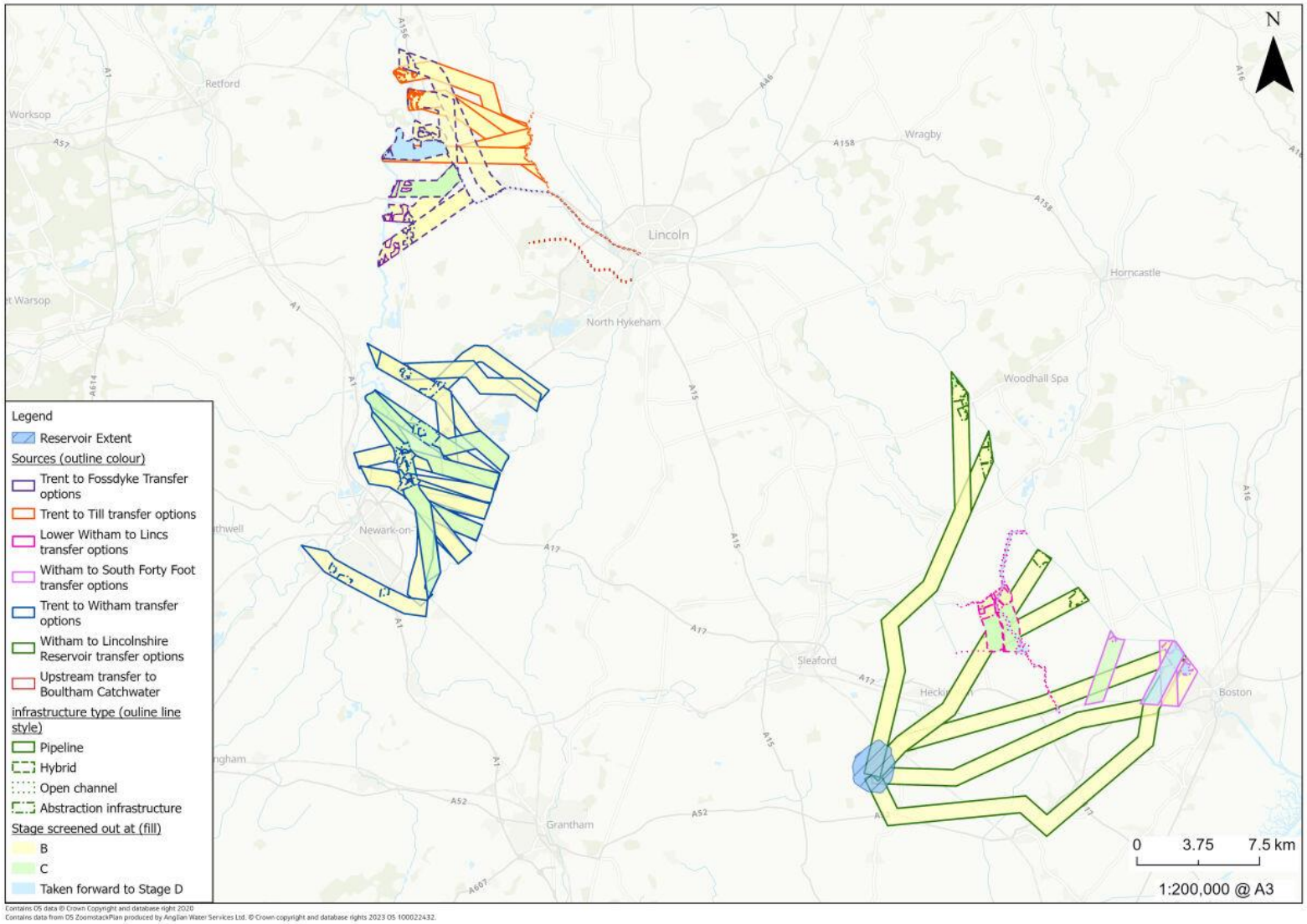
3.5.1 Figure 3.12 depicts the components identified and considered for the upstream infrastructure during the options appraisal process.

3.5.2 The components remaining at the end of the Stage C options appraisal process were then combined into elements, joining the preferred transfer component with the preferred abstraction infrastructure component progressed to Stage D. The element options for the upstream infrastructure components progressed to Stage D are shown in Table 3-3.

Table 3-3: Upstream elements progressed to Stage D

Element name	Transfer component	Abstraction infrastructure component
River Trent to River Witham	Hybrid option via the Fossdyke with pipeline Corridor F4	Abstraction and treatment (if required) near Torksey at Polygon F4B
River Witham to South Forty Foot Drain – pipeline transfer	Pipeline option (Corridor S3) from River Witham to South Forty Foot Drain	Abstraction at River Witham and treatment (if required) at Polygon SB
River Witham to South Forty Foot Drain – open channel transfer	Hybrid option via Kyme Eau, Holland Dyke and Skerth Drain	Abstraction from River Witham at Polygon K0A. Abstraction from Kyme Eau and treatment (if required) at Polygons K2A and K2B.

Figure 3.12: Summary of the Lincolnshire Reservoir upstream infrastructure options appraisal process



4 Downstream infrastructure

4.1 Introduction

4.1.1 This chapter outlines the approach and results of the first three stages of the options appraisal process (initial screening, coarse screening and fine screening) for the downstream infrastructure. This included identifying the broad search areas (Stage A), defining feasible downstream components (Stage B) and determining the preferred components (Stage C) for progression to Stage D for identifying the best performing whole scheme option.

4.1.2 Downstream infrastructure is required to treat and transfer water from the Lincolnshire Reservoir to the existing supply network. The start of each transfer is the reservoir and the end of the transfer is within the vicinity of the identified connection point to the existing Anglian Water supply network.

4.1.3 The components of the downstream transfer elements include the following:

- **Water treatment works**, required to treat the water to drinking water standards so that it is safe to drink.
- **Downstream transfer**, pipelines which would convey water from the water treatment works to the service reservoirs. Open channels are not suitable for downstream transfers of treated water because of the need to avoid contamination of the water which is treated to drinking water standard.
- **Service reservoirs** to store treated water at the connection points. Service reservoirs provide storage to manage daily fluctuations in water demand. They also allow supply to be maintained to the network in the event of an upstream interruption to the water treatment works or pipeline transfer. Locating the service reservoir close to the network it supplies is preferred as this reduces the likelihood of supply failure due to issues upstream of the service reservoir.

4.1.4 There are no existing facilities for transferring water between the Lincolnshire Reservoir location and the connection points and therefore new transfer infrastructure is required.

Connection Points

4.1.5 Anglian Water's revised draft WRMP24 identified that the water from the Lincolnshire Reservoir would be supplied to the Ruthamford North water resource zone with a transfer from Ruthamford North to Bourne water resource zone but did not identify specific connection points within the water resource zones. At Stage A and B of the associated water infrastructure options appraisal developed options to connect to three existing water distribution hubs within the two water resource zones:

- Wilthorpe: located in Lincolnshire to the south-west of Thurlby and is within the Bourne water resource zone.
- Etton: located in Cambridgeshire to the north-west of Peterborough and is within the Ruthamford North water resource zone.
- Chesterton: located in Cambridgeshire to the south-west of Peterborough and is within the Ruthamford North water resource zone.

4.1.6 Further consideration of specific connection points and integration with the existing Anglian Water network was undertaken in parallel with the options appraisal process to identify the points in the network for the associated water infrastructure to connect into. This concluded during Stage C of the associated water infrastructure options appraisal and identified two required connection points at Wilsthorpe and Chesterton. Etton was therefore not progressed as a connection point in Stage C.

4.1.7 As Bourne water resource zone is between the Lincolnshire Reservoir and the Ruthamford North water resource zone, transfer options to both Etton and Chesterton were developed via Wilsthorpe.

4.2 Stage A – Initial screening

4.2.1 Initial screening was completed to identify broad search areas in which the water treatment works, downstream transfers and service reservoirs for each of the confirmed connection points could be feasibly sited. These broad search areas are shown on Figure 4.1.

4.2.2 The delivery points for treated water from the reservoir have been defined by Anglian Water in its rdWRMP24 as Ruthamford North water resource zones, but the rdWRMP24 did not identify specific connection points. Further assessment of connection points and integration with the existing Anglian Water network was undertaken in parallel with the options appraisal process. At Stage A the search areas therefore focussed on three existing Anglian Water distribution hubs:

- Wilsthorpe, in Lincolnshire
- Etton, in Cambridgeshire
- Chesterton, in Cambridgeshire

Downstream pipelines

4.2.3 Two Stage A search areas have been developed for the transfer pipelines from the Lincolnshire Reservoir to Etton via Wilsthorpe, and the Lincolnshire Reservoir to Chesterton via Wilsthorpe. These are shown at Figure 4.1.

4.2.4 The shortest and most direct pipeline route between start and end locations was identified and the search area was then defined by drawing an ellipse enclosing the start and end locations based on 1.5 times the shortest, most direct route between the start and end points. This constraint was applied to avoid excessively long pipeline routes, taking account of environmental, carbon, resource use and cost factors for both construction and operational phases of delivery that increase with the length of any pipeline. The multiplier of 1.5 was used to define the extent of the ellipse as professional judgement suggested this would provide a practical limit, whereby pipelines extending beyond these bounds were likely to be prohibitively long.

Water treatment works

4.2.5 The search area for the downstream potable water treatment works was defined by considering the downstream pipeline search areas between the Lincolnshire Reservoir and the closest network connection point. The Stage A search area for the water treatment works is included at Figure 4.1.

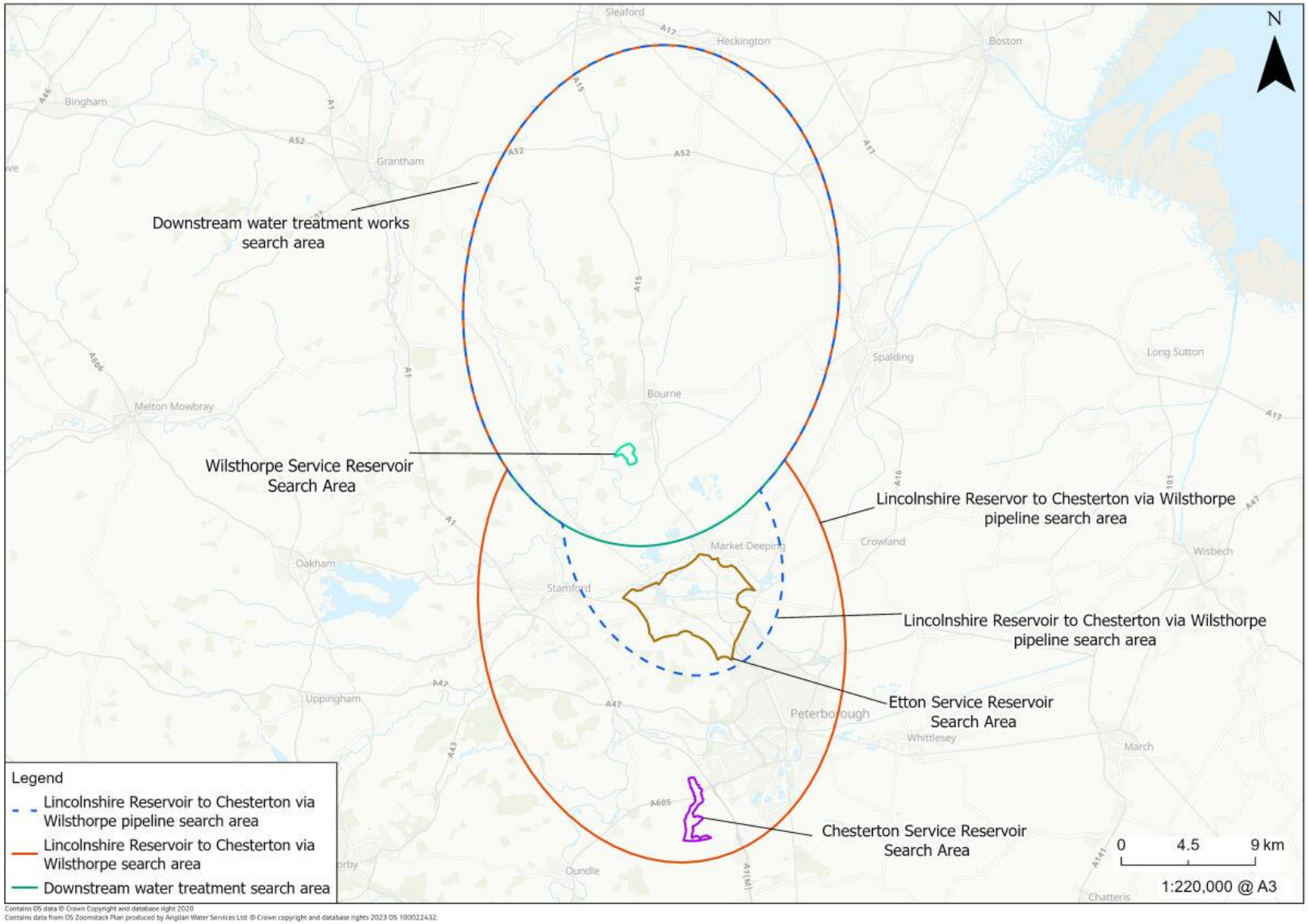
Service reservoirs

4.2.6 New service reservoirs were considered at each of the three connection points (Etton, Chesterton, and Wilsthorpe), which are close to existing service reservoirs. The new and existing service reservoirs need to be close as they will be required to work together hydraulically so that the water levels move up and down in conjunction with each other, thereby maintaining current pressure and flow direction in the existing network[20]. To achieve this, the new and existing service reservoirs would need to be at a similar elevation and to connect to the existing network in a similar location.

4.2.7 The search areas for the new service reservoirs have therefore been focussed around the location of the existing service reservoirs. Topographical contour lines were used to determine the ground level at the existing service reservoirs. Ideally the proposed and existing reservoirs would have the same top water level; however, a practical limit on the difference in ground elevation of 8m was selected in order to develop a search area that was large enough to contain multiple feasible sites once further constraints have been excluded. The search area selected would achieve a similar elevation at existing and new service reservoirs. The Stage A search areas developed for service reservoirs are included at Figure 4.1.

[20] Changes in pressure and flow direction in the network can cause increased leakage and water quality issues.

Figure 4.1: Downstream transfer search areas



4.2.8 The engineering, environmental, planning, and social and community constraints mapping were applied to the broad search areas identified in Stage A (see Appendix A for details of the criteria applied) for the water treatment works and service reservoirs to identify exclusion areas. This refers to areas within the broad search areas where existing constraints (e.g. built-up areas) would prevent the placement of above-ground infrastructure within that area.

4.2.9 The engineering, environmental, planning, and social and community constraints mapping was not applied at Stage A to the pipeline search areas as they are below-ground assets and constraints can be avoided, or impacts mitigated by routing the pipeline around constraints or using trenchless construction techniques (such as trenchless crossings).

4.3 Stage B – Coarse screening

4.3.1 The purpose of Stage B was to identify component options within the search areas identified in Stage A and to assess the component options against the Stage B options appraisal criteria.

4.3.2 Component options were screened against the environmental, planning, engineering, land use, social and community criteria set out in Appendix A identified as being considered at Stage B. These criteria were selected to allow key constraints to be identified for each option identified in the search areas to understand the likely feasibility of each option and potential consenting risks. This was used to inform decision making on which those options to take forward for Stage C fine screening for more detailed assessment against the Stage C criteria. The component options with the least constraints, which as a result are likely to carry the lowest risk to project delivery, were carried forward to Stage C for fine screening and a more detailed assessment against criteria.

4.3.3 Within the broad search areas, potential routings for the downstream pipelines and locations for the water treatment works and service reservoirs were identified.

4.3.4 The downstream options considered at Stage B are presented at Figure 4.2, while the water treatment works considered at Stage B are presented at Figure 4.4.

Downstream pipelines

4.3.5 Pipeline corridors have been defined between the reservoir (as the water treatment works location was unknown at this stage) to each connection point in the same way as has been described for upstream pipelines.

4.3.6 Seventeen corridor options were identified across the three search areas, as shown in Figure 4.2 and Figure 4.3:

- Lincolnshire Reservoir to Wilsthorpe: Six pipeline corridor options.

- Wilsthorpe to Etton: Five pipeline corridor options.
- Wilsthorpe to Chesterton: Six pipeline corridor options.

Figure 4.2: Lincolnshire Reservoir to Wilsthorpe transfer component options considered at Stage B

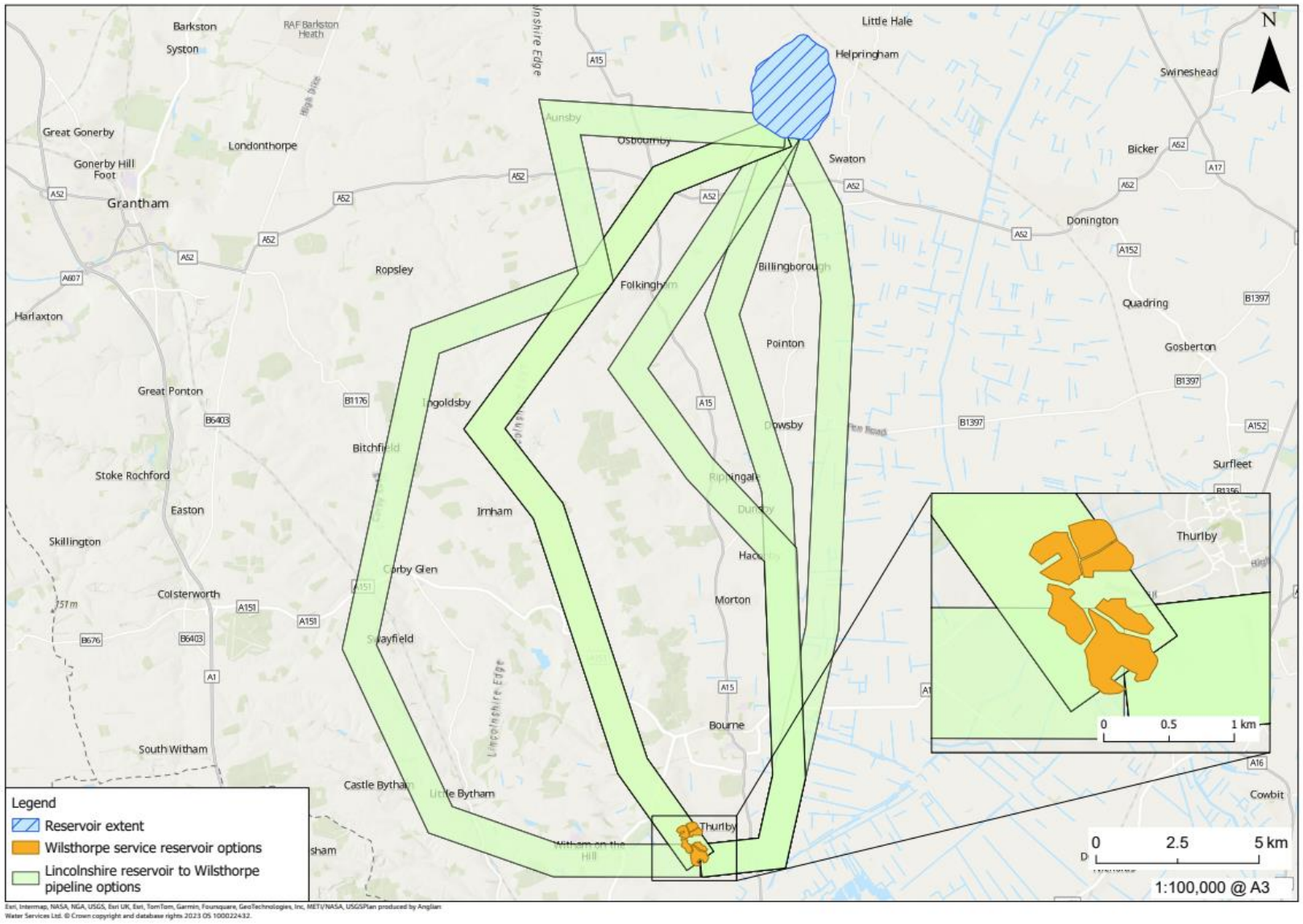
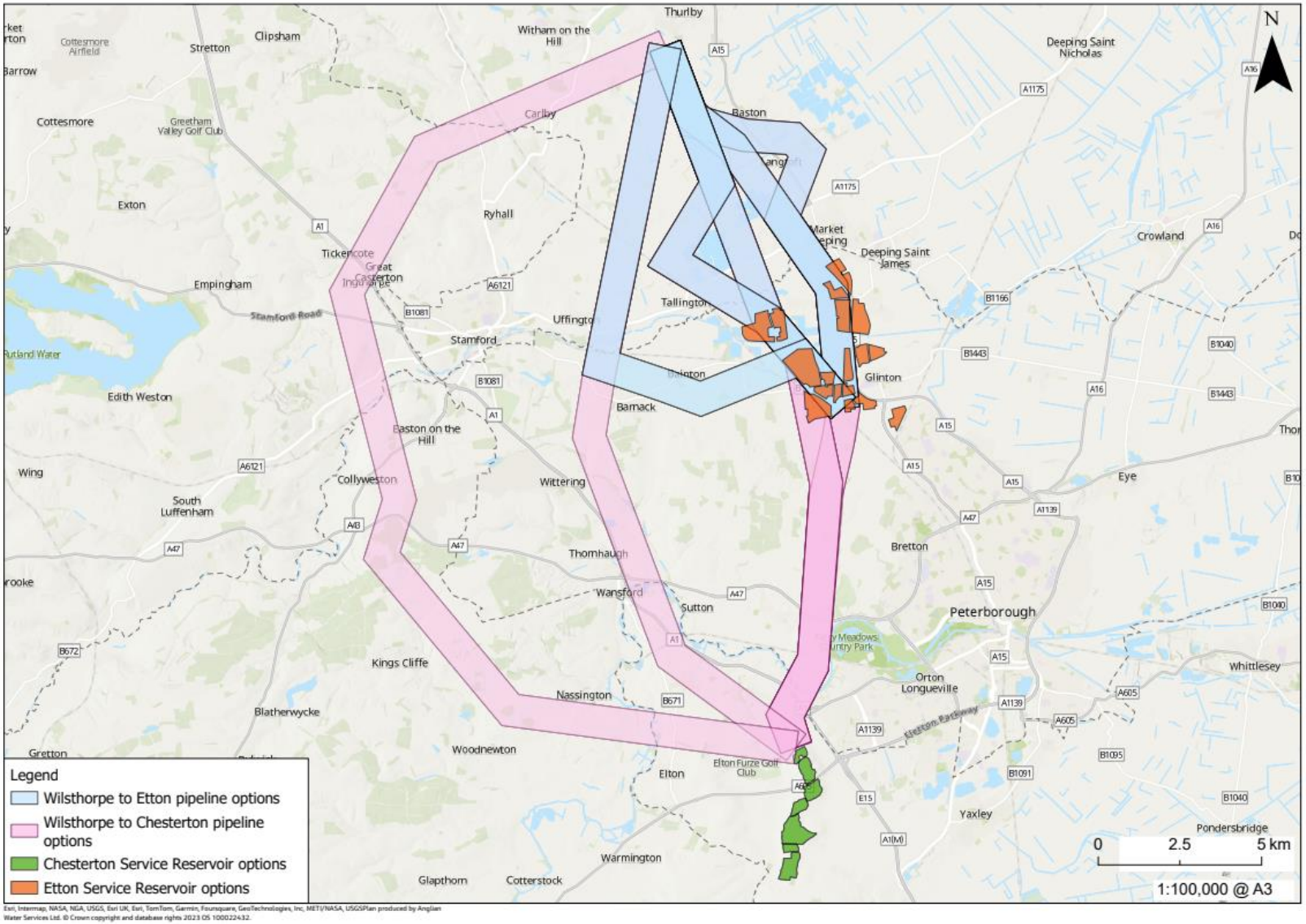


Figure 4.3: Wilsthorpe to Etton and Wilsthorpe to Chesterton transfer component options considered at Stage B



Water treatment works

4.3.7 Water treatment works polygons were required to have a minimum land area of 18.4ha to allow space for both the water treatment works and the temporary space needed during construction.

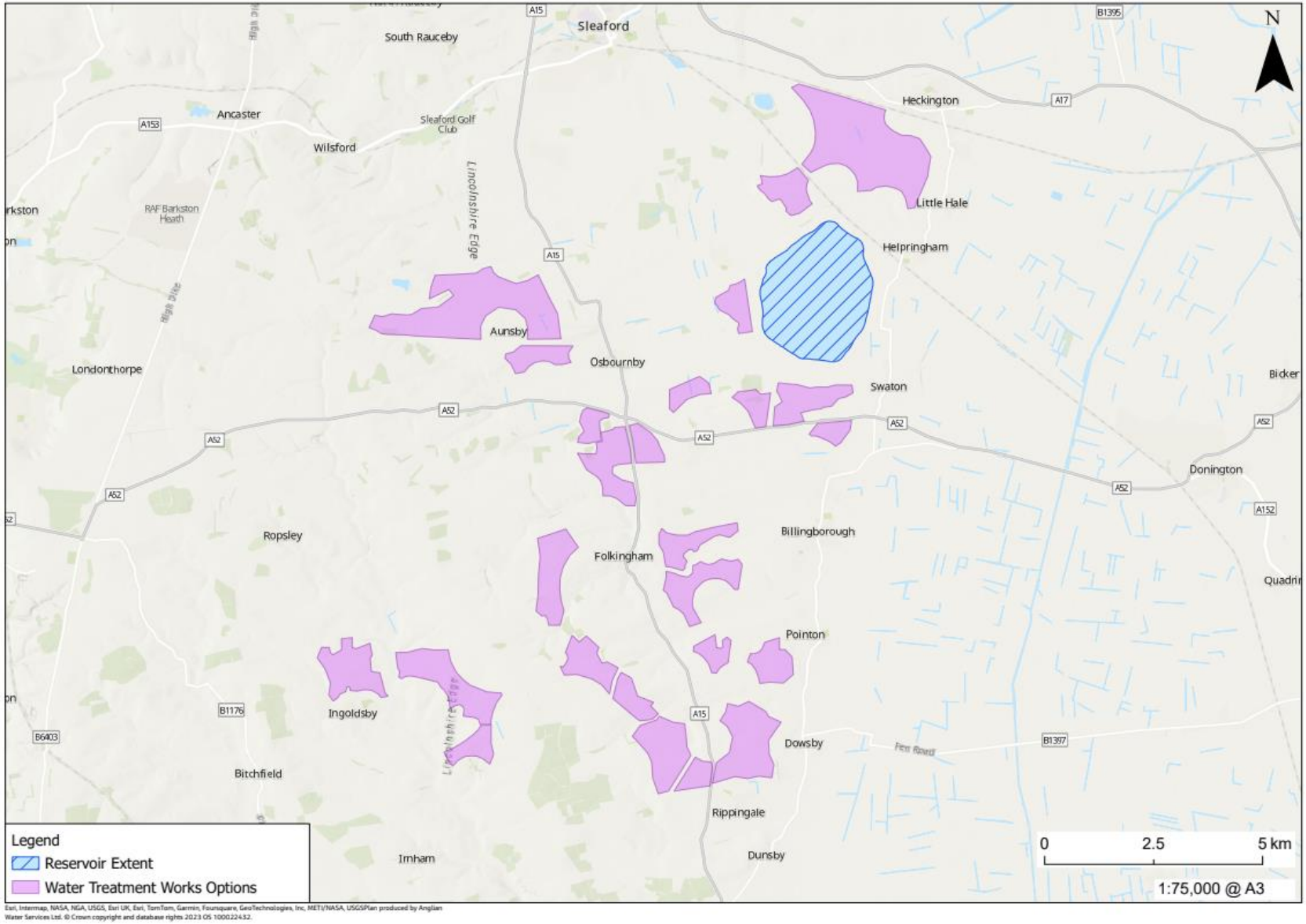
4.3.8 Flood mapping was used to identify suitable areas located outside Flood Zones 2 and 3 in accordance with the Sequential Test[21]for critical infrastructure, and so this flood mapping was used as an additional constraint during the development of polygons.

4.3.9 Eighty potential locations for the water treatment works were identified within the search area. Forty-three polygons were assessed to be smaller than the minimum land area required and a further 12 polygons were distant from any of the identified pipeline corridor options; these 55 polygons were therefore not assessed against the Stage B criteria.

4.3.10 The remaining 25 polygons were assessed against the at Stage B criteria and their locations are shown in Figure 4.4.

[21] https://www.gov.uk/guidance/flood-risk-and-coastal-change#the-sequential-approach-to-the-location-of-development

Figure 4.4: Water treatment works component options considered at Stage B



Service reservoirs

4.3.11 The area of land required for each service reservoir was assessed based on being able to accommodate both the footprint size of the service reservoir, and the temporary space (based on an early preliminary assessment) needed during construction. This assessment then informed the minimum land area for the polygons identified at Stage B, which were.

- Chesterton: Seven polygons, minimum area 3ha.
- Etton: Eighteen polygons, minimum area 5ha.
- Wilsthorpe: Six polygons, minimum area 4ha.

4.3.12 Thirty-one potential locations for service reservoirs were identified at the three connection locations, as shown in Figure 4.2 and Figure 4.3.

Stage B screening

4.3.13 Stage B screening was undertaken for the downstream infrastructure as described for the upstream infrastructure in paragraphs 3.3.17 to 3.3.24.

4.3.14 Following the identification of least constrained components, a review was undertaken to identify any geographic 'gaps' between components that would be required to be combined into elements, e.g. water treatment works and downstream pipeline corridors. No gaps were identified, and therefore no additional components were required to link the components together.

4.3.15 The Stage B options were considered against the Stage B criteria set out in Appendix A to identify potential constraints that may affect the feasibility of the component or introduce consenting risk compared to the alternative options available. Preference was given to options with less constrained land on the basis that those options were likely to carry the overall lowest risk to consenting and project delivery. Further detail on this part of the process can be found in paragraph 3.3.17 to 3.3.24. These options were taken forward to Stage C fine screening for more detailed assessment against the Stage C criteria:

- Three pipeline corridors from Lincolnshire Reservoir to Wilsthorpe.
- Two pipeline corridors from Wilsthorpe to Etton.
- Three pipeline corridors from Wilsthorpe to Chesterton.
- Three water treatment works polygons. These are located between Scredington, Spanby, and Swaton in Lincolnshire.
- Three service reservoirs at Etton, two at Chesterton and two at Wilsthorpe.

4.4 Stage C – Fine screening

4.4.1 Fine screening incorporated four steps to support and inform decision-making on the options (from Stage B) for progression to Stage D – preferred whole scheme options appraisal for the associated water infrastructure elements. These were:

- Refinement of components taking into account the Stage B appraisals.
- The Stage C technical appraisals (the appraisal criteria can be found in Appendix A) to assess options against more detailed criteria and stakeholder engagement on individual components.
- Combination of the best-performing components into elements and technical appraisal of the combinations to ensure that when considered as part of an element, the best-performing components remained the best-performing components.

4.4.2 Where more than one element option was created from the best-performing component options, these were compared against each other to identify the best-performing element options for progression to Stage D.

Design refinement

4.4.3 Design refinement primarily involved amendment of pipeline corridors and above-ground infrastructure polygons to minimise encroachment on key constraints and maximise distance from sensitive receptors. Design refinement was based on the outcomes of the consideration of the criteria considered at Stage A and Stage B (as set out in Appendix A) which identified constraints, so that opportunities to refine the design could be identified to avoid these constraints, where reasonably practicable at this early stage in the process.

4.4.4 At this stage, pipeline corridor options were reduced from 1km to 500m. A corridor width of 500m is still many times wider than the actual corridor width that would be required for construction; however, it allows flexibility for the detailed routing of the pipeline at a later stage within the wider area of land being considered in the corridor. At some places, the width of the corridor was narrowed to less than 500m or its alignment was altered at specific points along the route in order to avoid or minimise potential impacts on particular environmental sensitivities and engineering constraints.

4.4.5 The polygons identified at Stage B for water treatment works and service reservoirs were not reduced in size to more closely match the expected land requirements. Keeping the full polygons at this stage gives greater flexibility for siting of the infrastructure within the polygon to avoid, reduce or mitigate any potential impacts. The preferred siting of the infrastructure within the polygons will identified at a later stage of the Project.

4.4.6 Further consideration of specific connection points and integration with the existing Anglian Water network to refine the connection points within the zones identified in the WRMP was undertaken in parallel with the associated water infrastructure options appraisal process. This concluded during Stage C and identified that preferred connection points were Wilsthorpe and Chesterton. These connection points enable the further transfer of water to other existing service reservoirs that were identified in Anglian Water's WRMP. **Service reservoir options at Etton and transfer corridors from Lincolnshire Reservoir to Etton, were therefore not considered at Stage C**.

Technical appraisals

4.4.7 Technical appraisals followed the same approach taken for upstream infrastructure, described in paragraphs 3.4.7 to 3.4.10. The full list of criteria considered at Stage C is included in Appendix A. The following sections present the outcomes of the assessments for the downstream infrastructure, focussing on aspects that are key differentiators between options or where there are potential consenting risks.

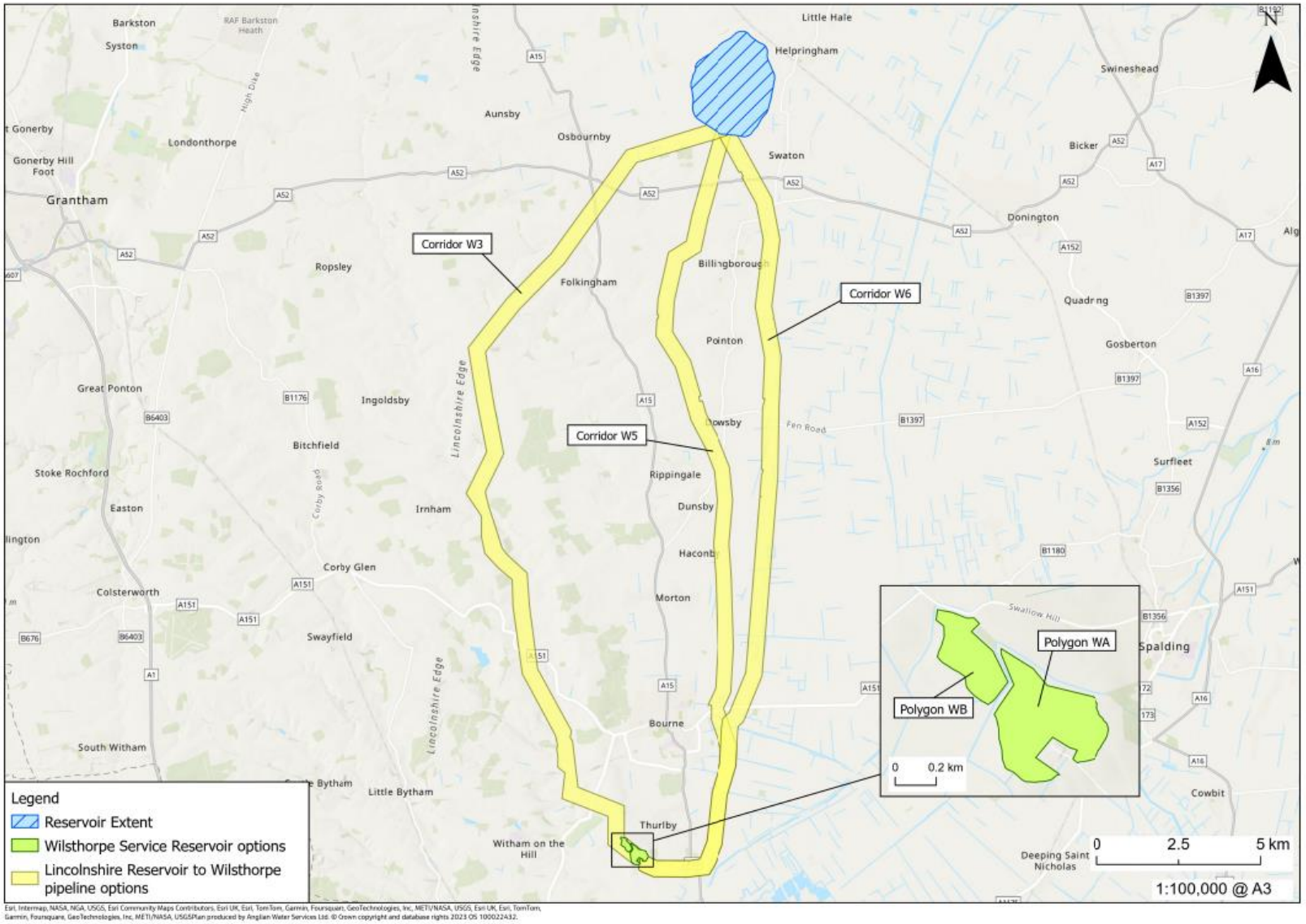
Lincolnshire Reservoir to Wilsthorpe

4.4.8 The component options brought forward from Stage B to Stage C are summarised in Table 4-1 and shown in Figure 4.5.

Table 4-1: Downstream component options for Lincolnshire reservoir to Wilsthorpe transfers progressed to Stage C

Transfer component	Associated water treatment works polygons	Associated service reservoir polygons
Pipeline Corridor W3	Polygon LR01, Polygon LR10, Polygon LR80	Polygon WA, Polygon WB
Pipeline Corridor W5		
Pipeline Corridor W6		

Figure 4.5: Lincolnshire Reservoir to Wilsthorpe transfer component options considered at Stage C



Pipeline transfers from Lincolnshire Reservoir to Wilsthorpe service reservoir

4.4.9 Three potential pipeline corridors have been considered between the reservoir and Wilsthorpe at Stage C. These are Corridors W3, W5 and W6.

4.4.10 Corridor W3 leaves the reservoir in a south-westerly direction towards Ingoldsby, crossing the A52 and A15 close to their intersection. It then turns to a southerly direction, crossing the A151 near Edenham, west of Bourne, and crossing the A6121 to the north of Toft. The corridor ends at the service reservoir location to the south-west of Thurlby.

4.4.11 Corridor W5 initially passes from the reservoir site towards Laughton, crossing the A52 to the east of Threekingham. Before reaching the A15 the corridor turns in a southerly direction, approximately parallel to the A15 and passing to the east of Rippingale and Bourne. It crosses the A151 to the east of Bourne. Near Thurlby the corridor turns west, crossing the A15 to the south of Thurlby and ending at the service reservoir location.

4.4.12 Corridor W6 is the most easterly option, crossing the A52 to the south of the Lincolnshire Reservoir and passing in a southerly direction to the east of Horbling, Billingborough and Pointon. It joins the W5 corridor to the east of Bourne as the corridors cross the A151. From there Corridor W6 follows the same alignment as W5, ending at the service reservoir location.

4.4.13 Corridor W3 goes through higher ground and therefore water would be pumped to an intermediate break pressure tank[22] close to the high point between Pickworth and Lenton from where it would gravitate to Wilsthorpe. In comparison Corridors W5 and W6 have flatter profiles and water would be pumped directly from the water treatment works to Wilsthorpe, without any intermediate break pressure tank.

4.4.14 Corridor W3 is the longest route and has a larger diameter pipeline in the gravity section beyond the break pressure tank compared to Corridors W5 and W6 which are more direct and require a smaller diameter pipeline.

4.4.15 Ground conditions are a key engineering differentiator as poorer ground conditions will likely increase construction cost and time. Based on the desktop assessments undertaken at this stage using British Geological Society maps[23], ground conditions for Corridor W3 are 76% moderately preferable and 24% favourable; however, due to topography, it is expected that the ground may slope across the corridor which would be more challenging for construction. In comparison, Corridor W5 is in unfavourable

[22] A break pressure tank, similar to a small service reservoir, is used in pipelines with an intermediate high point to manage pressure fluctuations within the pipeline when the pumps stop and start.
[23] British Geological Survey (BGS) 2023, Bedrock and superficial geology, made ground and mass movement 1:50,000 and British Geological Survey (BGS) 2020, Bedrock and superficial geology 1:625,000

ground conditions, typically made up of peat and alluvium for 13% of its length, and Corridor W6 is in unfavourable ground for 42% of its length.

4.4.16 Another key engineering differentiator is the length of the corridor in Flood Zone 3 which will impact on construction cost and complexity. The extent of the corridor in Flood Zone 3 increases for the three pipeline corridors from west to east with 6% of the area of Corridor W3, 19% of Corridor W5 and 42% of Corridor W6 in Flood Zone 3.

4.4.17 There are 35 Grade I and Grade II Listed Buildings in close proximity to Corridor W3, including a small number within the corridor, and so there is a potential for the construction of the pipeline to impact on the setting of the designated assets, although any impacts would be temporary during the construction period. It is considered that with suitable mitigation, including routing the pipeline away from heritage assets to avoid or minimise impacts where practicable, any substantial harm to these designated heritage assets would be avoided. Further assessment and engagement with stakeholders is required as the Project progresses.

4.4.18 Corridor W5 passes within 180m of the Sempringham Priory Scheduled Monument and Corridor W6 passes adjacent to the moated site Scheduled Monument north-east of Sempringham House Farm. Both corridors lie within 10m of the earthworks of Car Dyke Scheduled Monument in Park Wood. Historic England has noted that there is a potential for impact on these heritage assets and further assessment is required to understand any potential impact and mitigation. In accordance with NPS, Corridor W6 could result in substantial harm on the value of the moated site. Both Corridors W5 and W6 could result in substantial harm on the value of the scheduled section of Car Dyke, as well as non-designated sections. Car Dyke was, and still is in places, a water-filled channel which is likely to have created conditions to preserve archaeological remains and therefore there is a risk that any dewatering of the ground could impact any remains. Under the requirements of the NPS, non-designated heritage assets of archaeological interest that are demonstrably of equivalent significance to scheduled monuments should be considered subject to the policies for designated heritage assets. Corridor W3 is therefore preferred over Corridors W5 and W6 from a heritage perspective.

4.4.19 All three corridor options have potential hydrological connections to The Wash SPA, The Wash Ramsar and The Wash and North Norfolk Coast SAC. Corridor W3 is the only option that does not cross the Ouse Washes Goose and Swan Functionally Linked Land. Corridors W5 and W6 cross an area of Functionally Linked Land to the east of Bourne, although the Functionally Linked Land does not extend across the whole corridor width in either case. There could be temporary land requirements of Functionally Linked Land within Corridors W5 and W6, therefore, they have the potential for direct impact on functional habitat used by birds that are qualifying features of the designated sites, as well as indirect impacts of disturbance from construction activities. As such, Corridor W3 is preferred over W5 and W6 in this respect.

4.4.20 Corridor W6 was least preferred as it has a similar capital cost to Corridor W5 but has a longer proportion of the route in unfavourable ground conditions, and therefore a higher risk that construction cost and duration of the construction programme will increase. The impact of poor ground conditions for the trenchless crossings is not fully understood at this time as no ground investigations have been undertaken at the crossing locations. Corridor W6 is also least preferred from an environmental perspective. **Corridor W6 has therefore not been taken forward to Stage D.**

4.4.21 Corridor W3 is expected to have a higher capital and whole life cost than Corridor W5 but has lower engineering risks related to ground conditions and construction within the flood zones. Corridor W5 crosses through some Functionally Linked Land and has greater potential for heritage impacts compared to Corridor W3. **Both Corridor W3 and Corridor W5 were taken forward to Stage D to allow further consideration of each option against the criteria and as whole scheme options.**

Wilsthorpe service reservoir

4.4.22 Two polygons for the Wilsthorpe service reservoir were assessed at Stage C. These are Polygons WA and WB. The polygons are both located to the south-west of Thurby, close to the existing service reservoir.

4.4.23 Polygon WA is in proximity to the existing service reservoir and at a similar elevation, facilitating integration with the existing system. It is the largest of the two polygons and offers flexibility for siting the service reservoir within the polygon.

4.4.24 Polygon WB is further from the existing service reservoir, but it is at a similar elevation. However, it offers limited flexibility for service reservoir siting within the polygon as it is smaller in size and because the irregular shape of the polygon leaves limited room for siting.

4.4.25 There are no significant environment differentiators between the polygons based on the wide range of criteria considered, other than Polygon WA is in closer proximity to Dole Wood, which is a SSSI and a Lincolnshire Wildlife Trust Nature Reserve. The boundary of Polygon WA is approximately 58m from Dole Wood SSSI at the closest point, whereas Polygon WB is 486m away. There is flexibility for locating the service reservoir within Polygon WA further away from Dole Wood SSSI and it is expected that any construction or operational impacts could be avoided, reduced or mitigated through siting, good design and construction methodology.

4.4.26 **Polygon WA has been taken forward as the preferred option** as it is closer to the existing service reservoir facilitating integration with the existing system. There is flexibility for siting the service reservoir within Polygon WA to mitigate the potential risks associated with proximity to Dole Wood SSSI.

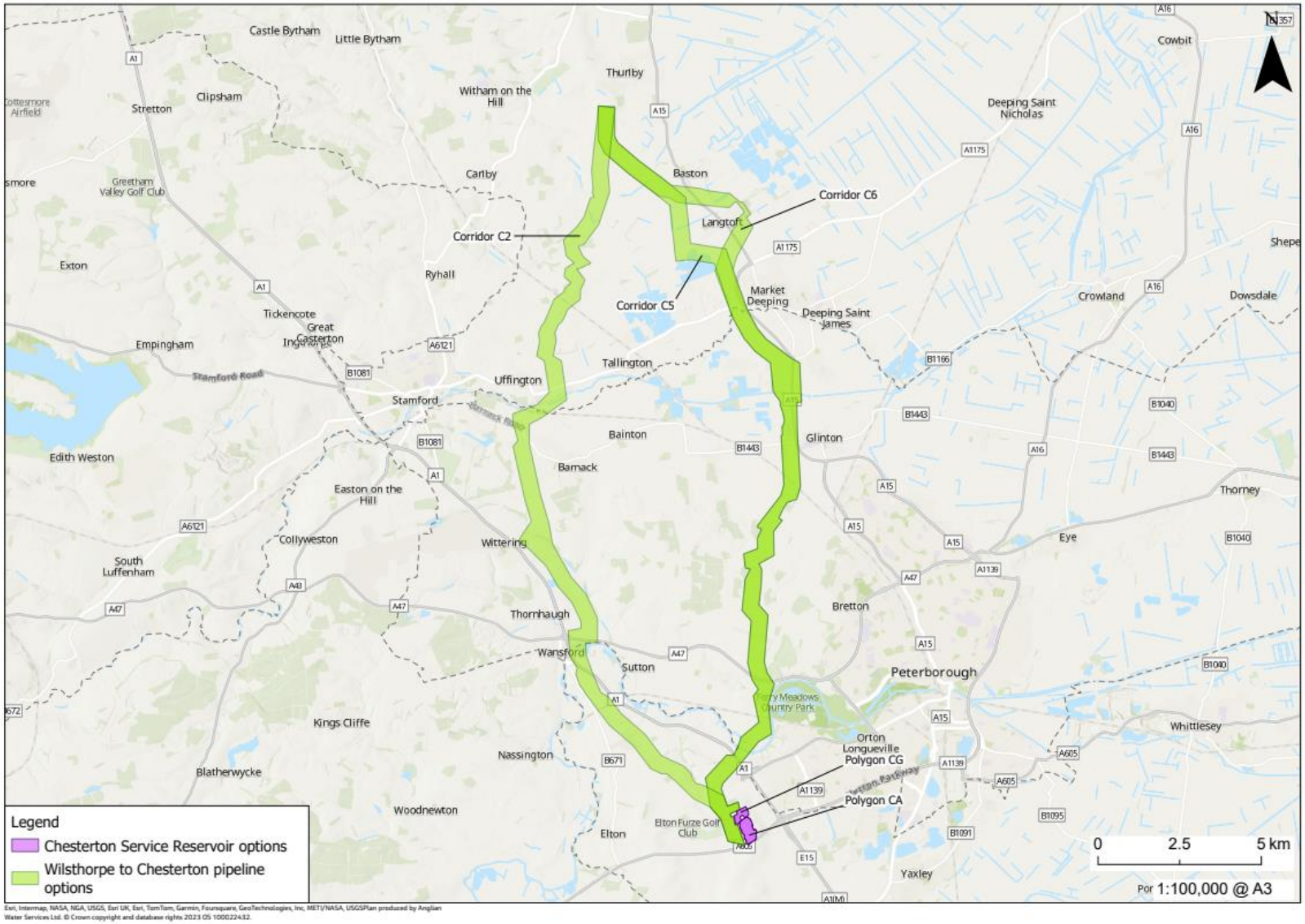
Wilsthorpe to Chesterton

4.4.27 The components brought forward from Stage B to Stage C are summarised in Table 4-2 and shown in Figure 4.6.

Table 4-2: Downstream component options for Wilsthorpe to Chesterton transfers progressed to Stage C

Transfer component	Associated service reservoir polygons
Pipeline Corridor C2	Polygon CA, Polygon CG
Pipeline Corridor C5	
Pipeline Corridor C6	

Figure 4.6: Wilsthorpe to Etton and Wilsthorpe to Chesterton transfer component options considered at Stage C



***Pipeline transfers from Wilsthorpe* to *Chesterton* service reservoir**

4.4.28 Three potential pipeline corridors have been considered between Wilsthorpe and Chesterton at Stage C. These are Corridors C2, C5 and C6.

4.4.29 Corridor C2 is the most westerly route, from the Wilsthorpe service reservoir site to the south-west of Thurlby it goes in a southerly direction towards Wittering, crossing the A1175 to the east of Uffington. The corridor then follows the east side of the A1 to Stibbington, crossing the A47 to the east of Wansford. After crossing the A1 near Stibbington the corridor turns south-east towards the Chesterton service reservoir location, west of Peterborough.

4.4.30 Corridors C5 and C6 follow a common alignment apart from in the vicinity of Tallington Lakes. From Wilsthorpe service reservoir the corridors run in a southerly direction, crossing the River Glen to the east of Wilsthorpe. At this point the corridors diverge with Corridor C5 passing to the west of Langtoft Village where the space for a pipeline corridor is very constrained, whereas Corridor C6 passes to the east of Langtoft, crossing the A15 twice, to avoid the very constrained area. Corridor C5 and C6 rejoin to the west of Market Deeping and follow the west side of the A15 to Glinton. The corridors then continue in a southerly direction, crossing the A47 near Peterborough between Ailsworth and Ferry Meadows Country Park. The corridors pass west of Peterborough crossing the A1 near Alwalton and ending at the Chesterton service reservoir location, west of Peterborough.

4.4.31 The engineering assessment of Corridor C5 also took into account recent Anglian Water experience of constructing a pipeline in the same geographic area. From this experience, it is understood that there is insufficient space to construct a pipeline between Langtoft Village and the Tallington Lakes, south of Stowe Road. Space will be further constrained in the future by a planned housing development. **It has therefore been concluded that Corridor C5 is not feasible** because of the physical constraints which means there is insufficient space to construct a pipeline through this section. Corridor C6 also has space constraints in the vicinity of Langtoft Village, however it is considered to have sufficient space to construct the pipeline, although further assessment and design work is required to better understand any construction challenges.

4.4.32 Corridor C2 provides opportunity to cross-connect into existing mains supplying another existing Anglian Water service reservoir, which provides additional operational benefits. This cross-connection is not possible with Corridors C5 or C6 and therefore another new pumping station would be required to supply the service reservoir.

4.4.33 The length of route in Flood Zone 3 is less of a differentiator for the Wilsthorpe to Chesterton corridor. Approximately 4% of Corridor C2 is within Flood Zone 3 compared to 23% for Corridor C5 and 24% for Corridor C6.

4.4.34 Corridor C2 is slightly less preferable for WFD considerations, compared to Corridor C6, as it crosses a larger area of Source Protection Zones. This option has the potential to impact eight surface water bodies and five groundwater bodies. In comparison Corridor C6 has the potential to impact nine surface water bodies and three groundwater bodies. Further assessment is required to understand any potential risks and mitigation that may be required.

4.4.35 The Stage C corridors have been refined such that there are no Scheduled Monuments within the corridors. Corridor C2 is in close proximity to six Scheduled Monuments, Corridor C5 is in close proximity to five Scheduled Monuments and Corridor C6 is in close proximity to four Scheduled Monuments. If associated non-designated remains were to extend outside the scheduled boundary, construction works may remove or partially remove these remains. From a heritage perspective, there are similar risks with all the corridors, taking account of the number of scheduled monuments in close proximity to the corridors, there is slight preference for Corridor C6 over Corridors C2 and C5.

4.4.36 There is the potential for the construction of the pipeline to temporarily impact the setting of the designated heritage assets in close proximity to the corridor, but this is expected to be mitigatable, including through sensitively routing the pipeline away from the designated asset within the wider corridor area, wherever practicable. This is common to Corridors C2, C5 and C6 and is therefore not a differentiator.

4.4.37 Corridor C2 is the preferred option from Wilsthorpe to Chesterton as it provides the opportunity for additional cross-connections for operational flexibility, which removes the need for an additional new pumping station. Corridor C2 avoids the spatially constrained area near Tallington and less of the corridor is in Flood Zone 3. There are no major environmental differentiators between Corridor C2 and Corridor C6 that would alter the preference for Corridor C2. **Corridor C2 was therefore taken forward to Stage D as the preferred transfer option from Wilsthorpe to Chesterton.**

Chesterton service reservoir

4.4.38 Two polygons for the Chesterton service reservoir were assessed at Stage C. These are Polygons CA and CG. Polygon CG is the smaller of the two polygons and is in proximity to the existing Anglian Water service reservoir site. Polygon CA is immediately to the south of Polygon CG and is approximately double the area. Between Polygons CA and CG are a number of buildings and a minor road.

4.4.39 The areas to the west and north of Polygon CG are steeply sloping and therefore there is insufficient space within the search area defined at Stage A for the new service reservoir which was based on a practical limit on the difference in ground elevation of 8m to the existing service reservoir; therefore no polygons were identified within these areas at Stage B. Construction of a service reservoir on these steep slopes would require extensive excavation and filling to create a level foundation for the service reservoir. Founding a structure on fill creates a risk of settlement and cracking which

could lead to failure of the service reservoir. There is also existing water infrastructure that is part of the existing service reservoir within this area, and this would need diverting. As a result, these areas are not suitable for locating a new service reservoir, and so they are not considered as alternative options.

4.4.40 There is a Roman barrow Scheduled Monument to the north-east of Polygon CG. Construction of a new service reservoir to the north-east of Polygon CG has the potential to impact the setting of the Scheduled Monument. There is potential for unidentified archaeological remains being discovered which, if associated with the Scheduled Monument, could be subject to the same policies in the NPS that afford a high degree of protection. The presence of the Scheduled Monument to the north-east of Polygon CG resulted in no potential polygons being identified in this area at Stage B.

4.4.41 Polygon CG is closer to the Scheduled Monument and also to the deciduous woodland priority habitat to the south-west of the existing reservoir than Polygon CA and therefore has greater potential for impacts on these sites. The shape of Polygon CG limits the flexibility for siting of the service reservoir within the polygon to mitigate any potential impacts.

4.4.42 The land within Polygon CG is currently used for fruit production and as a camping site and these land uses could be permanently impacted by the construction of a new service reservoir within the polygon. These impacts may be reduced through siting of the service reservoir within the polygon.

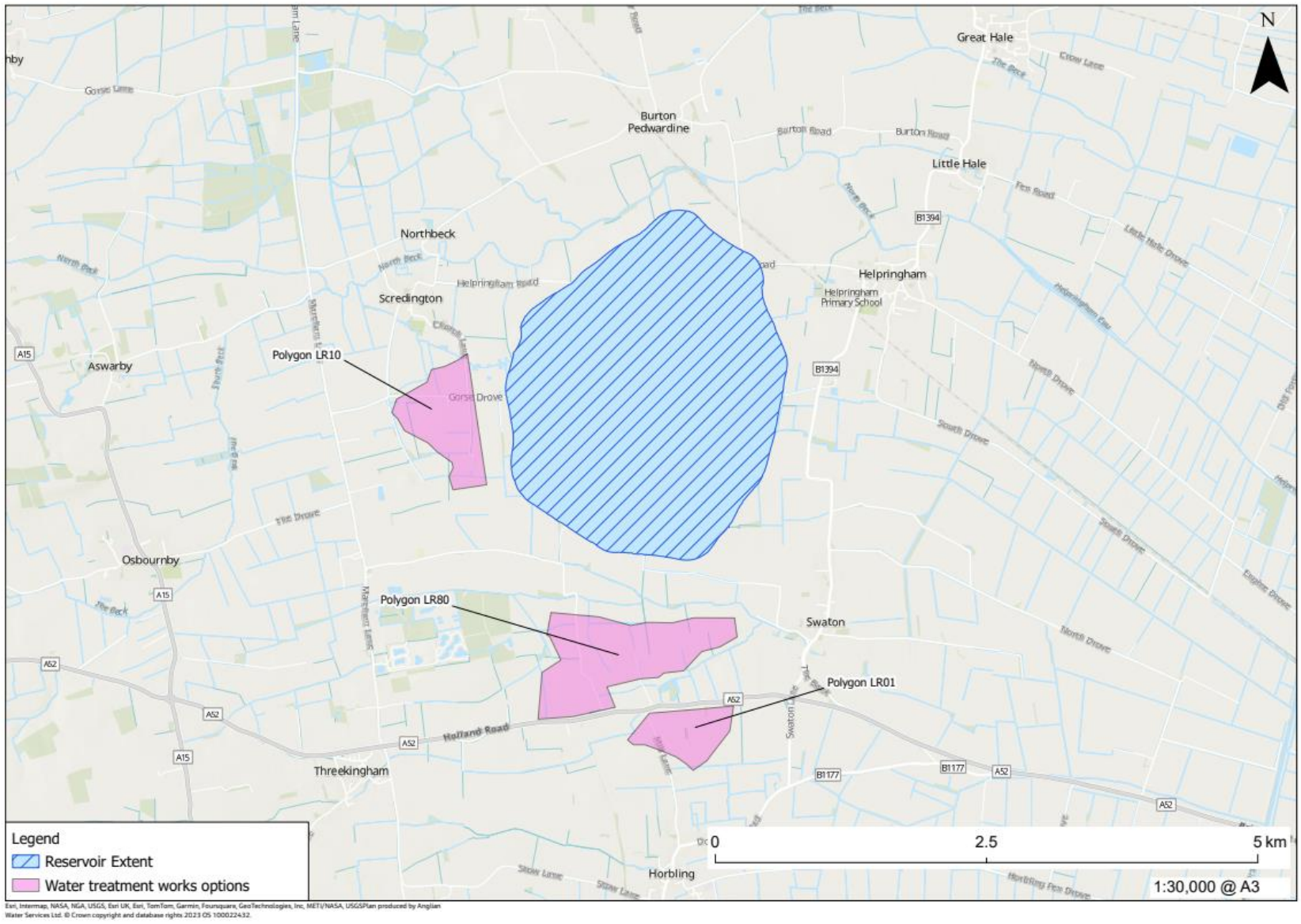
4.4.43 **Both Polygons CA and CG have been taken forward from Stage C.** There are no strong engineering differentiators between the polygons. The environmental constraints indicate a preference for Polygon CA, whereas Polygon CG would be preferred on grounds of proximity to the existing service reservoir and integration with the existing network. Engagement with landowners and the impact on existing businesses need to be explored further before identifying a preferred polygon.

Water treatment works

4.4.44 Three potential land polygons for the water treatment works location have been assessed against the Stage C fine screening criteria, as shown at Figure 4.7. These are:

- LR01 to the south of the Lincolnshire Reservoir site and south of the A52.
- LR10 to the west of the Lincolnshire Reservoir site, between Scredington and Spanby.
- LR80 to the south of the Lincolnshire Reservoir site and north of the A52.

Figure 4.7: Water Treatment Works options considered at Stage C



4.4.45 The identified polygons are larger than the area required for the permanent water treatment works site and have sufficient space to accommodate the additional space requirements during the construction period (as identified based on a preliminary assessment). Preferred locations for the water treatment works within the overall polygons have not been determined at this stage and would be assessed as the design develops. This flexibility in siting of the water treatment works within the larger polygon area allows further assessments to be undertaken to inform the design work so that the water treatment works can be sited in a location that avoids or minimises potential impacts wherever practicable.

4.4.46 The treatment process would be the same regardless of the location of the water treatment works and therefore is not a factor in differentiating between the polygons.

4.4.47 The capital cost and carbon emissions estimates are similar for three sites: LR80 is the lowest cost option and LR10 the highest cost option. The difference in whole life cost between LR80 and LR10 is approximately 5% based on the differences in:

- Offsite pipeline, e.g. between the water treatment works and the Lincolnshire Reservoir. For example, the raw water pipeline from the reservoir is expected to be shorter for LR80 than LR10.
- The amount of cut and fill that is expected to be required, noting that the siting of the water treatment works within the polygon has not yet been determined.
- Length of the access road to the water treatment works from an existing road.

4.4.48 LR01 and LR80 are both south of the reservoir site, as is the treated water transfer from the reservoir towards the Anglian Water supply network. The raw water pipeline between the reservoir and water treatment works is therefore transferring water towards the network connection point. The length of the raw water main therefore contributes to a reduction in the length of the treated water pipeline from the water treatment works. In comparison LR10 is to the west of the reservoir and therefore the raw water pipeline does not contribute to a reduction in length of the treated water pipeline which leaves the site in a southerly direction.

4.4.49 The ground levels at the polygons mean that for LR80 the water can gravitate from the reservoir to the water treatment works for the greatest operating range of the reservoir. For LR01 water can gravitate to the water treatment works through the majority of the reservoir operating range, however a pumping station will be required for when the reservoir levels are low. LR10 is at a higher elevation and therefore water would need to be pumped to the water treatment works, except when the reservoir is near full.

4.4.50 The assessment of power availability has concluded that a power upgrade would be needed for each of the polygons. The works required are assumed to be similar for each site and therefore not considered to be a differentiator.

4.4.51 LR01 is the smallest of the three sites (34 ha) and therefore there is limited flexibility in siting of the water treatment works within the polygon.

4.4.52 LR01 has a watercourse intersecting with the western boundary of the polygon which is potentially hydrologically connected to European sites (The Wash SPA, Ramsar, and The Wash and North Norfolk Coast SAC) and therefore an Appropriate Assessment is expected to be required. This could be mitigated by the selection of location for the water treatment works within the polygon to avoid the watercourse which would remove the risk of direct impacts. Further investigation is needed to assess the likely direct and indirect impacts and potential measure to avoid or reduce (mitigate) any impacts.

4.4.53 The LR01 polygon is within the Horbling Fen SSSI Impact Risk Zone and there is potential hydrological connectivity that would therefore require assessment.

4.4.54 LR01 is closest to the Horbling Conservation Area and would likely affect the greatest number of residential visual receptors, including the settlement edges of Swaton and Horbling. There may also be potential impacts on several Grade I listed buildings (churches) through changes to their setting. Adverse impacts to the value of these designated heritage assets could be managed through landscape mitigation. However, there may be residual changes to their setting, in particular due to the inter-relationship between the churches.

4.4.55 LR10 spans a ridge from which the land falls away to the north, south and west. There are four residential buildings on the ridge. The topography means that the water treatment works would be sited on the ridge and the sloping ground to the south which would impact on the existing residential properties, requiring demolition of some properties.

4.4.56 LR80 is the largest water treatment works polygon (103ha) of the three polygons considered at Stage C and therefore offers greatest flexibility for siting the water treatment works within the polygon. It is closest to the main reservoir and therefore has the shortest pipelines between reservoir site and water treatment works and, as the polygon is along the route of the downstream transfer, the overall length of the downstream pipeline for the transfer of treated water towards the Anglian Water network will be reduced by that amount.

4.4.57 LR80 is the most preferred polygon from a heritage perspective, although there is a Grade I listed building (Church of St Michael) approximately 1.3km to the east of the polygon, and there could be potential indirect impacts through changes to its setting.

4.4.58 LR80 is preferred over LR01 and LR10 for both engineering and environmental perspective. It is the largest polygon and therefore offers the greatest flexibility for water treatment works siting. The ground level of the polygon allows water to gravitate to the water treatment works across the greatest range of water levels in the reservoir, minimising operational cost associated with transfer of raw water to the

water treatment works. There are no residential properties within the polygon, unlike LR10, and therefore no requirement for demolition.

4.4.59 **Polygon LR80 was carried forward to Stage D as the preferred location for the water treatment works**.

4.5 Element identification

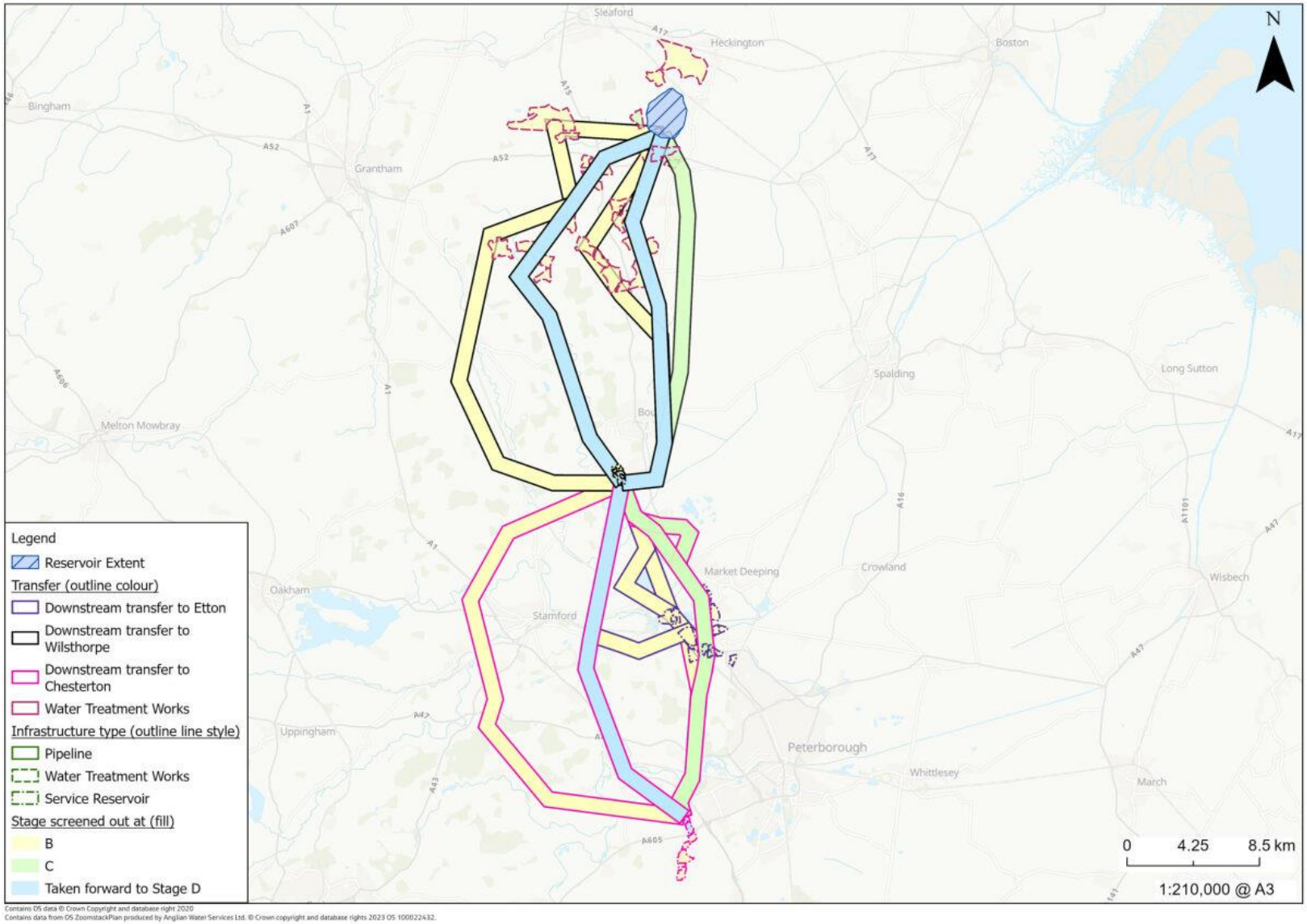
4.5.1 Figure 4.8 depicts the components identified and considered for the downstream infrastructure during the options appraisal process.

4.5.2 The components remaining at the end of the Stage C options appraisal process were then combined into elements, joining the preferred transfer component with the preferred water treatment works component and preferred service reservoir components. The element options for the downstream infrastructure components progressed to Stage D are shown in Table 4-3.

Table 4-3: Downstream elements progressed to Stage D

Element name	Transfer component	Water treatment works component	Service Reservoir component
Lincolnshire Reservoir to Wilsthorpe – option 1	Pipeline option (Corridor W3)	Polygon LR80	Polygon WA
Lincolnshire Reservoir to Wilsthorpe – option 2	Pipeline option (Corridor W5)		Polygon WA
Wilsthorpe to Chesterton	Pipeline option (Corridor C2)	n/a	Polygons CA and CG

Figure 4.8: Summary of the Lincolnshire downstream infrastructure options appraisal process



5 Emergency drawdown disposal route

5.1 Introduction

5.1.1 This chapter outlines the approach and results of the options appraisal process for the disposal routes for flows from an emergency drawdown event. This included identifying the broad search areas (Stage A) and defining the preferred discharge flow route at Stage B. No further refinement of the emergency flow route was required at Stage C.

5.1.2 The purpose of the disposal route for flows from the reservoir in an emergency drawdown event is to allow the water level in the reservoir to be lowered in a controlled way. By identifying disposal routes for flows in the event of an emergency the risk of a catastrophic flood arising from the very unlikely circumstances of infrastructure failure is reduced. Such an emergency situation is very unlikely to occur over the lifetime of the reservoir, but as part of designing the reservoir the ability to draw it down must be included within the design, and consent secured for the safe disposal of water should it be required.

5.1.3 The options appraisal process has identified the preferred discharge channel route for flows in an emergency drawdown event. Managed watercourses that flow from the reservoir site towards the sea (which is a permanent disposal receptor) are preferred for disposal of drawdown flows.

5.1.4 Due to the circumstances in which any emergency drawdown event would occur, any expected significant adverse environmental effects that might arise from the highly unlikely operation of the emergency drawdown are proposed to be assessed, alongside the risks associated with catastrophic infrastructure failure, under the Major Accidents and Disasters assessment under the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. The assessment will, where appropriate, identify measures envisaged to prevent or mitigate any identified significant adverse environmental effects and provide details of the preparedness for such an event and proposed response(s).

5.1.5 If following the relevant work being undertaken in association with the Major Accidents and Disasters assessment, including any outcomes of ongoing engagement with technical stakeholders, further consideration is needed to investigate any potential additional interventions associated with emergency drawdown, this process and its outcomes will be reported at a later date.

5.2 Stage A – Initial screening

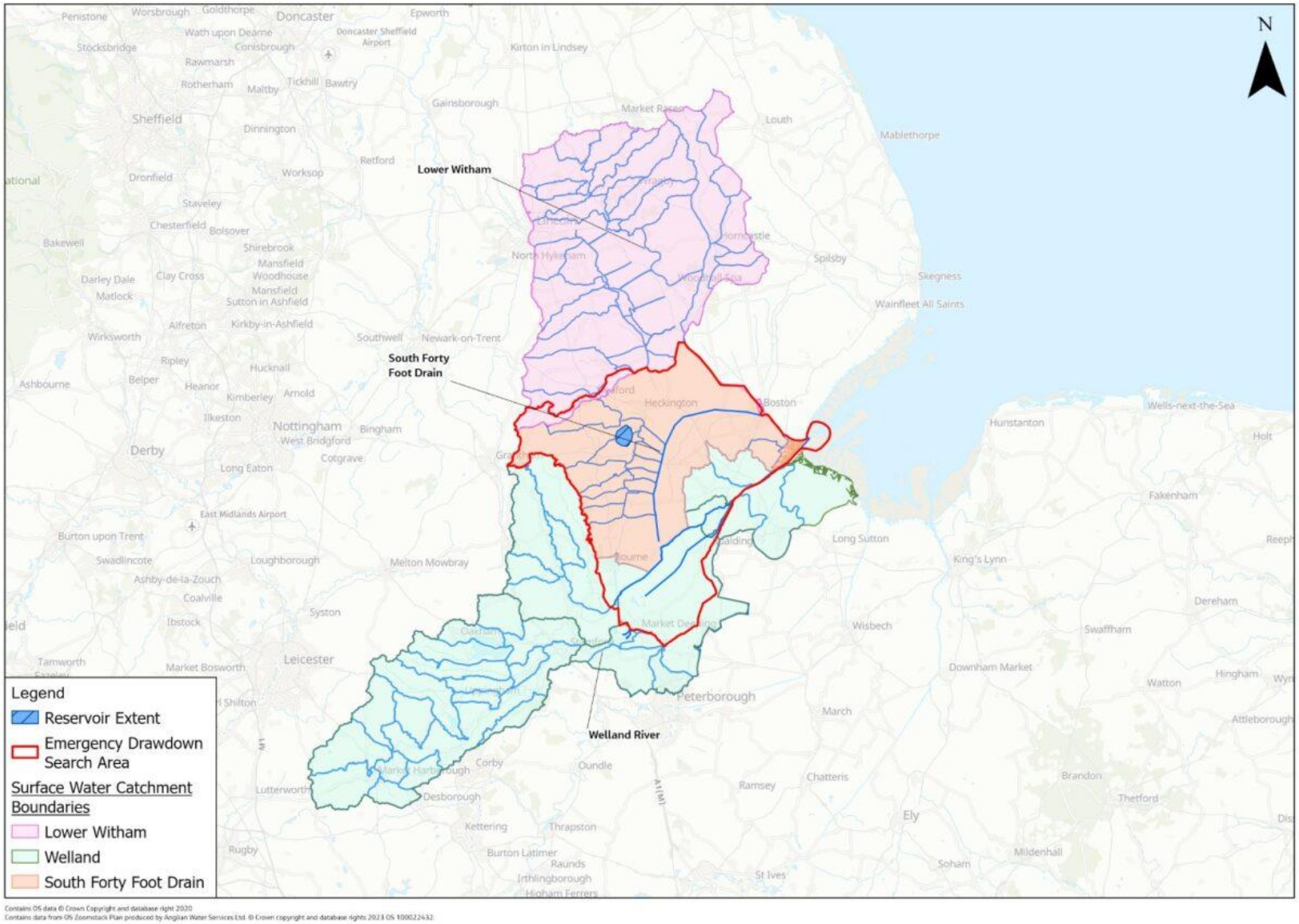
5.2.1 The initial screening for identifying the search area for emergency drawdown disposal routes comprised the following steps:

- Identification of the existing managed watercourses with connection to the proposed reservoir location.
- Identification of the existing flow direction of these watercourses.
- Identification of a potential ultimate disposal location.
- Definition of a suitable search area based on watercourse catchments and the existing flow direction.

5.2.2 The Lincolnshire Reservoir is within the South Forty Foot Drain catchment, which is adjacent to the Welland River basin to the south and the Witham River basin to the north, both of which discharge to the sea at The Wash, which is situated on the east coast of England at Boston. The South Forty Foot catchment joins the River Witham catchment at Black Sluice, near Boston. There is no existing connection between the South Forty Foot catchment and the River Welland catchment.

5.2.3 The existing water systems surrounding the proposed location of the Lincolnshire Reservoir drain to the east into the South Forty Foot Drain, which in turn eventually drains out to The Wash. The ultimate disposal location for emergency drawdown is therefore considered to be The Wash (the sea). The Stage A emergency drawdown disposal route search area is bounded by the River Witham to the north and the River Welland to the south. Its extent to the west is limited by topography so that flow from the Lincolnshire Reservoir to the preferred disposal route is by gravity. The emergency drawdown disposal route search area is shown in Figure 5.1.

Figure 5.1: Search area for emergency drawdown disposal route



5.3 Stage B – Coarse screening

5.3.1 The ultimate destination of any water released during an emergency drawdown event is The Wash (the sea). Stakeholder engagement with the Environment Agency and the Black Sluice IDB has been undertaken as part of Stage B to identify all potential options for routing the emergency drawdown flow from the reservoir to The Wash.

5.3.2 Operation of the drawdown in an emergency situation may change the freshwater inputs into The Wash for the duration that the flow route is utilised. The operational impacts of this on The Wash SPA, Ramsar, SSSI and The Wash & North Norfolk Coast SAC are uncertain at this stage, with modelling and further environmental assessment required as the Project progresses. This is common across all of the emergency drawdown disposal route options and therefore is not a differentiator in the selection of the preferred disposal route for water released during an emergency drawdown.

Main flow route

5.3.3 The hydraulic capacity of existing managed channels within the search area defined at Stage A was estimated using channel dimensions, or hydraulic models (where available). Hydraulic modelling assumed that any existing pumping stations that form part of the flow route can operate at their full design capacity at any point during a tidal cycle.

5.3.4 One existing managed channel was identified as a potential flow route to The Wash. This involves using the South Forty Foot Drain to the Black Sluice near Boston and then on to The Wash.

5.3.5 An alternative option of constructing a deep tunnel from the Lincolnshire Reservoir to The Wash was considered to create a new flow path to The Wash. The NPS (paragraph 4.3.13) says 'The highest level of biodiversity protection is afforded to sites identified through international conventions. The Habitats Regulations […] provide statutory protection for habitat sites'. The deep tunnel option would require construction activities within The Wash (SPA, Ramsar, SSSI) which would have direct impacts on the European and nationally designated sites and therefore, **discharge via the South Forty Foot Drain was identified as the preferred flow route**.

5.4 Stage C – Fine screening

5.4.1 No further assessment of the preferred flow route, the South Forty Foot Drain, was required for the disposal route in the event of an emergency drawdown at Stage C and the preferred disposal route identified at Stage B was carried forward to Stage D.

5.5 Transfer between the Lincolnshire Reservoir and the preferred flow route

5.5.1 The Lincolnshire Reservoir site is approximately 5km east of the South Forty Foot Drain, therefore transfer routes utilising open channels are required to transfer any water released from the reservoir during an emergency event to the main disposal route, the South Forty Foot Drain.

5.5.2 The South Forty Foot Drain is also both a source of supply for the Lincolnshire Reservoir and an open channel transfer for water from other sources, a transfer option between the South Forty Foot Drain and the Lincolnshire Reservoir is therefore also required for upstream transfers (see paragraphs 3.2.2 to 3.2.3).

5.5.3 Three existing watercourses were identified that flow from the vicinity of the Lincolnshire Reservoir to the South Forty Foot Drain and therefore are potential options for both transferring water from the reservoir to the emergency drawdown disposal route (the South Forty Foot Drain) and forming the upstream transfer from the South Forty Foot Drain to the reservoir :

- Helpringham South Beck
- Helpringham North Beck
- Swaton Eau.

5.5.4 The capacity of all three channels would need to be increased to transfer water released during an emergency from the Lincolnshire Reservoir to the South Forty Foot Drain.

5.5.5 The Swaton Eau option requires construction works through the village of Swaton, which present engineering challenges relating to space constraints for the required expansion of the existing channel, resulting in direct impact on a road and residential properties. Therefore, Swaton Eau was the least preferred option.

5.5.6 Helpringham South Beck requires extensive raising and widening which could result in a risk of WFD deterioration. This will change the hydromorphology of the channel and potentially lead to further floodplain disconnection which could pose a risk of WFD deterioration, although it is noted that the channel has already been extensively straightened/modified, so overall impact is expected to be less than for Helpringham North Beck.

5.5.7 The Helpringham North Beck option would require bank raising and the land available for constructing this is space constrained by the B1394 and nearby properties. Furthermore, the section of the North Beck that would be used for the transfer is relatively unmodified with greater hydromorphological diversity compared to Helpringham South Beck, so impacts on hydromorphology from any upgrades are

expected to be greater. The Grade II listed bridge that crosses the Helpringham North Beck would be likely to be impacted by the upgrade works to the Helpringham North Beck and the option could result in the bridge needing to be removed to facilitate the works. If removal of the bridge was required, this would be a significant impact on the designated heritage asset which would likely amount to substantial harm. There are further potential setting impacts on Helpringham Conservation Area, and changes to the historic landscape.

5.5.8 Helpringham South Beck offers the benefit for the channel to be used not only for emergency drawdown but also open channel transfer of water from South Forty Foot Drain to the reservoir site for filling the reservoir. Helpringham North Beck is a higher elevation and longer route, therefore it is more challenging to reverse flows from the South Forty Foot Drain to the reservoir site.

5.5.9 There are further opportunities with Helpringham South Beck option for the channel to provide navigation for leisure and transportation of materials for reservoir construction. The Helpringham North Beck does not offer these same opportunities. The rail bridge and Grade II listed bridge that cross the North Beck restrict headroom and therefore navigation opportunities.

5.5.10 Both Helpringham North Beck and Helpringham South Beck cross non-designated sections of the Car Dyke; there is potential for unidentified archaeological remains being discovered which, if associated with the Car Dyke Scheduled Monument, could be subject to the same policies in the NPS that afford a high degree of protection. The NPS (paragraph 4.8.5) says 'Non-designated heritage assets of archaeological interest that are demonstrably of equivalent significance to Scheduled Monuments should be considered subject to the policies for designated heritage assets[24]. The absence of designation for such heritage assets does not indicate lower significance'. Helpringham South Beck crosses Car Dyke in close proximity to the designated section and therefore could potentially impact the setting of Car Dyke Scheduled Monument. Historic England has advised that the heritage value of all aspects of Car Dyke needs to be considered and when choosing how to cross it, a proactive assessment is needed using appropriate data to inform this selection process. To reduce the potential for impacts on the designated section of Car Dyke, the Helpringham South Beck option includes a modification to alignment of Helpringham South Beck in the vicinity of the Scheduled Monument.

5.5.11 **Helpringham South Beck is taken forward in preference to Helpringham North Beck and Swaton Eau** for providing open water transfer to connect the Lincolnshire Reservoir and the South Forty Foot Drain. Helpringham South Beck is preferred when considered against both engineering and environmental criteria, as well being more suitable as an open channel transfer route for upstream transfers from the South Forty

[24] There will be archaeological interest in a heritage asset if it holds, or may potentially hold, evidence of past human activity worthy of expert investigation at some point.

Foot Drain. Helpringham South Beck has greater potential for navigation opportunities as Helpringham North Beck has physical constraints at existing bridges. Further assessment is needed to identify the best point at which to cross Car Dyke and this will be considered in consultation with Historic England.

6 Stage D – Whole scheme preferred option

6.1 Introduction

6.1.1 The final stage of the options appraisal process involved a comparative review of the whole scheme options based on desk-based technical appraisals, consideration of wider benefits and stakeholder input to establish the preferred location and routing of associated water infrastructure (upstream infrastructure, downstream infrastructure and the emergency drawdown disposal route) for the Lincolnshire Reservoir. This chapter summarises the approach and outcome of Stage D – whole scheme preferred options appraisal.

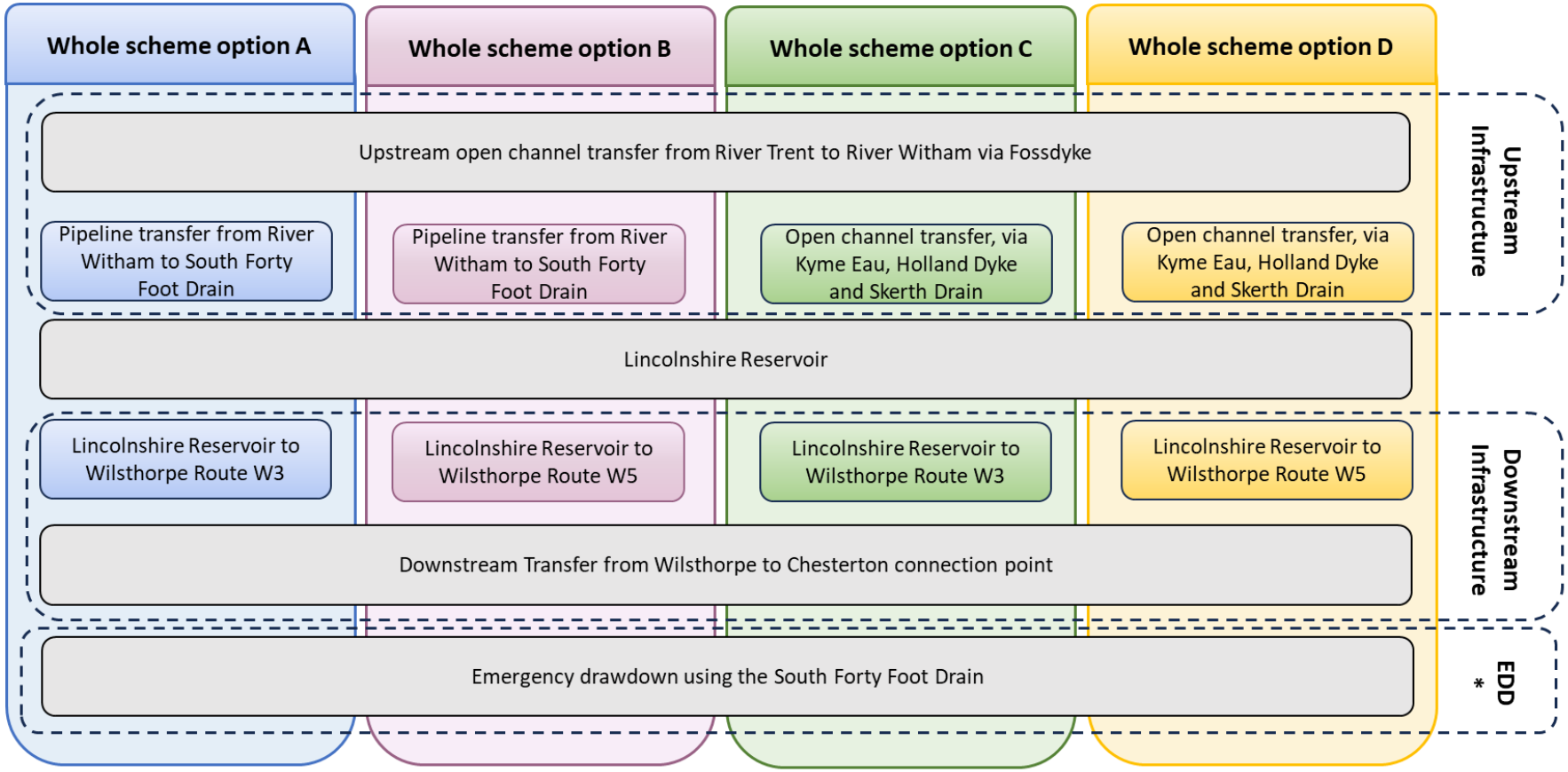
6.1.2 The preferred components identified through Stage C were combined to form four whole scheme options at Stage D. As shown in Figure 6.1, the key difference between the four whole scheme options is associated with:

- The upstream transfer of water from the River Witham to the South Forty Foot Drain.
- The downstream transfer of water from the Lincolnshire Reservoir to Wilsthorpe.

6.1.3 The other elements that form the whole scheme options were the same for all four whole scheme options.

6.1.4 The best-performing reservoir location has been identified through an earlier, separate options appraisal process. Stage D therefore focussed on the associated water infrastructure elements of the whole scheme options.

Figure 6.1: Overview of the Lincolnshire Reservoir Whole Scheme Options



*EDD = Emergency Drawdown

6.2 Whole scheme option A

6.2.1 An overview of WSO-A is included in Appendix C.1.

Upstream infrastructure

Table 6-1: Upstream elements included in WSO-A

Element name	Transfer component	Abstraction infrastructure component
River Trent to River Witham	Hybrid option via the Fossdyke with pipeline Corridor F4	Abstraction and treatment (if required) near Torksey at Polygon F4B
River Witham to South Forty Foot Drain – pipeline transfer	Pipeline Corridor S3 from River Witham to South Forty Foot Drain	Abstraction at River Witham and treatment (if required) at Polygon SB

River Trent to River Witham

6.2.2 Whole scheme option A (WSO-A) would take water from the River Trent, through the Fossdyke to the River Witham. An intake would be constructed on the River Trent, near to Torksey Lock, and water would be pumped through a pipeline to either the Fossdyke or a treatment works, if treatment is required.

6.2.3 Water quality treatment and any measures for INNS treatment, if required, would be placed south of Torksey Lock and to the west of the A1133. From the treatment works water would be transferred by pipeline to the Fossdyke.

6.2.4 Water would flow along the Fossdyke and into the River Witham. Some works may be required at constrained points along the Fossdyke to maintain water velocities that are suitable for the existing navigation on the channel. These works may include bypasses to increase capacity at specific constraints, such as bridges, or localised channel widening. However, further technical investigation is required to understand whether these works are needed.

River Witham to South Forty Foot Drain

6.2.5 From the River Witham water would be conveyed through a 3.9km pipeline to the South Forty Foot Drain. The intake would be on the west bank of the River Witham near Anton's Gowt. If water quality treatment and measures for INNS treatment and prevention were required, these would be located close to the intake. The discharge location to the South Forty Foot Drain would be close to Hubberts Bridge.

6.2.6 The South Forty Foot Drain and Helpringham South Beck would form an open channel transfer of water to the Lincolnshire Reservoir, where the water would be abstracted and pumped into the reservoir.

Downstream infrastructure

Table 6-2: Downstream elements included in WSO-A

Element name	Transfer component	Water treatment works component	Service reservoir component
Lincolnshire Reservoir to Wilsthorpe	Pipeline option Corridor W3	Polygon LR80	Polygon WA
Wilsthorpe to Chesterton	Pipeline option Corridor C2	n/a	Polygons CA and CG

6.2.7 From the reservoir, water will be treated and conveyed to the existing supply network at Wilsthorpe and Chesterton.

Lincolnshire Reservoir to Wilsthorpe

6.2.8 The water treatment works is proposed south of the reservoir between Swaton and Spanby. The 103ha land parcel is bordered by the A52 to the south. This is significantly larger than the 18.4ha estimated to be required for the both the water treatment works and the temporary space needed during construction.

6.2.9 From the water treatment works, treated water would be conveyed by pressurised pipeline to new service reservoirs at the two connection points into the Anglian Water supply network at Wilsthorpe (near Bourne) and Chesterton (near Peterborough). These reservoirs would store the treated water near to the existing supply network so that it can be released into the existing network.

6.2.10 The downstream pipeline corridor towards Wilsthorpe leaves the water treatment works in a westerly direction before turning south-west near Spanby. Near Lenton the corridor runs in a southerly direction towards Thurlby where the preferred area for the Wilsthorpe service reservoir is located to the west of Thurlby. The corridor is 28.4km in length and would require a 1,300 to 1,400mm diameter steel pipeline. The preferred construction method for the pipeline would be open cut installation techniques. Trenchless construction techniques have been assumed to be used to cross physical constraints such as A roads and main rivers, where open cut would be unlikely to be approved.

6.2.11 The preferred area of land identified for siting of a new Wilsthorpe service reservoir is between Thurlby and Manthorpe, to the south of Swallow Hill.

Wilsthorpe to Chesterton

6.2.12 From Wilsthorpe, the downstream transfer continues in a southerly direction, crossing the A1175 to the east of Uffingham and then running south to Wittering. From Wittering the corridor follows the A1 alignment, crossing the A1 near Wansford and then passing south-east towards the preferred area for the Chesterton service reservoir, to the west of Peterborough. The Wilsthorpe to Chesterton corridor is 24km

of 900 to 1,050mm diameter steel pipeline and would be installed by open cut installation techniques. Where the pipeline corridor crosses other critical crossings where open cut is not suitable, trenchless crossing techniques will be required as set out in paragraph 3.3.9 (e.g. rail, A road/ motorway, main rivers).

6.2.13 Two options remain for the siting of a new Chesterton service reservoir. These are Polygons CA and CG and they are both west of Orton Southgate and north of the A605.

Emergency drawdown disposal route

6.2.14 Discharge would be to an upgraded Helpringham South Beck and South Forty Foot Drain with discharge via Black Sluice identified as the preferred disposal route.

6.3 Whole scheme option B

6.3.1 An overview of WSO-B is included in Appendix C.2.

Upstream infrastructure

Table 6-3: Upstream elements included in WSO-B

Element name	Transfer component	Abstraction infrastructure component
River Trent to River Witham	Hybrid option via the Fossdyke with pipeline Corridor F4	Abstraction and treatment (if required) near Torksey at Polygon F4B
River Witham to South Forty Foot Drain – pipeline transfer	Pipeline Corridor S3 from River Witham to South Forty Foot Drain	Abstraction at River Witham and treatment (if required) at Polygon SB

6.3.2 Whole scheme option B (WSO-B) would transfer water from the River Trent to the River Witham and from River Witham to South Forty Foot Drain in the same way as WSO-A (refer to paragraphs 6.2.2 to 6.2.6).

Downstream infrastructure

Table 6-4: Downstream elements included in WSO-B

Element name	Transfer component	Water treatment works component	Service reservoir component
Lincolnshire Reservoir to Wilsthorpe	Pipeline option Corridor W5	Polygon LR80	Polygon WA
Wilsthorpe to Chesterton	Pipeline option Corridor C2	n/a	Polygons CA and CG

Lincolnshire Reservoir to Wilsthorpe

6.3.3 The water treatment works would be in the same location as for WSO-A (refer to paragraph 6.2.8).

6.3.4 From the water treatment works the pipeline corridor runs in a southerly direction, passing to the west of Birthorpe and running approximately parallel to the A15 to Bourne. The corridor stays to the east of Bourne and then turns west, crossing the A15, to the south of Thurlby.

6.3.5 The preferred location for the Wilsthorpe service reservoir is the same as for WSO-A (refer to paragraph 6.2.11).

Wilsthorpe to Chesterton

6.3.6 The downstream transfer between Wilsthorpe and Chesterton and the preferred location of the Chesterton service reservoir is the same as for WSO-A (refer to paragraphs 6.2.12 to 6.2.13).

Emergency drawdown disposal route

6.3.7 The emergency drawdown disposal route for WSO-B is as per that described above for WSO-A (refer to paragraph 6.2.14).

6.4 Whole scheme option C

6.4.1 An overview of WSO-C is included in Appendix C.3.

Upstream infrastructure

Table 6-5: Upstream elements included in WSO-C

Element name	Transfer component	Abstraction infrastructure component
River Trent to River Witham	Hybrid option via the Fossdyke with pipeline Corridor F4	Abstraction and treatment (if required) near Torksey at Polygon F4B
River Witham to South Forty Foot Drain – open channel transfer	Open channel option KO via Kyme Eau, Holland Dyke and Skerth Drain	Abstraction from River Witham at Polygon K0A. Abstraction from Kyme Eau and treatment (if required) at Polygon K2A or K2B

River Trent to River Witham

6.4.2 Whole scheme option C (WSO-C) would transfer water from the River Trent to the River Witham in the same way as WSO-A (refer to paragraphs 6.2.2 to 6.2.4).

River Witham to South Forty Foot Drain

6.4.3 Water would be transferred via open channel from the River Witham to the South Forty Foot Drain, via the Kyme Eau, upgraded Holland Dyke and Skerth Drain.

6.4.4 New locks and sluice gates would be provided at the downstream end of the Kyme Eau before its confluence with the River Witham, to allow water levels to be raised in the Kyme Eau and transfer into Holland Dyke. The banks of the Kyme Eau would need to be improved for up to 5.6km to facilitate the increase in water levels (see paragraph 3.4.68).

6.4.5 An intake would be constructed on the River Witham upstream of the confluence with the Kyme Eau and water would be pumped either to the Kyme Eau or to a water treatment works, if treatment was required.

6.4.6 If water quality treatment and/or measures for INNS treatment and prevention are required, the plant would be placed north of the Kyme Eau and to the west of Chapel Hill. From the treatment works, water would be transferred by pipeline to the Kyme Eau.

6.4.7 Holland Dyke is not currently connected to the Kyme Eau and its existing capacity would need to be increased to allow the transfer. Increasing the capacity would require the channel to be widened and the banks to be raised, modifying Holland Dyke to a high-level carrier.

6.4.8 If water quality treatment and/or measures for INNS treatment/prevention were required between the Kyme Eau and Holland Dyke, this would be located with the abstraction from the Kyme Eau to the east of South Kyme where Holland Dyke is close to the Kyme Eau. An open channel connection between the Kyme Eau and Holland Dyke would only be provided if treatment was not required in order to avoid bypassing the treatment.

6.4.9 Holland Dyke would feed into Skerth Drain, which is a tributary of the South Forty Foot Drain. Around 4.75km of the Skerth Drain would be used to facilitate the transfer.

6.4.10 The South Forty Foot Drain and Helpringham South Beck would form an open channel transfer of water to the Lincolnshire Reservoir, where the water would be abstracted and pumped into the reservoir.

Downstream infrastructure

Table 6-6: Downstream elements included in WSO-C

Element name	Transfer component	Water treatment works component	Service reservoir component
Lincolnshire Reservoir to Wilsthorpe	Pipeline option Corridor W3	Polygon LR80	Polygon WA
Wilsthorpe to Chesterton	Pipeline option Corridor C2	n/a	Polygons CA and CG

Lincolnshire Reservoir to Wilsthorpe

6.4.11 The water treatment works, downstream transfer from the Lincolnshire Reservoir to Wilsthorpe and the associated service reservoir would be the same as for WSO-A (refer to paragraphs 6.2.8 to 6.2.11).

Wilsthorpe to Chesterton

6.4.12 The downstream transfer from Wilsthorpe to Chesterton and the associated service reservoir would be the same as for WSO-A (refer to paragraphs 6.2.12 to 6.2.13).

Emergency drawdown disposal route

6.4.13 The emergency drawdown disposal route for WSO-C is the same as described above for WSO-A (refer to paragraph 6.2.14).

6.5 Whole scheme option D

6.5.1 An overview of WSO-D is included in Appendix C.4.

Upstream infrastructure

Table 6-7: Upstream elements included in WSO-D

Element name	Transfer component	Abstraction infrastructure component
River Trent to River Witham	Hybrid option via the Fossdyke with pipeline Corridor F4	Abstraction and treatment (if required) near Torksey at Polygon F4B
River Witham to South Forty Foot Drain – open channel transfer	Open channel option KO via Kyme Eau, Holland Dyke and Skerth Drain	Abstraction from River Witham at Polygon K0A. Abstraction from Kyme Eau and treatment (if required) at Polygon K2A or K2B

River Trent to River Witham

6.5.2 Whole scheme option D (WSO-D) would transfer water from the River Trent to the River Witham in the same way as WSO-A (refer to paragraphs 6.2.2 to 6.2.4).

River Witham to South Forty Foot Drain

6.5.3 Transfer from the River Witham to the South Forty Foot Drain would be the same as WSO-C (refer to paragraphs 6.4.3 to 6.4.10).

Downstream infrastructure

Table 6-8: Upstream elements included in WSO-D

Element name	Transfer component	Water treatment works component	Service reservoir component
Lincolnshire Reservoir to Wilsthorpe	Pipeline option Corridor W5	Polygon LR80	Polygon WA
Wilsthorpe to Chesterton	Pipeline option Corridor C2	n/a	Polygons CA and CG

Lincolnshire Reservoir to Wilsthorpe

6.5.4 The water treatment works would be in the same location as for WSO-A (refer to paragraph 6.2.8).

6.5.5 The water treatment works, downstream transfer from the Lincolnshire Reservoir to Wilsthorpe and the associated service reservoir would be the same as for WSO-B (refer to paragraphs 6.3.4 to 6.3.5).

Wilsthorpe to Chesterton

6.5.6 The downstream transfer from Wilsthorpe and Chesterton and the associated service reservoirs would be the same as for WSO-A (refer to paragraphs 6.2.12 to 6.2.13).

Emergency drawdown disposal route

6.5.7 The emergency drawdown disposal route for WSO-D is as described above for WSO-A (refer to paragraph 6.2.14).

6.6 Comparison of whole scheme options

Overview

6.6.1 The similarities between the four whole scheme options as detailed above means that all options performed similarly against planning and flood risk appraisal criteria. There was a minor preference for WSO-A against noise, health and transport appraisal criteria based on number of receptors, but WSO-B was preferred for air quality based

on number of receptors. There was a minor preference for WSO-D against access and amenity appraisal criteria.

6.6.2 There is no difference in yield between the four whole scheme options as the same sources are included in all the whole scheme solutions.

Considerations that are common to all whole scheme options

6.6.3 The following associated water infrastructure elements are the same for all four whole scheme options and therefore give rise to common risks, which are not differentiators between the whole scheme options for the purpose of decision making:

- Sources are River Trent, River Witham and South Forty Foot Drain.
- River Trent to River Witham upstream transfer, via the Fossdyke.
- Downstream water treatment works location.
- Downstream transfer from Wilsthorpe to Chesterton, including the location of the Wilsthorpe and Chesterton service reservoirs.
- Emergency drawdown disposal route.

6.6.4 All of the whole scheme options abstract water from the River Trent, River Witham and South Forty Foot Drain and would therefore change the quantity of water flowing into the Humber estuary and The Wash. There is potential for impacts on the European designated sites such as the Humber Estuary SAC/SPA/Ramsar and The Wash SPA/Ramsar and The Wash and North Norfolk Coast SAC. Further investigation is needed to assess the likely impacts and the significance of any impacts. This is common to all options and therefore not a differentiator.

6.6.5 The downstream pipeline corridors for all four whole scheme options cross watercourses that drain to The Wash and therefore there are potential impact pathways on the hydrologically connected designated sites of The Wash SPA Ramsar and The Wash and North Norfolk Coast SAC. It is likely that a Stage 2 Appropriate Assessment, under The Conservation of Habitats and Species Regulations 2017 will be required to assess the risk of likely significant effects from the proposed infrastructure on the integrity of the designated sites and their conservation objective, and to consider ways to avoid or reduce (mitigate) any potential for adverse effects on the integrity of the sites, including any qualifying features.

6.6.6 There are potential heritage risks that are common to all four whole scheme options (and therefore not a differentiator), which need to be further assessed and mitigations identified:

- The River Trent to Fossdyke pipeline corridor lies less than 50m from Torksey medieval town Scheduled Monument, which is on the north side of the Fossdyke, whereas the abstraction infrastructure would be on the south side of the

Fossdyke. If improvements are required to the Fossdyke to enable the transfer, there is a potential for impact on the value of Saxilby Bridge Street Conservation Area.

- The water treatment works site has potential to result in indirect impacts on the setting of the Grade I listed Church of St Michael, in Swaton.
- The Wilsthorpe to Chesterton transfer corridor crosses the line of the non-designated Stamford Canal. Historic England has advised this is likely to be of equivalent importance to a Scheduled Monument. Further assessment and engagement is required to understand any potential for impacts.
- There is a Roman barrow Scheduled Monument 80m to the north of Polygon CG for the Chesterton service reservoir. There is archaeological potential for finds in the area around the scheduled site and also a potential risk through change to setting of the scheduled site.

6.6.7 Helpringham South Beck would be upgraded to provide an open channel connection between the Lincolnshire reservoir site and the South Forty Foot Drain, including crossing an undesignated section of Car Dyke, a Roman age channel.

Comparison of whole scheme options

Comparison of upstream elements

6.6.8 WSO-C and WSO-D would reverse the direction of flow in the lower section of Kyme Eau which has both hydrological and water quality risks for WFD. Creation of a new hydrological connection between the Kyme Eau catchment and South Forty Foot Drain catchment could result in the spread and increase in density of INNS, potentially spreading downstream to The Wash SPA Ramsar, The Wash and North Norfolk Coast SAC and the Humber Estuary Ramsar/ SPA/SAC.

6.6.9 WSO-A and WSO-B upstream pipeline transfer between the River Witham and South Forty Foot Drain also has a WFD water quality risk but does not have the hydrological risk associated with the Kyme Eau for WSO-C and WSO-D.

6.6.10 There are more potential WFD opportunities associated with the open channel transfer via the Kyme Eau (WSO-C and WSO-D) than the pipeline transfer from River Witham to South Forty Foot Drain (WSO-A and WSO-B). Please refer to paragraphs 3.4.78 to 3.4.80 for more information.

6.6.11 WSO-C and WSO-D upstream transfer between the River Witham and South Forty Foot Drain via the Kyme Eau is expected to have temporary setting impacts on several listed buildings, however these are expected to result in less than substantial harm. There is also potential for medieval remains of local or regional importance that may be need to be removed as part of the works for WSO-C and WSO-D associated with the

upstream transfer between the River Witham and South Forty Foot Drain, via the Kyme Eau.

6.6.12 Roman archaeological remains of potential regional importance may be present within WSO-A and WSO-B upstream pipeline corridors between River Witham and South Forty Foot Drain. Further investigation and assessment ar0e required to understand whether there is potential for such remains to be removed as part of the works.

Comparison of downstream elements

6.6.13 The downstream transfer corridors for WSO-B and WSO-D intersect with the Functionally Linked Land associated with The Washes SPA and there may be temporary land requirements and potential disturbance to the geese and swans, using the Functionally Linked Land, that are amongst the qualifying features of the linked SPA. It is therefore likely that a Stage 2 Appropriate Assessment will be required under The Conservation of Habitats and Species Regulations 2017 (as amended) to assess this risk to the integrity of the European designated site and whether mitigation can likely be achieved to avoid affecting the integrity of the site. The downstream corridors for WSO-A and WSO-C do not intersect with Functionally Linked Land.

6.6.14 There are no Scheduled Monuments, Grade I Listed Buildings, Conservation Areas or Registered Parks and Gardens within any of the downstream corridors. There are Grade II Listed Buildings within the corridors but it is expected that any impacts would be mitigatable, including through sensitivity routing the pipeline away from the designated asset within the wider corridor area, wherever practicable. There is potential for temporary impacts on setting for a larger number of designated heritage assets on downstream pipeline corridors for WSO-B and WSO-D. WSO-B and WSO-D cross a large area of fen deposits, as well as the fen edge, therefore there is the potential for preservation of organic archaeological remains. The corridor between the reservoir and Wilsthorpe for WSO-B and WSO-D also has evidence for dense settlement and activity, particularly in the Roman period. WSO-A and WSO-C therefore perform better from a heritage perspective.

6.6.15 All whole scheme options include an upgrade to Helpringham South Beck as part of the upstream transfers, near to Swaton which would cross Car Dyke. The heritage assets on downstream corridors for WSO-B and WSO-D also include a number of sections of Car Dyke. Historic England has expressed concerns about potential impact of the overall Project on Car Dyke. Car Dyke is a largely non-designated asset but has several sections that are designated as a scheduled monument, one of which is immediately adjacent to these downstream corridors for options WSO-B and WSO-D at Thurlby. These corridors also cross non-designated sections of Car Dyke. There is therefore a greater potential for in-combination effects on the Car Dyke from potential impacts across different sections of the Project with WSO-B and WSO-D.

6.6.16 Downstream route corridors for WSO-B and WSO-D are least preferred from a biodiversity and habitat loss perspective. WSO-B and WSO-D have the potential for

hydrological and air quality impacts to Baston and Thurlby Fens SSSI (located 70m from the corridor), three ancient woodlands (within 10m), and Local Wildlife Sites (five intersected by the corridor and one additional within 10m).

6.6.17 There are a number of known risks associated with the downstream route corridor for WSO-B and WSO-D which have the potential to increase both the timescales for delivering the Project and the overall cost of these options. The risks include poorer ground conditions with more peat and alluvium, increased length in floodplain and higher risk of archaeological finds.

Comparison of cost and carbon

6.6.18 Based on the cost and carbon estimation work carried out to date at this early stage of the Project development, WSO-B is expected to have the lowest whole life cost and WSO-C is expected to have the highest whole life cost. WSO-A and WSO-D are expected to have similar whole life costs. Further cost analysis and assessment will be progressed as the Project develops and there is a greater level of information available.

6.6.19 WSO-D is expected to have the lowest total carbon emissions and WSO-A is expected to have the highest. Opportunities to reduce the total carbon emissions will be investigated as the Project develops.

Preferred Whole Scheme Selection

6.6.20 Overall, WSO-A is considered to be the preferred whole scheme option when considered against the wide range of appraisal criteria. In particular, WSO-A offers the following advantages:

- It is expected to have a lower whole life cost than WSO-C based on the information available at this stage, although WSO-A has been estimated to have higher total carbon emissions.
- WSO-A (and WSO-B) has reduced WFD risk associated with the upstream transfer between the River Witham and the Kyme Eau, compared to WSO-C and WSO-D.
- WSO-A does not directly impact on Goose and Swan Functionally Linked Land (in common with WSO-C).
- WSO-A has less risk for potential impacts on the value heritage assets for the downstream corridors, compared to WSO-B and WSO-D, and in particular the overall risk of potential impacts on Car Dyke is reduced (in common with WSO-C).
- Downstream route corridors for WSO-A and WSO-C are preferred from a biodiversity and habitat loss perspective.

6.6.21 Anglian Water acknowledges the potential benefits and opportunities associated with the open channel transfer between the River Witham and South Forty Foot Drain, via the Kyme Eau, Holland Dyke and Skerth Drain (WSO-C and WSO-D).

6.6.22 There are two whole scheme options that could deliver these benefits. Out of these, WSO-C is preferred to WSO-D as WSO-C is considered to have less potential for environmental impacts associated with the downstream transfers.

6.6.23 Whilst the benefits and opportunities associated with the Kyme Eau open channel transfer are important to stakeholders including the Environment Agency, the higher costs of this option are not currently considered to offer the same level of value as the piped transfer. The options appraisal process has therefore identified WSO-A as the preferred whole scheme option, in preference to WSO-C, as WSO-A has a lower whole life cost than WSO-C and less WFD risk. WSO-A has higher total carbon emissions compared to WSO-C and opportunities to reduce the total carbon emissions will be investigated as the Project develops.

6.6.24 However, given cost is one of the prime differentiators between WSO-A and WSO-C and the strength of support for WSO-C from key stakeholders, Anglian Water is considering if alternative funding source(s) to progress WSO-C could be secured to meet the additional costs required. As such, at this stage, both WSO-A and WSO-C are being kept open. However, to meet the overall project programme and achieve the planned Development Consent Order submission dates the additional funding source(s) would need to be confirmed at the earliest opportunity to retain consideration of this option.

7 Options appraisal – next steps

7.1.1 The four-stage options appraisal process has considered the technical feasibility of sites and options for the associated water infrastructure for the Lincolnshire Reservoir. Through the consideration of the options appraisal criteria across the four stages, Anglian Water identified a preferred whole scheme option.

7.1.2 Preferred whole scheme option WSO-A would deliver wider system benefits of open channel transfers through abstraction and transfer of water from the sources (tidal River Trent, River Witham and South Forty Foot Drain) utilising the Fossdyke, the River Witham, the South Forty Foot Drain and Helpringham South Beck for open channel transfer.

7.1.3 There is an opportunity to integrate the transfer from the River Trent with the existing Trent – Witham – Ancholme transfer and this will be explored further with the Environment Agency.

7.1.4 Heritage risks have been identified during the options appraisal and, where practicable, will be avoided or minimised through design development. These potential impacts, along with other potential environmental impacts associated with the preferred whole scheme option, will be assessed further through the Environmental Impact Assessment (EIA) process. The EIA will assess potential impacts during both construction and operation, temporary and permanent, to identify whether there are any likely significant effects on the environment and to identify methods of avoiding, minimising or mitigating effects that would reduce the impact to a level where significant effects would not occur. This process will involve engagement with relevant stakeholders, including statutory environmental bodies such as the Environment Agency, Natural England and Historic England.

7.1.5 The impact of the abstractions from the River Trent, River Witham and South Forty Foot Drain on the European designated sites such as the Humber Estuary SAC/SPA/ Ramsar, The Wash SPA/Ramsar and The Wash and North Norfolk Coast SAC will be further assessed.

7.1.6 There remains optionality for some of the components that form the preferred whole scheme option, WSO-A. Further assessment of the component options and engagement with stakeholders are required to develop the preferred component options. Components with optionality and uncertainty include the following:

- Arrangement of the abstraction from River Trent at Torksey Lock and routing of the pipeline from the abstraction to the Fossdyke, potentially via a treatment works.
- The extent of works required along the Fossdyke to allow the transfer whilst managing any increase in water velocity which may impact navigation.

- Two polygons remain under consideration for the Chesterton service reservoir.

7.1.7 Further engagement with regulators is required to determine whether any additional works are required to enable the safe discharge of water from the reservoir in an emergency.

7.1.8 Engagement with stakeholders is required to explore potential for additional funding source(s) to deliver WSO-C and the benefits and opportunities associated with an open channel transfer between the River Witham and South Forty Foot Drain, via the Kyme Eau, Holland Dyke and Skerth Drain. Both WSO-A and WSO-C are being kept open at this stage.

Appendix A – Options Appraisal Criteria

A.1 The criteria applied during the options appraisal process have been grouped into five categories that represent key themes for assessing options for the Project. Table A-1 lists the criteria that were considered during the different stages of the options appraisal process explained in Chapters 1 to 6 to inform the best performing components and preferred whole scheme option. When considering attributes in the assessment the presence or proximity of that attribute have been considered, for example the presence of national trails or the proximity of residents or dwellings.

A.2 The criteria were selected as they would allow a robust technical, engineering and consenting appraisal to be completed against core legislative and policy requirements that would be factors in the future consenting and decision-making processes. These criteria were developed using the Government policy and regulations, including:

- National Policy Statement for Water Resources Infrastructure (April 2023).
- Environmental Impact Assessment Regulations 2017.
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.
- The Conservation of Habitats and Species Regulations 2017 (as amended).
- National Planning Policy Framework (2023).

Table A-1: Attributes considered against the respective criteria during options appraisal

Category	Criterion	Attributes considered	Stage applied		
			A	B	C
Social and community	Built-up areas	Identification of large areas of existing developments (excluding brownfield sites)	✓	✓	
	Population and human health	Identification of national trails		✓	✓
		Identification of open access land		✓	✓
		Identification of national cycle routes		✓	✓
		Assessment of population health sensitivity			✓
		Assessment of the number of population health exposure risk			✓
	Socio-economics and community	Identification of residents/dwellings			✓
		Identification of business owners/businesses			✓
		Identification of tenants/landowners			✓
		Identification of community infrastructure such as education or healthcare facilities			✓
	Access and amenity	Identification of public rights of way, cycleways, footpaths			✓

Category	Criterion	Attributes considered	Stage applied		
			A	B	C
		Identification of bridleways			✓
		Identification of open space used for play and amenity (formal and informal)			✓
		Identification of recreational facilities (sports clubs and indoor/outdoor pitches and sites)			✓
		Identification of public transport			✓
	Equalities	Identification of places of worship			✓
		Identification of social infrastructure catering for needs of a specified protected characteristic group			✓
Engineering	Carbon[25]	Assessment of capital carbon		✓	✓
		Assessment of operational carbon		✓	✓
		Assessment of whole life carbon			✓
	Cost[26]	Assessment of capital cost		✓	✓
		Assessment of operational cost		✓	✓
		Assessment of whole life costs			✓
	Major Infrastructure	Proximity to A roads suitable for heavy goods vehicle traffic		✓	✓
		Proximity to airfields	✓	✓	
		Identification of utilities			✓
		Assessment of the number of rail crossings		✓	
		Assessment of the number of A road crossings		✓	
		Assessment of the number of main river crossings		✓	
		Assessment of the number of strategic gas/electric/pipelines crossings		✓	
	Technical	Assessment of trenchless crossings and associated ground condition risks			✓
		Assessment of site topography			✓
		Assessment of ground condition risk			✓
		Assessment of number of pumping stations			✓

[25] At Stage B proxies for cost and carbon were considered e.g. length of pipeline and pumping head based on topography

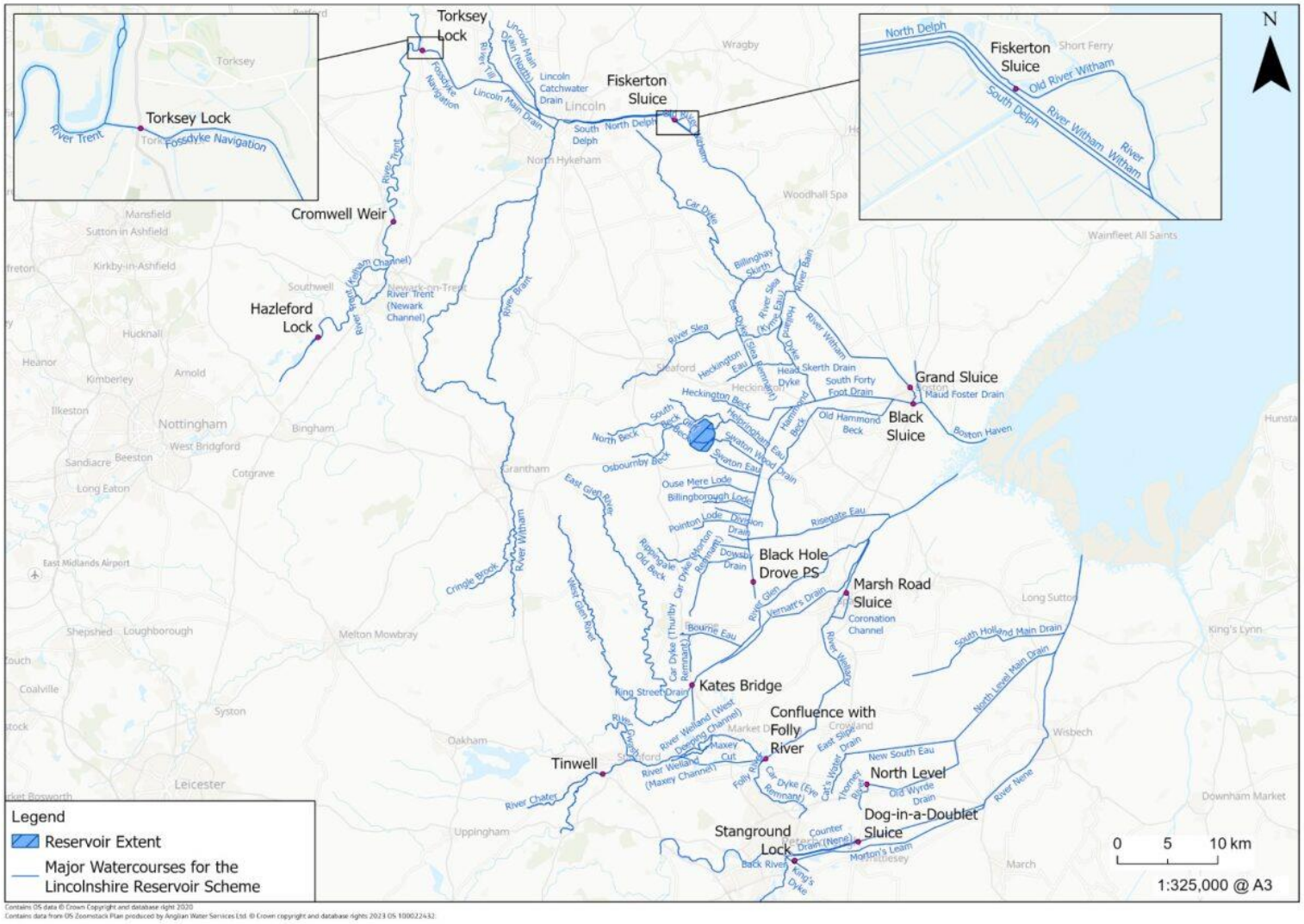
[26] Costs excluded consideration of land purchase, construction/operation of water quality treatment works and INNS treatment/prevention, and cost of power upgrades. These were not considered differentiators for the purposes of the options appraisal process as further investigation and engagement would be needed to confirm requirements and associated costs regardless of the whole scheme solution taken forward.

Category	Criterion	Attributes considered	Stage applied A	B	C
		Assessment of suitability of terrain for pipelines			✓
		Assessment of operational complexity (scheme operation and maintenance)			✓
		Assessment of power availability			✓
		Assessment of the potential for future expansion		✓	
		Assessment of cut and fill			✓
		Assessment of general uncertainty			✓
		Alignment between open channel transfers and emergency drawdown disposal route options			✓
		Assessment of impact on navigation			✓
Environment	Air quality	Identification of Air Quality Management Areas		✓	✓
		Identification of sensitive human receptors			✓
	Historic environment	Identification of Scheduled monuments	✓	✓	✓
		Identification of World Heritage Sites	✓	✓	✓
		Identification of Registered Parks and Gardens	✓	✓	✓
		Identification of Registered Battlefields	✓	✓	✓
		Identification of Listed buildings	✓	✓	✓
		Identification of Conservation Areas		✓	✓
		Identification of locally listed buildings (non-designated assets)			✓
		Identification of archaeological assets (non-designated assets)			✓
	Landscape character	Identification of Areas of Outstanding Natural Beauty	✓	✓	✓
		Identification of National Parks	✓	✓	✓
		Identification of local landscape designations			✓
		Identification of open greenspaces		✓	✓
	Biodiversity	Identification of National Nature Reserves	✓	✓	✓
		Identification of Ramsar sites (including listed or proposed Ramsar sites)	✓	✓	✓
		Identification of SAC (including possible SAC)	✓	✓	✓
		Identification of SPA (including potential SPA)	✓	✓	✓

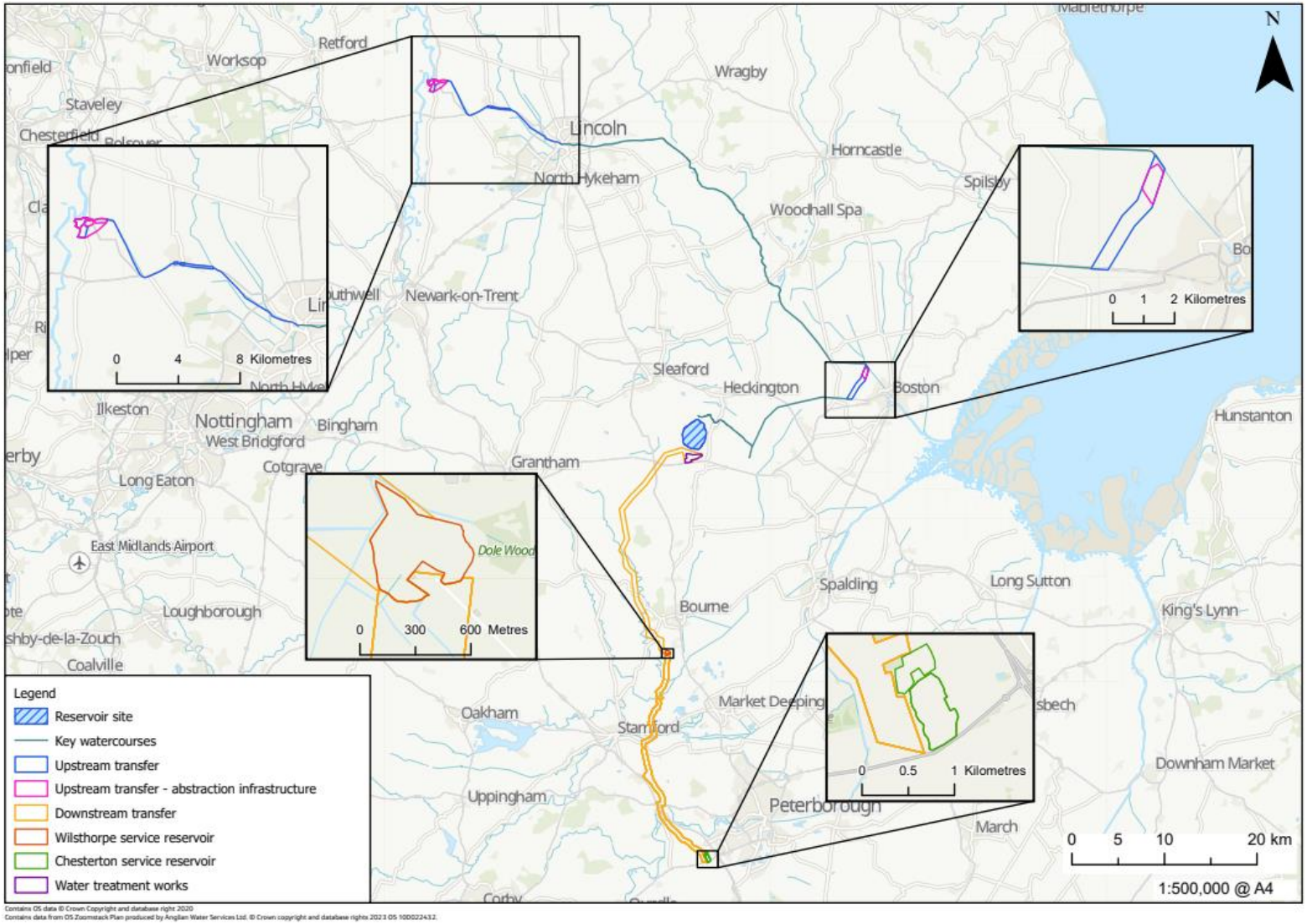
Category	Criterion	Attributes considered	Stage applied		
			A	B	C
		Identification of Sites of Special Scientific Interest	✓	✓	✓
		Identification of Goose and Swan Functional Land		✓	
		Identification of Ancient woodland	✓	✓	✓
		Identification of ancient/veteran trees			✓
		Identification of Local Wildlife Site (LWS) / County Wildlife Site (CWS)		✓	✓
		Identification of Local Nature Reserves		✓	✓
		HRA screening			✓
		Identification of priority habitats		✓	✓
		Identification of nature reserves (where not SSSI, LWS/CWS or LNR)			✓
		Assessment of Biodiversity Net Gain			✓
	Noise	Identification of noise-sensitive receptors (construction and operational)			✓
	Water environment	Identification of flood risk zones (fluvial flooding, flooding surface water, flooding in Internal Drainage Board areas, flooding from existing reservoirs, and flooding from groundwater)		✓	✓
		Identification of defended fluvial flood areas			✓
		Identification of areas at risk of flooding from existing reservoirs			✓
		Identification of areas at risk from ground water flooding			✓
		WFD Level 1 screening assessment for surface water and groundwater bodies (and review of high level 2 classes)			✓
		Identification of main rivers	✓	✓	✓
		Identification of watercourses and water bodies	✓		
		Identification of Source Protection Zones		✓	✓
	Geology and soils	Identification of Local Geological Sites		✓	✓
		Identification of Best and Most Versatile land and Agricultural Land Classification		✓	✓
		Identification of peat soils			✓
		Identification of Contaminated land		✓	✓

Category	Criterion	Attributes considered	Stage applied		
			A	B	C
		Assessment of geomorphology of river abstraction and discharge sites		✓	✓
	Materials and waste	Identification of historic and authorised landfill		✓	✓
	Land designation	Identification of Mineral Safeguarding Zones		✓	✓
	Traffic and transport	Assessment of road network			✓
Planning and land use	Development conflicts, land use and planning	Identification of Mineral safeguarding sites		✓	✓
		Presence of other Nationally Significant Infrastructure Projects		✓	✓
		Identification of designated common land		✓	✓
		Identification of committed development including those under construction		✓	✓
		Identification of Green Belt		✓	✓
		Identification of Mineral safeguarding zones			✓
		Identification of Special Category Land/Protected Undertakers			✓
Potential for benefits and opportunities	Water environment	Identification of fluvial flooding opportunities			✓
		Identification of surface water flooding opportunities			✓
		Identification of defended breach flooding risks			✓
		Identification of WFD opportunities			✓
		Identification of flood risk management			✓
	Noise	Identification of noise improvement opportunities			✓
	Opportunities	Identification of navigation opportunities			✓
		Identification of agricultural opportunities			✓
		Identification of wetland habitat creation opportunities			✓

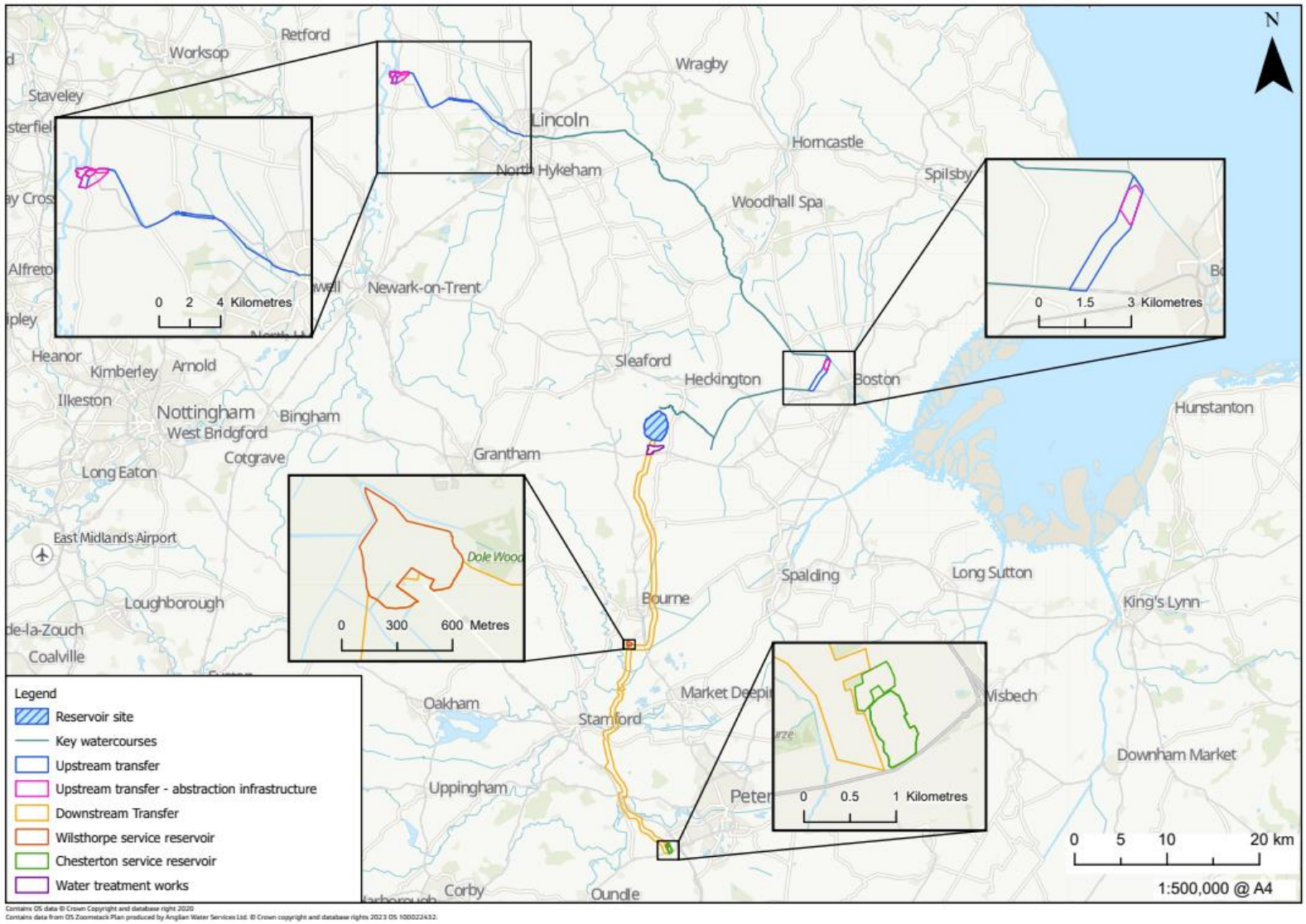
Appendix B – Major Watercourses



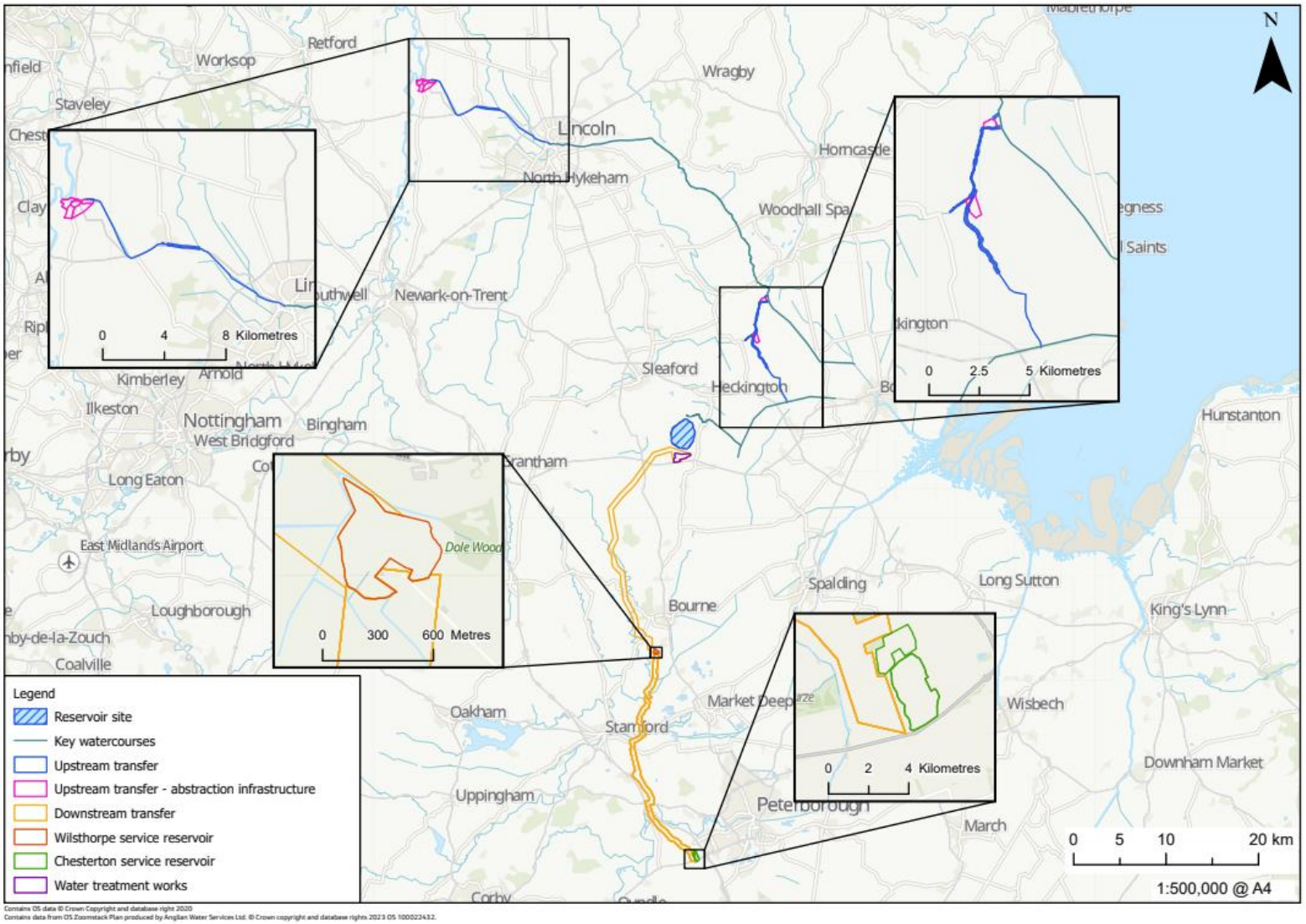
Appendix C.1 – Whole Scheme Solution A



Appendix C.2 – Whole Scheme Solution B



Appendix C.3 – Whole Scheme Solution C



Appendix C.4 – Whole Scheme Solution D