VikingCCS

Viking CCS Pipeline

Environmental Statement Volume IV - Appendix 11-5: Flood Risk Assessment - Revision B (Clean)

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a Harbour Energy Company
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Date: July 2024

Harbour Energy | AECOM

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EN070008	EN070008/APP/6.4.11.5	Revision 1	October 2023
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1 Flood Risk Assessment

1.1 Introduction

1.1.1 This Flood Risk Assessment (FRA) has been prepared on behalf of Chrysaor Production (U.K.) Limited, a Harbour Energy Company, for the Viking Carbon Capture Storage (CCS) Pipeline hereafter referred to as "the Proposed Development". Conditioned and compressed CO_2 will be transported by buried pipeline from a nominated outlet at the Immingham Industrial Cluster, into secure storage in a depleted Southern North Sea gas reservoir, known as the Viking Fields.

1.1.2 For the purpose of this assessment, the route is divided into five sections as described in **Section 2.**

- Section 1 – Immingham Facility to A180;
- Section 2 – A180 to A46;
- Section 3 – A46 to Pear Tree Lane;
- Section 4 – Pear Tree Lane to Manby Middlegate (B1200); and
- Section 5 – Manby Middlegate (B1200) to Theddlethorpe and down to mean low water spring (MLWS).

1.1.3 This FRA forms *Environmental Statement (ES) Volume II Appendix 11.5 (Application Document 6.4.11.5)*.

1.1.4 This FRA is supported by the following figures and annexes:

- Figure 1: Flood Map for Planning;
- Figure 2: EA's Historic Flood Map;
- Figure 3: EA's Risk of Flooding from Reservoirs Map;
- Figure 4: EA's Risk of Flooding from Surface Water Map;
- Figure 5: 0.5% AEP tidal event overtopping depth mapping Present day (2006) (2010 Northern Area Tidal Modelling study);
- Figure 6: 0.1% AEP tidal event overtopping depth mapping Present day (2006) (2010 Northern Area Tidal Modelling study);
- Figure 7: 0.5% AEP tidal event breach depth mapping Present day (2006) (2010 Northern Area Tidal Modelling study);
- Figure 8: 0.1% AEP tidal event breach depth mapping Present day (2006) (2010 Northern Area Tidal Modelling study);
- Figure 9: 0.5% AEP tidal event overtopping depth mapping Climate Change (2115) (2010 Northern Area Tidal Modelling study);
- Figure 10: 0.1% AEP tidal event overtopping depth mapping Climate Change (2115) (2010 Northern Area Tidal Modelling study);
- Figure 11: 0.5% AEP tidal event breach depth mapping Climate Change (2115) (2010 Northern Area Tidal Modelling study);
- Figure 12: 0.1% AEP tidal event breach depth mapping Climate Change (2115) (2010 Northern Area Tidal Modelling study);

- Annex A: Pre-submission Consultation Responses;
- Annex B: Regional and Local Planning Policy; and
- Annex C: Technical Note

1.1.5 The DCO Site Boundary is shown on **Figure 1**. This FRA assesses the flood risk within the DCO Site Boundary, which include watercourse crossings and associated above ground structures.

Revision: 1 Drawn: LC Checked: KB Approved: MW Date: 2024-05-16

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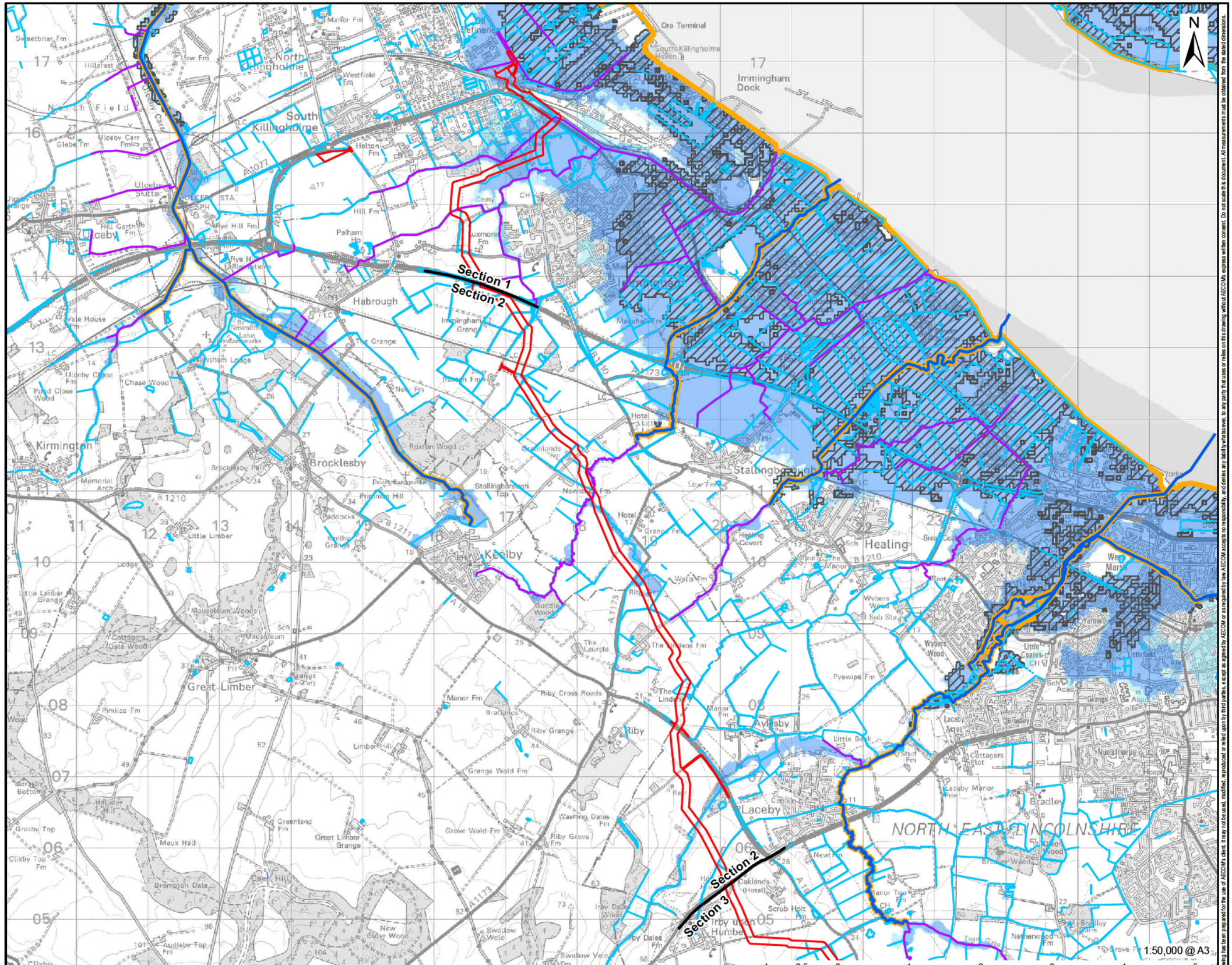

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PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break
- Ordinary Watercourse
- IDB Maintained Watercourse
- EA Main River
- Flood Defence
- Reduction in Risk of Flooding from Rivers and Sea due to Defences
- Flood Zone 3
- Flood Zone 2

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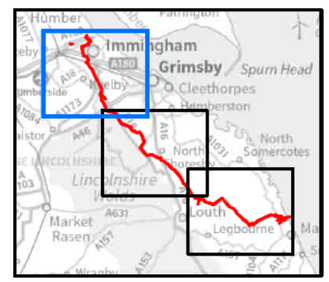

FIGURE TITLE

Figure 1 (1 of 3)
Environment Agency Flood Map for Planning

ISSUE PURPOSE

FLOOD RISK ASSESMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_1

Revision: 1 Drawn: LC Checked: KB Approved: MW Date: 2024-05-16

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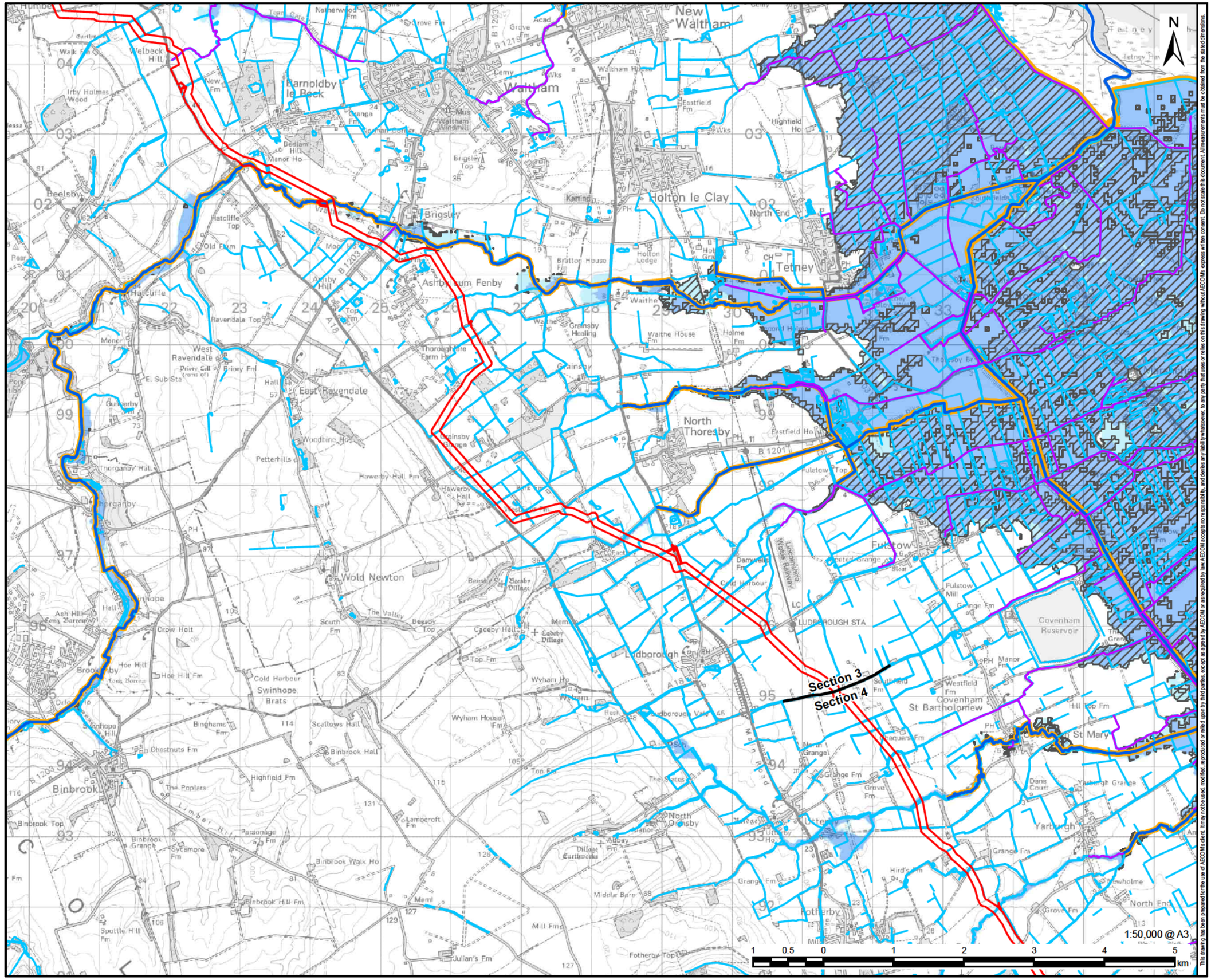

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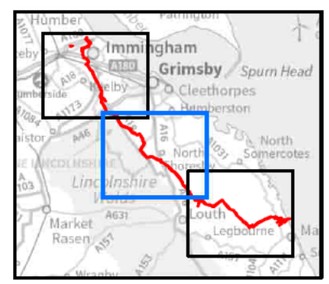

FIGURE TITLE

Figure 1 (2 of 3)
Environment Agency Flood Map for Planning

ISSUE PURPOSE

FLOOD RISK ASSESMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_1

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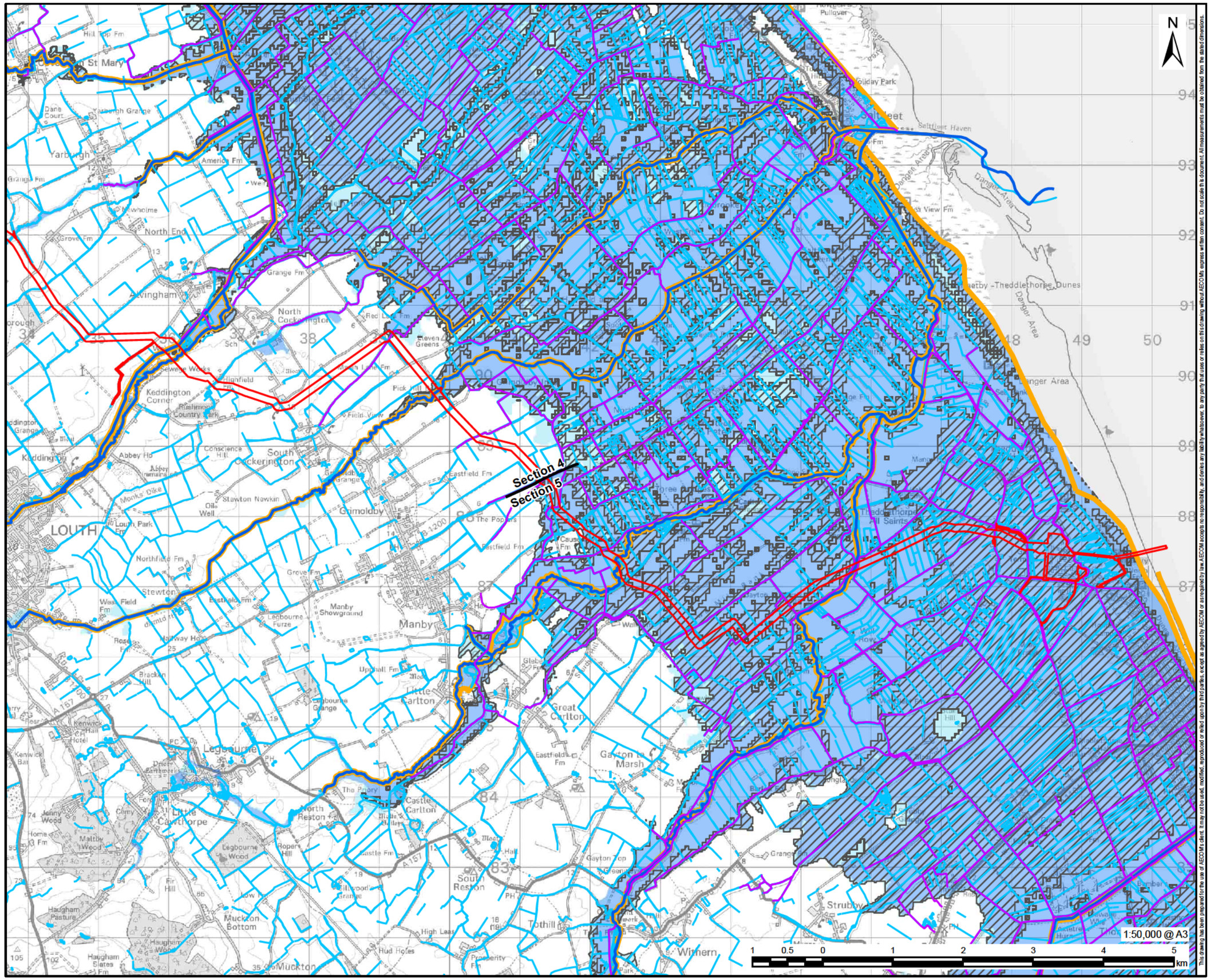

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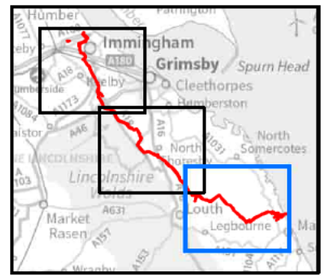

FIGURE TITLE

Figure 1 (3 of 3)
Environment Agency Flood Map for Planning

ISSUE PURPOSE

FLOOD RISK ASSESMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_1

1.1.1 For the purposes of this report the terms used to identify the various parts of the DCO Site Boundary are consistent with the terms used elsewhere in the ES.

1.2 Purpose and Scope of the Assessment

1.2.1 The Environment Agency (EA) Flood Map for Planning (Rivers and Sea) (**Ref 1**) indicates that the DCO Site Boundary lies within Flood Zones 1, 2 and 3, defined in accordance with the Flood Risk and Coastal Change Planning Policy Guidance (PPG) (Ref 2) and summarised in **Table 1**.

Table 1: Environment Agency Flood Zone Definitions

Flood Zone	Definition	Risk of flooding
Flood Zone 1	Land that has a low probability of flooding (less than 1 in 1,000 annual probability of river or sea flooding (<0.1%))	Low
Flood Zone 2	Land that has a medium probability of flooding (between 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1-1%), or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1-0.5%)	Medium
Flood Zone 3a	Land that has a high probability of flooding (1 in 100 year or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%)	High
Flood Zone 3b (Functional Floodplain)	This zone comprises land where water has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: • land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or • land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding). Please note, this zone is not usually included within the EA Flood Map for Planning and is normally defined in a Strategic Flood Risk Assessment.	Very High

Source: Planning Practice Guidance (2022) (Ref 2)

1.2.2 The EA Flood Map for Planning (reproduced in **Figure 1**) indicates that the DCO Site Boundary predominantly lies in Flood Zone 1, however, the DCO Site Boundary crosses six main rivers which have associated Flood Zone 2 (medium risk of flooding from fluvial or tidal sources) and Flood Zone 3 (high risk of flooding from fluvial or tidal sources) extents.

1.2.3 In addition, the DCO boundary crosses local Ordinary Watercourses and land drains which have associated Flood Zone 2 (medium risk of flooding from fluvial or tidal sources) and Flood Zone 3 (high risk of flooding from fluvial or tidal sources) extents.

1.2.4 Immingham Facility and Theddlethorpe Facility lie predominantly within Flood Zone 3 and are considered to be at high risk of flooding from tidal sources.

1.2.5 The National Planning Policy Framework (NPPF) (Ref 3) and the Flood Risk and Coastal Change PPG specify that applications for development proposals greater than 1 hectare (ha) in area, or located in Flood Zone 2 and 3, should be accompanied by a FRA that identifies and assesses all forms of flooding to and from the Proposed Development. A FRA should demonstrate how these flood risks will be managed so that the development remains safe throughout its lifetime, taking into account the vulnerability of the Proposed Development and the potential impact of climate change on risk.

1.2.6 The aim of this study is to undertake a FRA that is appropriate to the nature and scale of the Proposed Development, which determines existing flood risk within and arising from the DCO Site Boundary, and, where required recommends mitigation measures so the Viking CCS Pipeline remains safe over its lifetime. The mitigation measures recommended in the FRA are captured within the Draft Construction Environmental Management Plan (CEMP) (*ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)*) which is secured via a requirement in the Draft DCO (*Application Document 2.1)*.

1.2.7 The objectives of the report are to:

- Collect and review existing information relating to the flood risk posed to and from the Proposed Development from all sources (e.g., fluvial, tidal, surface water, artificial. groundwater, drain and sewer flooding);
- Consult with the EA, Lead Local Flood Authorities (LLFAs), North East Lincolnshire Council and East Lindsey Council, and the North East Lindsey and Lindsey Marsh Internal Drainage Boards (IDBs), in relation to flood risk and their requirements for management of any risk;
- Assess the flood risk to the Proposed Development under existing and post-development conditions (considering climate change); and
- Outline any mitigating measures needed to ensure the Proposed Development and facility occupants will be safe for the lifetime of the development and to meet the requirements of the NPPF

1.3 Data Sources

1.3.1 The baseline conditions within the DCO Site Boundary have been established through a desk study, including a review of publicly available information, supporting modelling and hydrology study reports (where available), and via consultation with the associated LLFAs, IDBs and the EA.

1.3.2 Relevant consultation responses are provided in **Annex A**. This information has been utilised to inform the assessment made within the FRA. Data collected during the course of this assessment is described in **Table 2**.

Table 2: Sources of Data

Purpose	Data Source	Comments
Identification of Hydrological Features	1: 10,000 Ordnance Survey (OS) mapping	Identifies the position of the DCO Site Boundary, local hydrological features, and riparian owners.
Identification of Existing Flood Risk	EA Flood Map for Planning (Ref 1 and reproduced in **Figure 1**)	Identifies fluvial/ tidal inundation extents.
	EA Product 4, 5, 6, and 7 information, including 2010 Northern Area Tidal Modelling	Identifies fluvial/ tidal inundation extents, including overtopping and breach flood depths.

Purpose	Data Source	Comments
	Study Reports, Model Inputs and Model Outputs	
	EA Long Term Flood Risk Maps (Ref 4 and reproduced in **Figure 3**)	Identification of flood risk from surface water.
	EA Flood Inundation Mapping (Ref 5 and reproduced in **Figure 4**)	Provides information on the risk of flooding from reservoirs (artificial sources).
	EA Groundwater Conditions Map (Ref 6)	Identification of groundwater designations through geology.
	Grimsby and Ancholme: Catchment Flood Management Plan (Ref 7) North East Lincolnshire Council Preliminary Flood Risk Assessment (PFRA) (Ref 8) North East Lincolnshire Council Strategic Flood Risk Assessment (SFRA) (Ref 9) Lincolnshire Council Preliminary Flood Risk Assessment (PFRA) (Ref 10) East Lindsey District Council Strategic Flood Risk Assessment (SFRA) (Ref 11) Consultation with Environment Agency, East Lindsey Council (LLFA), North East Lincolnshire Council (LLFA), Lindsey Marsh (IDB) and North East Lindsey (IDB) (**Annex A**)	Assesses flood risk across the North East Lincolnshire Council and East Lindsey District Council boundary areas. Includes flood risk from fluvial, tidal, sewers, overland flow and groundwater.
Identification of Ground Conditions	British Geological Survey (BGS) records (Ref 12) *ES Volume II Chapter 9: Geology and Hydrogeology (Application Document 6.2.9)*	Provides details of ground conditions.
Identification of Historical Flooding	SFRAs and PFRAs (as above) Consultation (**Annex A**) DEFRA Data Services Platform (Ref 14) with associate mapping reproduced in **Figure 2.**	Provides details of historical flooding.
Details of the Proposed Works	Design of Proposed Works (*ES Volume II Chapter 3: Description of the Proposed Development (Application Document 6.2.3)*)	Provides indicative layouts of the DCO Site Boundary, outline design of diversion culvert etc.

Purpose	Data Source	Comments
Crossing Schedule	Schedule of Crossings *(ES Volume II Appendix 3.2 (Application Document 6.4.3.2))*	Provides details of indicative watercourse crossings.
Surface Water Drainage	Drainage Strategy *(ES Volume IIV Appendix 11.3 (Application Document 6.4.11.3))*	Provides a strategy for the management of surface water drainage for above ground infrastructure.
Flood risk over the development lifetime	EA Product 5, 6, and 7 information, including 2010 Northern Area Tidal Modelling Study Reports, Model Inputs and Model Outputs	Identifies tidal inundation extents, including overtopping and breach flood depths for the Year 2115.

1.4 Hydrology and Flood Risk Management Infrastructure

Surface Water Features

1.4.1 For the purposes of the FRA, the DCO Site Boundary was adopted as the study area. As flood risk can also impact upstream and downstream, the FRA also considers a wider study area outside of the DCO Site Boundary, where relevant. Professional judgement has been applied to identify the extent to which such features are considered.

1.4.2 A site walkover was undertaken 27 February – 3 March 2023. Using observations taken on this visit, together with data from OS mapping and the EA, the surface waterbodies listed in **Table 3** were identified within 1km of the DCO Site Boundary and are presented on *ES Volume II Chapter 11 Figure 11-2.*

Table 3: Surface Waterbodies

Relevant Route Section	Waterbody	Coastal / Main River / Ordinary Watercourse / Stillwater	Watercourse Description
1-5	River Humber (North Sea)	Tidal River	The Humber Estuary extends from Trent Falls, Faxfleet to the North Sea (at Spurn Point).
1	Habrough Marsh Drain	Ordinary Watercourse	Habrough Marsh Drain extends from South Killingholme Road to the Humber Estuary and is managed by North-East Lindsey IDB.
2	North Beck Drain	Ordinary Watercourse	North Beck Drain extends from Keelby to the Humber Estuary. The Drain is managed by North-East Lindsey IDB from Keelby to Stallingborough Road, where it becomes a Main River.
2	Old Fleet Drain	Ordinary Watercourse	Old Fleet Drain extends from Healing to the Humber Estuary. The Drain is managed by North-East Lindsey IDB from

Relevant Route Section	Waterbody	Coastal / Main River / Ordinary Watercourse / Stillwater	Watercourse Description
			Healing to Stallingborough Road, where it becomes a Main River.
3	Laceby Beck	Ordinary Watercourse	Laceby Beck extends from Welbeck Hill to the Humber Estuary. The Beck is managed by North-East Lindsey IDB from Welbeck Hill to the confluence with Team Gate Drain, where it becomes a Main River.
3	Waithe Beck	Main River	Waithe Beck extends from Kirmond Top Hall to Tetney, where the Beck becomes Tetney Drain / Mother Drain.
3	Black Leg Drain	Ordinary Watercourse	Black Leg Drain extends upstream of North Thoresby and joins New Dike downstream of North Thoresby. The Drain is an ordinary watercourse until it becomes Main River at North Thoresby.
4	Poulton Drain	Ordinary Watercourse	Poulton Drain extends south of Ludborough to Louth Canal. The Drain is an Ordinary Watercourse between Ludborough and Covenham St Mary, where it becomes Main River.
4	Yarburgh Beck	Ordinary Watercourse	Yarburgh Beck extends from Little Grimsby to Yarburgh, where it joins Black Dike.
4	Louth Canal	Main River	Louth Canal extends from Louth to Tetney Haven.
4	River Ludd (Lower)	Main River	The River Ludd extends from Louth to Melholme. The River is Main River from Louth to Alvingham, and then becomes an Ordinary Watercourse before joining Seven Towns North Eau.
4	Green Dike	Ordinary Watercourse	Green Dike extends from Rushmoor Country Park to new lands, where it joins South Dike.
4	Harrowsea Drain	Ordinary Watercourse	Harrowsea Drain extends from South Cockerington to New Lands, where it joins South Dike.
4	Greyfleet Drain	Main River	Greyfleet Drain extends from Grimoldby Grange to Saltfleet, where it joins Saltfleet Haven.

Relevant Route Section	Waterbody	Coastal / Main River / Ordinary Watercourse / Stillwater	Watercourse Description
4	Manby Middlegate Drain	Ordinary Watercourse	Manby Middlegate Drain extends from Eastfield Farm to Grimoldby Ings where it joins Sykes Drain.
4	Manby Middle Drain	Ordinary Watercourse	Manby Middle Drain extends from Middlegate Drain.
5	Sykes Drain	Ordinary Watercourse	Sykes Drain extends from Causeway Bridge to Grimboldby Ings, where it joins Grayfleet Drain.
5	Head Dike Drain	Ordinary Watercourse	Head Dike Drain extends from Manby to Willow Farm.
5	Long Eau	Main River	The Long Eau extends from Castle Carlton to Theddlethorpe, where it joins the Great Eau.
5	The Cut Drain	Ordinary Watercourse	The Cut Drain extends from Causeway Bridge to Theddlethorpe All Saints.
5	Two Mile Bank Drain	Ordinary Watercourse	Two Mile Bank extends from downstream of Great Carlton to Gayton Le Marsh Grange, where it joins from New Gayton Engine Drain.
5	Gayton North Fen Drain	Ordinary Watercourse	Gayton North Fen Drain extends from Gayton Le Marsh to Gayton Le Marsh Grange.
5	New Gayton Engine Drain	Ordinary Watercourse	New Gayton Engine Drain extends from Pyewipe Farm to Highbridge where it joins The Cut.
5	Old Engine Drain	Ordinary Watercourse	Old Engine Drain extends from Gayton Le Marsh Grange to Gayton Engine.
5	Great Eau	Main River	The Great Eau extends from Calceby Beck Houses to Saltfleet. The Great Eau becomes a Main River at Belleau.
5	Grove Road Drain	Ordinary Watercourse	Grove Road Drain extends from Will Row to Theddlethorpe All Saints where it joins The Cut.
5	Mills and Harps Drain	Ordinary Watercourse	Mills and Harps Drain extends from Neves Farm to Mablethorpe Road where it joins Rotten Row Drain.
5	Rotten Row Drain	Ordinary Watercourse	Rotten Row Drain extends from Park Farm to Mablethorpe Road where it joins The Cut.
5	The Cut	Ordinary Watercourse	The Cut extends from Theddlethorpe All Saints to Theddlethorpe Gas Terminal.

1.4.3 In addition to the watercourses described in **Table 3**, there are numerous drains and ditches in the study area. These are predominantly related to drainage infrastructure in the industrial areas, as well as artificial agricultural drainage channels. Many of these are managed by North East Lindsey and Lindsey Marsh IDBs.

1.4.4 Anticipated Ground Conditions and Hydrogeological Significance

1.4.5 The geology of the DCO Site Boundary is described in detail within *ES Volume II Chapter 9: Geology and Hydrogeology (Application Document 6.2.9)*, however, these have been summarised in this FRA to provide context for the assessment of groundwater flood risk.

Geology

1.4.6 Bedrock and superficial geology present beneath the Proposed Development is summarised in **Table 4.**

Table 4: Geology

Relevant Route Section	Superficial Geology	Bedrock Geology
1	Glacial Till Tidal Flat Deposits Glaciofluvial Deposits Alluvium Lacustrine Deposits	Burnham Chalk Formation
2	Glacial Till Glaciofluvial Deposits	Burnham Chalk Formation Welton Chalk Formation
3	Glacial Till Alluvium Lacustrine Deposits Glaciofluvial Deposits	Burnham Chalk Formation Welton Chalk Formation
4	Glacial Till Alluvium Lacustrine Deposits Glaciofluvial Deposits	Welton Chalk Formation
5	Glacial Till Tidal Flat Deposits Alluvium	Burnham Chalk Formation Welton Chalk Formation

Hydrogeology

1.4.7 Figures 9-4 and 9-5 in *ES Volume II Chapter 9: Geology and Hydrogeology* present the designated superficial and bedrock aquifers below the DCO Site Boundary, respectively. The designated aquifers have been defined by the EA (Ref 37) as:

- **Principal Aquifer:** *"layers of rock or drift deposits that have high intergranular and / or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and / or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer*";
- **Secondary Aquifer – A**: *"permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers";*

- **Secondary Aquifer – B**: *"predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers";*
- **Secondary Aquifer – Undifferentiated**: "*has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type"; and*
- **Unproductive Strata**: *"These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow".*

1.4.8 The entire stretch of the DCO Site Boundary is underlaid by a Principal Aquifer. Sections 1 – 4 of the DCO Site Boundary are located largely within Source Protection Zones (SPZ) 2 and 3, with part of Section 2 located within SPZ 1. Groundwater SPZs monitor the risk of contamination for any activities that may cause pollution to the surrounding area.

2 The Proposed Development

2.1.1 The Viking CCS Pipeline is proposed to transport compressed and conditioned dense phase Carbon Dioxide (CO_2) from the delivery point at Immingham to storage in depleted gas reservoirs in the Southern North Sea, via a buried pipeline. The pipeline will be located between Immingham and Theddlethorpe in Lincolnshire, refer to *ES Volume II Chapter 3 (Application Document 6.2.3)* for a full description of the Proposed Development.

2.2 Viking CCS Pipeline Components

2.2.1 The main elements of the Proposed Development comprise:

- The Immingham Facility;
- A new 55.5km onshore pipeline;
- Three Block Valve Stations;
- The Theddlethorpe Facility (Option 1 and Option 2);
- A tie-in to the existing LOGGS pipeline; and
- Replacement of the Dune Isolation Valve.

2.2.2 The ES specifically covers the Proposed Development from the point of receipt of CO_2 at the Immingham Facility, through its onshore transportation in the new pipeline to the Theddlethorpe Facility, and onward transportation through the existing LOGGS offshore pipeline to the MLWS tide mark. Subsequent transmission would be part of a separate consent application.

2.2.3 The key features of the DCO Site Boundary in relation to the assessment of flood risk are presented in **Table 5** below.

Table 5: Key Features of DCO Site Boundary

Section	Description
Section 1 – Immingham Facility to A180	*Immingham Facility:* The pipeline operation would be managed from a Central Control Room (CCR) currently premised to be at the Immingham Facility, however it is expected that the CCR is more likely to be co-located within the existing CCR at VPI Immingham. The CCR will remotely monitor all aspects of the pipeline operations such as flow, temperature and pressure. From the CCR it will also be possible to open or close valves at the block valve stations and the Theddlethorpe Facility as necessary. The CCR at the Immingham Facility would be manned 24 hours a day, seven days a week. *Buried pipeline:* *Option 1:* The pipeline leaves the tie-in at the Immingham Facility to A180. *Option 2*: If it is viable to route the pipeline through the Humber Refinery site, the pipe would exit between Houlton's Covert and Children's Avenue (which would be crossed using a trenchless technique) towards the south east to A180.

Section	Description
Section 2 – A180 to A46	*Buried pipeline:* A180 to the A46. *Washingdales Lane Block Valve Station:* would be principally unmanned excepting periodic visits for maintenance and inspection. The frequency of such visits is yet to be determined but would be in line with equipment supplier recommendations and risk assessments. The valve itself would be buried with a valve actuator extended above ground (circa 1.5 m), with bypass valves and pipework potentially located above ground subject to operational/maintenance requirements. The valves may be operated remotely for which the necessary equipment on site will be housed in a kiosk, which would be typically between 2-3 m in height, subject to final design.
Section 3 – A46 to Pear Tree Lane	*Buried pipeline:* A46 to Pear Tree Lane. *Thoroughfare Block Valve Station:* would be principally unmanned excepting periodic visits for maintenance and inspection. The frequency of such visits is yet to be determined but would be in line with equipment supplier recommendations and risk assessments. The valve itself would be buried with a valve actuator extended above ground (circa 1.5 m), with bypass valves and pipework potentially located above ground subject to operational/maintenance requirements. The valves may be operated remotely for which the necessary equipment on site will be housed in a kiosk, which would be typically between 2-3 m in height, subject to final design.
Section 4 – Pear Tree Lane to Manby Middlegate (B1200)	*Buried pipeline:* Pear Tree Lane to Manby Middlegate(B1200). *Louth Road Block Valve Station:* would be principally unmanned excepting periodic visits for maintenance and inspection. The frequency of such visits is yet to be determined but would be in line with equipment supplier recommendations and risk assessments. The valve itself would be buried with a valve actuator extended above ground (circa 1.5 m), with bypass valves and pipework potentially located above ground subject to operational/maintenance requirements. The valves may be operated remotely for which the necessary equipment on site will be housed in a kiosk, which would be typically between 2-3 m in height, subject to final design.

Section	Description
Section 5 – Manby Middlegate (B1200) to Theddlethorpe and down to MLWS	*Buried pipeline:* Manby Middlegate (B1200) connecting to the existing LOGGS pipeline at the Theddlethorpe Facility. *Theddlethorpe Facility:* On exiting the Theddlethorpe Facility the existing LOGGS pipeline travels east up to MLWS. An existing isolation valve is located on the existing LOGGS pipeline, west of the sand dunes. Principally unmanned excepting periodic visits for maintenance and inspection. The frequency of such visits is yet to be determined but would be in line with equipment supplier recommendations and risk assessments.

3 Planning Policy

3.1 National Policy Statements for Energy Infrastructure

3.1.1 A number of National Policy Statements (NPS) for energy infrastructure were designated by the Secretary of State (SoS) under the Planning Act 2008 on 19 July 2011 (Ref 15), specifically Overarching NPS for Energy (EN1) (Ref 34) and NPS for Gas Supply Infrastructure and Gas and Oil Pipelines (EN4) (Ref 36). These cover Nationally Significant Infrastructure Projects (NSIPs) that fall under the Planning Act 2008.

3.1.2 NPS EN-1 states that *"applications for energy projects of 1 hectare or greater in Flood Zone 1 and all proposals for energy projects located in Flood Zone 2 and 3 should be accompanied by a NPPF compliant flood risk assessment".*

3.1.3 In determining an application for consent, NPS EN-1 states that the decision-maker should be satisfied that where relevant:

- The application is supported by an appropriate FRA;
- The Sequential Test has been applied as part of site selection;
- A sequential approach has been applied at the site level to minimise risk by directing the most vulnerable uses to areas of lowest flood risk;
- The proposal is in line with the relevant national and local flood risk management strategy;
- Priority has been given to the use of Sustainable Drainage Systems (SuDS); and
- In flood risk areas the project is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be managed over the lifetime of the development.

3.1.4 Section 5.7.12 of NPS EN-1 also states that developments in Flood Zone 2 or 3 should not be consented unless the Sequential and Exception Test requirements have been met. Preference should be given to locating projects in Flood Zone 1, unless there is no reasonably available site in Flood Zone 1, then projects can be located in Flood Zone 2. NSIPs can be located in Flood Zone 3, subject to the Exception Test.

3.1.5 Sections 5.7.14 - 5.7.16 of NPS EN-1 states that the Exception Test provides a method of managing flood risk while still allowing necessary development to occur. The Exception Test is only appropriate for use where the sequential test alone cannot deliver an acceptable site, considering the need for energy infrastructure to remain operational during floods. All three elements of the test will have to be passed for development to be consented. For the Exception Test to be passed:

- It must be demonstrated that the project provides wider sustainability benefits to the community that outweigh flood risk;
- The project should be on developable, previous developed land or, if it is not on previously developed land, that there is no reasonable alternative sites on developable previously developed land subject to any exceptions set out in the technology-specific NPSs; and
- A FRA must demonstrate that the project will be safe, without increasing flood risk elsewhere and, where possible will reduce flood risk overall.

Revised Draft National Policy Statements

3.1.6 The Government is currently reviewing and updating the Energy NPSs. It is doing this in order to reflect its policies and strategic approach for the energy system that is set out in the Energy White Paper (December 2020), and to ensure that the planning policy framework enables the delivery of the infrastructure required for the country's transition to net zero carbon emissions. As part of the NPS review process, the Government published a suite of revised draft of NPS's for new energy infrastructure on 6 September 2021. They recently held public re-consultation that support the decision on major energy infrastructure, which closed in May 2023. These include the following Draft NPSs:

- Draft Overarching National Policy Statement for Energy (EN-1) (Ref 34); and
- Draft NPS for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (Ref 36).

3.1.7 The detail of these provisions are, however, subject to review following consultation and thereafter implementation. The timetable for adoption of the updated NPSs is unknown, however, it is expected that these will be finalised and shall replace the current NPSs by the time the Viking CCS Pipeline DCO application is submitted.

3.1.8 Given the importance of these NPSs, the assessment approach takes account of these new emerging documents and any subsequent formal adoption of new NSPs for energy infrastructure will be considered where relevant during the production of this FRA. The following summary indicates where the relevant Draft NPS contain requirements that differ from the requirements of the existing NPSs:

- Identifying and securing opportunities to reduce the causes and impacts of flooding overall during the construction period should be included as a minimum requirement for FRA as stated in EN-1 Draft 2023 Section 5.8 Flood Risk, Paragraph 5.8.15; and
- Inclusion of changes to the assessment of the existing status due to the impact of climate change on rainfall patterns and consequently water availability across the water environment in EN-1 Draft 2023 Section 5.16 Water Quality and Resources, Paragraph 5.16.13.

3.1.9 The Draft National Policy Statement (NPS) for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) (Ref 36) also addresses flood risk in relation to climate change resilience in Chapter 2.2 Climate Change Adaptation with the following statement:

"The government's Policy Statement on flood and coastal erosion risk management sets out the government's ambition to create a nation more resilient to future flood and coastal erosion risk. It outlines policies and actions which will accelerate progress to better protect and better prepare the country against flooding and coastal erosion.

All buildings in flood risk areas can improve their preparedness to reduce costs and disruption to key public services when a flood happens. Where infrastructure is not better protected as part of a wider community scale flood defence scheme, those who own and run infrastructure sites – whether in public or private hands – are expected to take action to keep water out, minimise the damage if water gets in through flood resilient materials, and reduce the disruption caused. This includes effective contingency planning to mitigate the impacts of flooding on the delivery of important services.

As climate change is likely to increase risks to some of this infrastructure, from flooding or rising sea levels for example, applicants should in particular set out how the proposal would be resilient to:

- *increased risk of flooding;*
- *effects of rising sea levels and increased risk of storm surge;*
- *higher temperatures;*

- *increased risk of earth movement, coastal erosion, or subsidence from increased risk of flooding and drought; and*
- *any other increased risks identified in the applicant's assessment.*

The Secretary of State must expect that climate change resilience measures will form part of the relevant impact assessment in the Environment Statement (ES) accompanying an application. For example, future increased risk of flooding should be covered in the flood risk assessment".

3.2 National Planning Policy Framework

3.2.1 Published by the Department for Levelling Up, Housing and Communities, the NPPF (Ref 3) was updated in September 2023. The NPPF has three overarching objectives to contribute to the achievement of sustainable development, one of which is the 'environmental objective'. This objective includes the requirement of "*to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy*" (Paragraph 8c).

3.2.2 The NPPF contains several statements which are relevant to flood risk. These include:

- Strategic policies should set out an overall strategy for:
    - Infrastructure for transport, telecommunications, security waste management, water supply, wastewater, flood risk and coastal change management, and the provision of minerals and energy (including heat) (Paragraph 20b); and
    - conservation and enhancement of the natural, built and historic environment, including landscapes and green infrastructure, and planning measures to address climate change mitigation and adaptation (Paragraph 20d).
- Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure. (Paragraph 153).
- Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere (Paragraph 159).
- When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:
    - within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;
    - the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;

- it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;
- any residual risk can be safely managed; and
- safe access and escape routes are included where appropriate, as part of an agreed emergency plan. (Paragraph 167).

- Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:
  - take account of advice from the lead local flood authority;
  - have appropriate proposed minimum operational standards;
  - have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and
  - where possible, provide multifunctional benefits (Paragraph 169).

3.2.3 The requirements of the NPPF with regards to flood risk have been taken into account in this FRA.

3.3 National Planning Policy Guidance

3.3.1 The Flood Risk and Coastal Change PPG (Ref 2) provides guidance for local planning authorities on assessing the significance of the Proposed Development. The guidance highlights that adequate water and wastewater infrastructure is needed to support sustainable development.

3.3.2 The NPPF and Flood Risk and Coastal Change section of the PPG recommend that Local Plans should be supported by a Strategic Flood Risk Assessment (SFRA) and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities (LLFAs) and Internal Drainage Boards (IDBs). Local Plans should apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impacts of climate change, by:

- Applying the Sequential Test;
- Applying the Exception Test, if necessary;
- Safeguarding land from development that is required for current and future flood management;
- Using opportunities offered by new development to reduce the causes and impacts of flooding; and
- Seeking opportunities to facilitate the relocation of existing development, including housing, to more sustainable locations if climate change is expected to increase flood risk.

3.3.3 All sources of flooding should be considered in order to steer development at the planning stage to area at the lowest risk of flooding in order to satisfy the Sequential Test. The Flood Zone definitions are presented in Table 1 of the NPPF and are defined in **Table 1**.

3.3.4 The EA's 'Flood Map for Planning' identifies that the DCO Site Boundary predominantly lie in Flood Zone 1, however, they cross six main rivers which have associated Flood Zone 2 (medium risk of flooding from fluvial or tidal sources) and Flood Zone 3 (high risk of flooding from fluvial or tidal sources) extents.

3.3.5 In addition, the DCO boundary crosses local ordinary watercourses which have associated Flood Zone 2 (medium risk of flooding from fluvial or tidal sources) and Flood Zone 3 (high risk of flooding from fluvial or tidal sources) extents.

3.3.6 Sections 1 and 5 of the DCO Site Boundary lie predominantly within Flood Zone 3 and are considered to be a high risk of flooding from tidal sources. This includes key above ground infrastructure, such as the Immingham Facility and Theddlethorpe facility which are considered to be at high risk.

Sequential Test

3.3.7 A Sequential Test is required to assess flood risks across strategic development sites and the NPPF/ PPG recommends that the test be applied at all stages of the planning process to direct new development to areas with the lowest probability of flooding (Flood Zone 1).

3.3.8 The DCO Site Boundary (Sections 1, 5 and the watercourse crossings) are partially located in Flood Zones 2 and 3 as defined in the EA's 'Flood Map for Planning'. The Proposed Development is for the transportation of compressed CO_2 and includes above ground structures.

3.3.9 In the North Lincolnshire Council (NLC) Local Development Framework (LDF) (Ref 16) Policy CS18 – Sustainable Resource Use and Climate Change states that the NLC will *"support new technology and development for carbon capture and the best available clean and efficient energy technology, particularly in relation to the heavy industrial users in North Lincolnshire, to help reduce CO_2 emissions".*

3.3.10 The North East Lincolnshire Council (NELC) Local Plan (Ref 17) Policy 31 – Renewable and Low Carbon Infrastructure states that "*Proposals for renewable and low carbon energy generating systems will be supported when any significant impacts are satisfactorily minimised, and the residual harm is outweighed by the public benefits of the proposal".*

3.3.11 The East Lindsey District Council (ELDC) Local Plan (Ref 18) Policy 27 – Renewable and Local Carbon Energy states that *"large-scale renewable and low carbon energy development (..) will be supported where their individual or cumulative impact is, when weighted against the benefits, considered to be acceptable".*

3.3.12 The UK Government has committed to a legally binding target of achieving Net Zero by 2050. The Proposed Development is potentially transformational on the UK's journey to net zero. Located in the Humber, the UK's most industrial and CO_2-emissions-intensive region, it is uniquely placed to help the UK decarbonise and grow, by providing a gateway for investment and the development of a regional low-carbon hub. Throughout the ongoing design process, consideration was given to a range of design options, including several pipeline corridor routes, appraised and refined to ensure an informed and robust decision could be made when selecting a preferred end to end corridor (further details regarding the design phase are provided in *ES Volume II Chapter 2 (Application Document 6.2.2))*. As such, it is considered that the Sequential Test is passed.

3.3.13 According to Table 2 of the Flood Risk and Coastal Change PPG, the Proposed Development, including a buried compressed CO_2 pipeline, and associated above ground structures, comprises the vulnerability classification of 'Essential Infrastructure'.

3.3.14 Annex 3 of the Flood Risk and Coastal Change PPG defines 'Essential Infrastructure as:

- *Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.*
- *Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary*

substations storage; and water treatment works that need to remain operational in times of flood.

- *Wind turbines.*
- *Solar farms.*

3.3.15 As the Proposed Development comprises utility infrastructure it therefore falls under the category of 'Essential Infrastructure'.

3.3.16 Table 3 within the PPG (replicated in **Table 6** below) provides a matrix identifying which vulnerability classifications are appropriate within each Flood Zone. The Proposed Development will not be operational during a breach event, due to the closure of the industries that feed CO_2 into the Proposed Development.

3.3.17 The design lifetime of the Proposed Development is considered to be 25 years, however, in line with flood risk policy, non-residential development should be assessed for a lifetime of 75 years.

Table 6: Flood Risk Vulnerability and Flood Zone Compatibility

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	✓	Exception test required	✓	✓
Flood Zone 3a	Exception test required	✓	×	Exception test required	✓
Flood Zone 3b (Functional Floodplain)	Exception test required	✓	×	×	×
Key *✓ Development is appropriate.* *× Development should not be permitted*					

3.3.18 In addition to Table 3 of the NPPF (replicated in **Table 6** above) other requirements of the Sequential Test are as follows:

- *In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.*
- *In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:*
    - remain operational and safe for users in times of flood;
    - result in no net loss of floodplain storage;
    - not impede water flows and not increase flood risk elsewhere.

Exception Test

3.3.19 As **Table 6** indicates, essential infrastructure is appropriate in Flood Zones 2 and 3, however, the application of the Exception Test is required for the elements of the Proposed Development located in Flood Zone 3. The Flood Risk and Coastal Change PPG states that for the Exception Test to be passed it must be demonstrated that:

- the development provides wider sustainability benefits to the community that outweigh flood risk; and
- the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere and, where possible, will reduce flood risk overall.

3.3.20 In addition to the requirements above, NPS EN1 (Ref 34) also requires that the project be on developable, previous developed land or, if it is not on previously developed land, that there is no reasonable alternative sites on developable previously developed land subject to any exceptions set out in the technology-specific NPSs.

3.3.21 All the elements of the test will have to be passed for development to be allocated or permitted.

3.3.22 The NLC LDF (Ref 16) identifies that generating energy from renewable energy is a key issue and that it is it essential to use the best available clean technologies, including developing carbon capture methods, to help reduce carbon emissions and enable NLC to meet renewable energy targets. To address climate change issues, Policy CS18 – Sustainable Resource Use and Climate Change states that the LDF will *"promote development that utilises low or zero carbon sustainable energy sources*" and "*Supporting new technology and development for carbon capture and the best available clean and efficient energy technology, particularly in relation to the heavy industrial users in North Lincolnshire, to help reduce CO2 emissions.* "

3.3.23 The NELC Local Plan (Ref 17) identifies that renewable and low carbon infrastructure provides a positive framework for delivering sustainable energy supplies and will ensure that the Borough contributes to achieving national renewable energy generation targets, which require an *"80% reduction in greenhouse gas emissions compared to 1990 levels by 2050".*

3.3.24 The ELDC Local Plan (Ref 18) identifies that ELDC is keen to encourage the exploitation of a range of low carbon sources that have potential in East Lindsey.

3.3.25 The Central Lincolnshire Local Plan (Ref 19), which includes the West Lindsey District Council (WLDC) area, identifies that the vision for Central Lincolnshire is to transition to a low carbon and net-zero future. The Proposed Development is in line with Central Lincolnshire's ambition to facilitate a net zero carbon future.

3.3.26 As discussed in *ES Volume II Chapter 3: The Viking CCS Pipeline (Application Document 6.2.3)*, the Humber industrial cluster is energy intensive and requires multiple CO_2 storage options to promote greater onshore capture infrastructure development. The Viking CCS project will enable local authorities to exploit renewable energy and low carbon sources that have potential in the region and contribute to a reduction in emissions. Further information is provided in the *Planning Statement (Application Document 7.1)*.

3.3.27 This FRA will demonstrate that the development will be safe for its lifetime without increasing the flood risk elsewhere. Mitigation measures, where required, are outlined in **Section 5** and **Section 6** of this assessment.

3.4 Non-Statutory Technical Standards for Sustainable Urban Drainage Systems

3.4.1 The Non-Statutory Technical Standards for Sustainable Drainage Systems (Ref 38) produced by Department for Environment, Food & Rural Affairs (DEFRA) represent the current guidance for the design, maintenance and operation of SuDS.

3.4.2 The standards set out that peak runoff rates from development sites should be as close as is reasonably practicable to the greenfield rate but should never exceed the pre-development runoff rate. The standards also set out that drainage systems should be designed so that flooding does not occur on any part of a site for a 1 in 30-year rainfall event, and that no flooding of a building (including basement) would occur during a 1 in 100-year rainfall event. It is also noted within the standards that pumping should only be used when it is not reasonably practicable to discharge by gravity.

3.4.3 The following guidance has been adopted for each of the sites considered within the Drainage Strategy *(ES Volume IV Appendix 11.3 (Application Document 6.4.11.3))*:

- Immingham Facility – NLC SuDS and Flood Risk Guidance Document;
- Washingdales Lane Block Valve Station – Non-Statutory Technical Standards for Sustainable Drainage Systems;
- Thoroughfare Block Valve Station – Non-Statutory Technical Standards for Sustainable Drainage Systems;
- Louth Road Block Valve Station – LCC Sustainable Drainage Design and Evaluation Guide;
- Theddlethorpe Facility Option 1 – LCC Sustainable Drainage Design and Evaluation Guide; and
- Theddlethorpe Facility Option 2 – LCC Sustainable Drainage Design and Evaluation Guide.

3.5 Regional and Local Planning Policy

3.5.1 The following Regional and Local Planning Policy is relevant to the Proposed Development and presented in **Annex B**:

- Humber River Basin District Flood Risk Management Plan (Ref 20);
- Anglian River Basin District Flood Risk Management Plan (Ref 21);
- Grimsby and Ancholme Catchment Flood Management Plan (Ref 7);
- Louth Coastal Catchment Flood Management Plan (Ref 22);
- Flamborough Head to Gibraltar Point Shoreline Management Plan (Ref 23);
- North Lincolnshire Council Local Development Framework (Ref 16);
- North East Lincolnshire Council Local Plan (Ref 17);
- North Kesteven District Council Central Lincolnshire Local Plan (Ref 19);
- East Lindsey District Council Local Plan (Ref 18);
- North Lincolnshire Council Local Flood Risk Management Strategy (Ref 24);
- North East Lincolnshire Council Local Flood Risk Management Strategy (Ref 25);

- Lincolnshire County Council Joint Lincolnshire Flood Risk and Water Management Strategy (Ref 26);
- North and North East Lincolnshire Strategic Flood Risk Assessment (Ref 9);
- East Lindsey Strategic Flood Risk Assessment (Ref 11);
- West Lindsey Strategic Flood Risk Assessment (Ref 27);
- North Lincolnshire Council Preliminary Flood Risk Assessment (Ref 28);
- North East Lincolnshire Council Preliminary Flood Risk Assessment (Ref 8);
- Lincolnshire County Council Preliminary Flood Risk Assessment (Ref 10);
- Lincolnshire Council Local Standards for Sustainable Drainage (Ref 29); and
- Building Standards Regulations 2000 Part H (Ref 30).

4 Methodology

Sources of Flood Risk

4.1.1 The NPPF requires the effects of all forms of flood risk, both to and from the Proposed Development, are considered within this FRA. There should be demonstration of how these should be managed so that the development remains safe throughout its lifetime, taking into account climate change. The flood risk sources considered in this assessment are outlined below.

Tidal Flooding

4.1.2 Tidal flooding occurs during extreme high tide and/or storm surge events, or the unlikely event of a breaching or overtopping scenario of existing tidal defences. High water levels within tidally influenced estuaries and rivers may also contribute to tidal flooding. As a consequence of climate change, sea level rises and increased storm surges are predicted, increasing the probability of flooding from overtopping or breach of tidal defences.

Fluvial Flooding

4.1.3 Fluvial flooding occurs when the capacity of a river is exceeded. This can occur in response to high flows. In tidal locations, raised water levels can occur in response to tide-locking / backwater effects.

Groundwater Flooding

4.1.4 Groundwater flooding can occur when groundwater levels exceed ground surface levels generally as a result of periods of sustained high rainfall. The underlying geology has a major influence on where this type of flooding takes place; it is most likely to occur in low-lying areas underlain by permeable rocks (aquifers) where the water table is more likely to be at shallow depth.

Surface Water (Pluvial) Flooding

4.1.5 Surface water flooding occurs when rainfall is unable to drain away quickly in response to rainfall. Pluvial flooding can occur in urban areas during extreme, high intensity, low duration rainfall events which overwhelm the local surface water drainage systems, or in rural areas during medium intensity, long duration events where saturated ground conditions prevent infiltration into the subsoil.

4.1.6 The EA Risk of Flooding from Surface Water Maps (Ref 4) indicate areas at risk from surface water flooding where floodwater would be conveyed via overland flow routes dictated by topography. As defined by the EA, the following levels of surface water flood risk can be classified as defined in **Table 7**.

Table 7: Definition of Risk from Surface Water Flooding

Risk Of Flooding	Definition
Very Low	Each year, the area has a chance of flooding of less than 1 in 1000 (0.1% Annual Exceedance Probability (AEP))
Low	Each year, the area has a chance of flooding of between 1 in 1000 (0.1% AEP) and 1 in 100 (1% AEP)
Medium	Each year, the area has a chance of flooding of between 1 in 100 (1% AEP) and 1 in 30 (3.3% AEP)
High	Each year, the area has a chance of flooding of greater than 1 in 30 (3.3% AEP)

Artificial Waterbodies

4.1.7 Artificial waterbodies include raised channels such as canals or storage features such as ponds and reservoirs. It should be noted that many of the watercourses (covered in the 'fluvial' section of this report, refer to Section 4.1.3) are artificial or heavily modified.

Drainage and Sewerage Infrastructure

4.1.8 Flooding from drains, sewers and surface waters are normally interconnected. Insufficient or reduced drainage capacity within the sewer network can result in drainage capacity being exceeded causing extensive surface water flooding. Likewise, increased volumes of surface water can overload sewers and drains, causing the drainage network to backup and surcharge causing surface water flooding.

4.2 Climate Change Allowances

Environment Agency Climate Change Guidance

4.2.1 The EA published updated climate change allowances in May 2022 (Ref 31) to support the NPPF, which supersede all previous allowances written in the Flood Risk & Coastal Change PPG: and are predictions of anticipated change for:

- Peak river flow by Management Catchment;
- Peak rainfall intensity;
- Sea level rise; and
- Offshore wind speed and extreme wave height.

4.2.2 These should be considered within an FRA in regard to future impacts from climate change on site specific planning applications. The EA's guidance outlines how and when allowances should be applied for FRAs.

Tidal Climate Change Allowances

4.2.3 **Table 8** is an extract replicated from the EA guidance detailing the revised anticipated rise in sea levels up to 2125. The total sea level rise for each epoch is in brackets.

Table 8: Sea Level allowances by river basin district for each epoch in mm for each year (based on a 1981 to 2000 baseline)

Areas of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Anglian	Higher Central	5.8 (203)	8.7 (261)	11.6 (348)	13 (390)	1.20
	Upper End	7 (245)	11.3 (339)	15.8 (474)	18.1 (543)	1.60
Humber	Higher Central	5.5 (193)	8.4 (252)	11.1 (333)	12.4 (372)	1.15
	Upper End	6.7 (235)	11 (330)	15.3 (459)	17.6 (528)	1.55

Fluvial Climate Change Allowances

4.2.4 For the areas of the Proposed Development with fluvial flood risk (the watercourse crossings), the flood risk vulnerability classification, the flood zone and lifetime of

development are of particular importance to determine the correct climate change allowance as detailed in **Table 9**.

Table 9: Environment Agency Climate Change Allowances to apply based upon the Flood Zone and Development Land Use Vulnerability

	Water Compatible	Less Vulnerable	More Vulnerable	Highly Vulnerable	Essential Infrastructure
Flood Zone 2	CA	CA	CA	CA	HCA
Flood Zone 3a	CA	CA	CA	X	HCA
Flood Zone 3b	CA	X	X	X	HCA
CA = Central Allowance; HCA = Higher Central Allowance; X = Development not permitted					

4.2.5 As the Proposed Development is defined as 'Essential Infrastructure' from the vulnerability classifications in Table 2 of the NPPF, the corresponding allowances that should be assessed within the Louth, Grimsby and Ancholme and Witham Management Catchments can be extracted from **Table 10**.

4.2.6 The Proposed Development has a lifetime of 25 years, however in line with flood risk policy a lifetime of 75 years will be assessed (i.e. to 2100). The central allowance should be used to assess the sections of the proposed pipeline located in Flood Zone 1 and the higher central allowance should be used to assess the sections located in Flood Zones 2 and 3.

Table 10: Environment Agency Peak River Flow Climate Change Allowances for the Louth, Grimsby and Ancholme and Witham Management Catchments

Management Catchment	Allowance	Total potential change anticipated for '2020s' (2015 to 2039)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Louth, Grimsby and Ancholme	Upper End Allowance	21%	19%	33%
	Higher Central Allowance	9%	5%	12%
	Central Allowance	4%	-1%	4%
Witham	Upper End Allowance	27%	32%	57%
	Higher Central Allowance	14%	15%	32%
	Central Allowance	9%	8%	21%

Pluvial Climate Change Allowances

4.2.7 To account for the anticipated changes in rainfall intensity, the corresponding allowances that should be assessed within the Louth, Grimsby and Ancholme and Witham Management Catchments are listed in **Table 11**.

4.2.8 The Drainage Strategy *(ES Volume IV Appendix 11.3 (Application Document 6.4.11.3))* includes a 40% uplift for a 1% AEP event, in line with the upper end climate change allowance for a 75-year lifetime.

Table 11: Peak Rainfall Intensity Allowances for the Louth, Grimsby and Ancholme and Witham Management Catchments

	Parameter	Allowance	Total potential change anticipated for '2050s'	Total potential change anticipated for '2070s'
Louth, Grimsby and Ancholme	1% annual exceedance rainfall event (2070 – 2115)	Upper End	40%	40%
		Central	20%	25%
	3.3% annual exceedance rainfall event (2070 – 2115)	Upper End	35%	35%
		Central	20%	25%
Witham	1% annual exceedance rainfall event (2070 – 2115)	Upper End	40%	40%
		Central	20%	25%
	3.3% annual exceedance rainfall event (2070 – 2115)	Upper End	35%	35%
		Central	20%	25%

4.2.9 When assessing a range of allowances for peak tidal, river flow or rainfall intensity, the following must be considered:

- Likely depth, speed and extent of flooding for each of the assessed climate change allowances;
- Vulnerability of the project types or land use allocations to flooding;
- 'Built in' resilience measures used, for example, raised floor levels; and
- Capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach.

H++ Allowances

4.2.10 NSIPs are major infrastructure projects. As the Proposed Development is classed as an NSIP, the flood risk from a credible maximum climate change scenario should be assessed as a 'sensitivity test' to identify how changes in the climate for future scenarios may affect the project and allow appropriate mitigation measures to be set.

4.2.11 A sea level rise of 1.9m for 2100 should be used to assess the above ground infrastructure and a storm surge estimate of 0.166m (+2mm per year from 2017 (83 years to 2100). Further information is provided in Section 5.14.

5 Assessment of Flood Risk

5.1 Historic Flooding

5.1.1 The EA's Historic Flood Map (Ref 32 and reproduced in **Figure 2**) indicates that Rosper Road, Immingham is the only part within the DCO Site Boundary within EA's historic flood map. Rosper Road flooded during the January 1953 Tidal Event.

Within the wider study area:

- Section 1 Port of Immingham, to the east, flooded during the 2013 tidal event, however, this flood extent does not infringe upon the boundary of the DCO Site Boundary.
- Waithe Beck (Section 2) previously flooded in 2007 at Brigsley, however this extent does not infringe upon the DCO Site Boundary.
- Poulton Drain (Section 4) previously flooded in November 2019 near Covenham St Mary and Yarburgh, however this extent does not infringe upon the DCO Site Boundary.
- Section 5 - the January 1953 Tidal Event inundated the coastline up to Kent Avenue and flooded the area south of Meers Bank, however this flood extent does not infringe upon the boundary of the DCO Site Boundary.

5.2 Groundwater Sources

5.2.1 The 1:50,000 British Geology Survey (BGS) Map of Britain (Ref 12) indicates the DCO Site Boundary crosses superficial deposits consisting of Tidal Flats (Clay and Silt) and Devensian Till (Diamicton), which are defined as Secondary Undifferentiated aquifers. The superficial deposits are underlain by Burnham Chalk Formation and Flamborough Chalk Formation bedrock, which is defined as a principal aquifer. There is therefore the potential for elevated groundwater beneath the site.

5.2.2 Groundwater levels tend to get re-charged during the winter and high groundwater levels can cause flooding as the water table rises. The rise in water table levels can be very slow, dependant on rainfall patterns and groundwater flooding can be long lasting (weeks or months).

5.2.3 Borehole records from the British Geological Survey (BGS) indicate that:

Section 1	a groundwater level of 2.7m below ground level (bgl) in the vicinity of Immingham Facility
Section 2	a groundwater level of 2.45m bgl near Stallingborough, however no other boreholes within Section 2 of the Proposed Development recorded any groundwater.
Section 3	groundwater was not encountered by any of the boreholes within Section 3 of the DCO Site Boundary.
Section 4	groundwater was not encountered by any of the boreholes within Section 4 of the DCO Site Boundary.
Section 5	groundwater was not encountered by any of the boreholes within Section 5 of the DCO Site Boundary.

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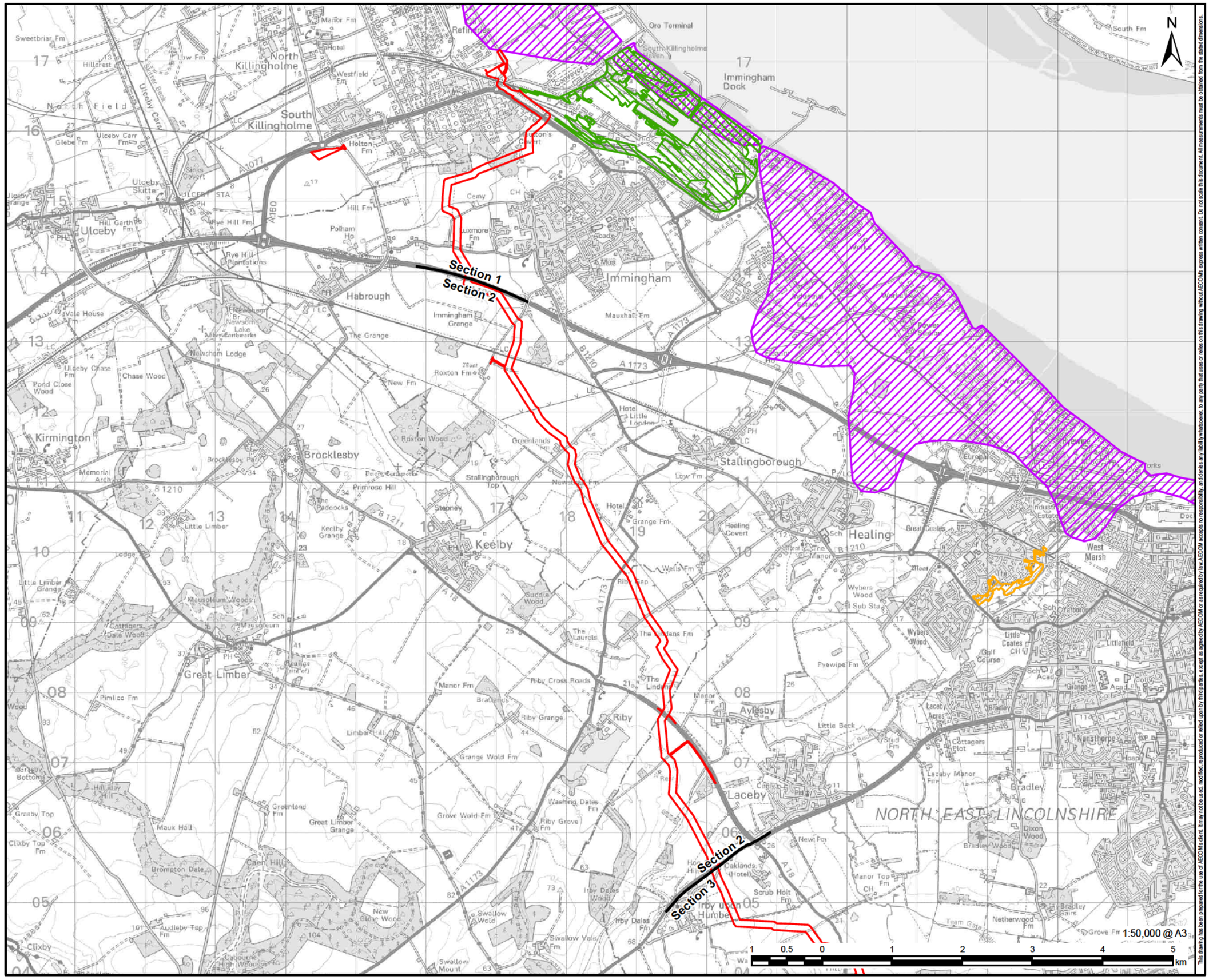

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Recorded Flood Outline

- 1953 January - Lincolnshire Coastline
- 2007 June - River Freshney
- 2013 December - Tidal Surge

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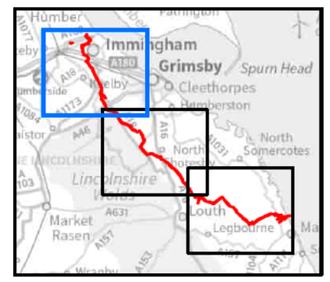

FIGURE TITLE

Figure 2 (1 of 3)
Environment Agency Historic Flood Map

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_2

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Revision: 1 Drawn: LC Checked: KB Approved: MW Date: 2024-05-16

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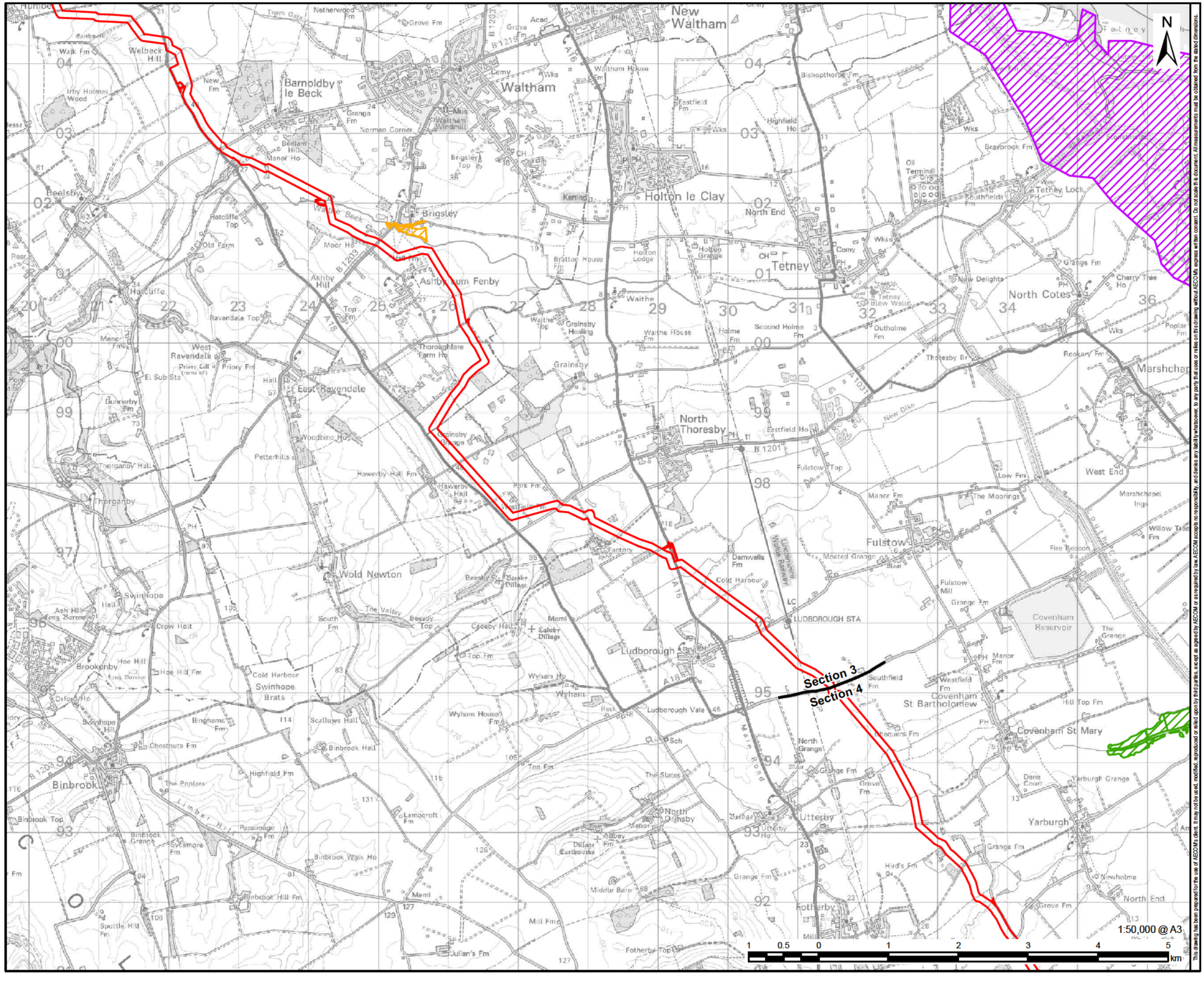

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Recorded Flood Outline

- 1953 January - Lincolnshire Coastline
- 2007 June - Waithe Beck
- 2019 November - Poulton Drain

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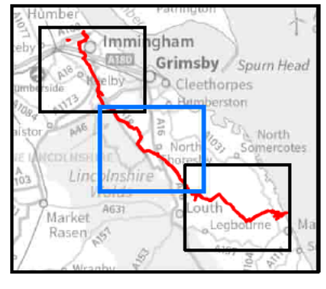

FIGURE TITLE

Figure 2 (2 of 3)
Environment Agency Historic Flood Map

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_2

Revision: 1 Drawn: LC Checked: KB Approved: MW Date: 2024-05-16

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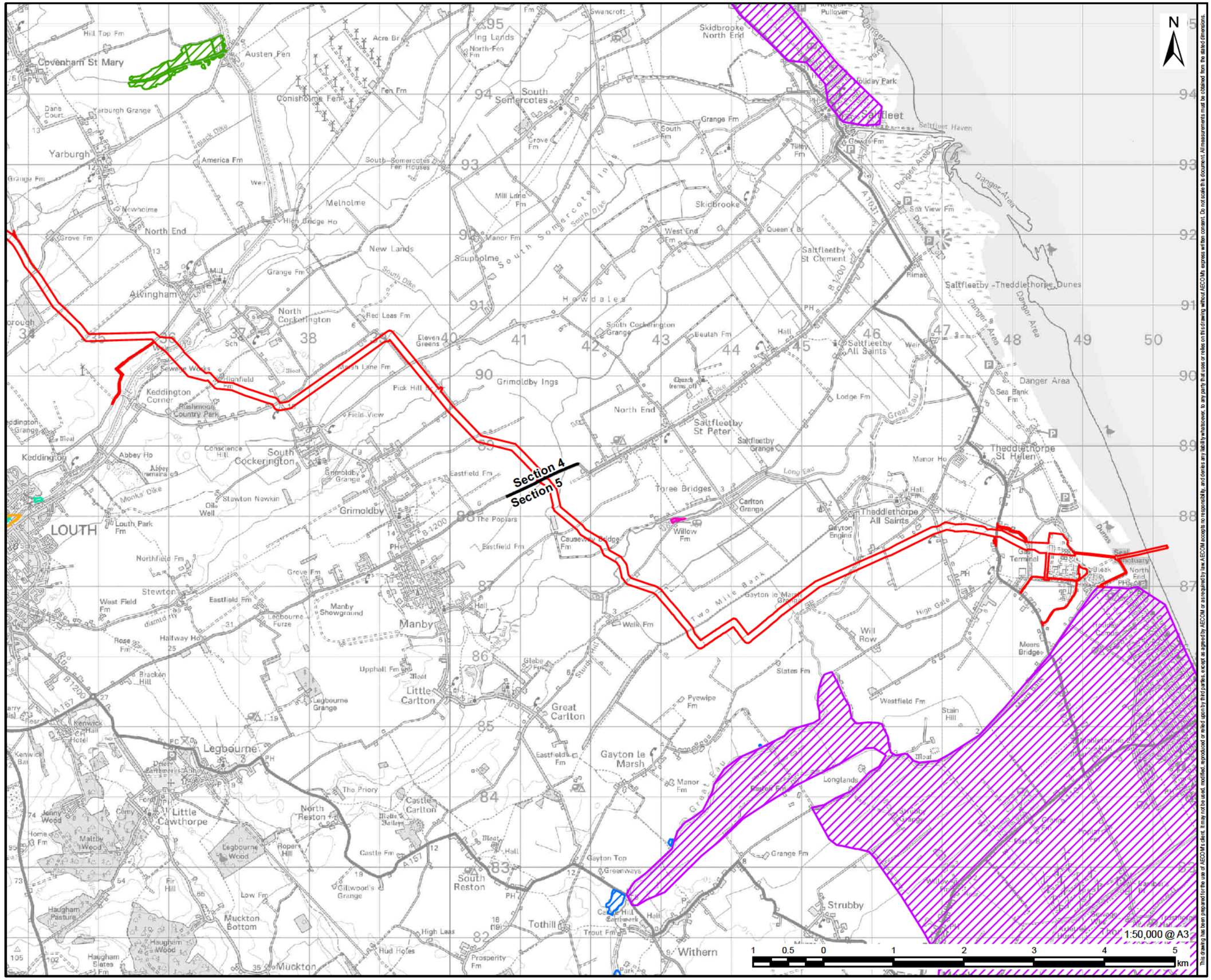

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Recorded Flood Outline

- 1920 May - River Lud
- 1953 January - Lincolnshire Coastline
- 2007 June - River Lud
- 2019 June - Great Eau
- 2019 June - Long Eau
- 2019 November - Poulton Drain

NOTES:

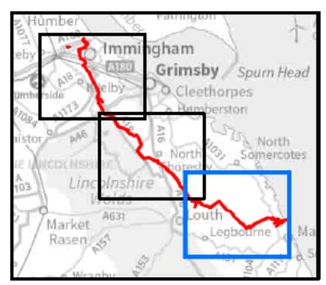

FIGURE TITLE

Figure 2 (3 of 3)
Environment Agency Historic Flood Map

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_2

5.2.4 The risk from groundwater flooding is considered to be low.

5.2.5 During the construction phase, appropriate construction practices will need to be adhered to in order to manage the risk of groundwater ingress into excavations during construction, such as dewatering and pumping techniques as required.

5.2.6 The pipeline route would be below ground across its entire route and therefore has the potential to encroach within the groundwater table. The pipeline will need to be designed appropriately to take into account hydrostatic pressure and the floatation risk to the pipe from elevated groundwater.

5.2.7 The direct impact of climate change on groundwater resources is dictated by the changes in rainfall intensity and soil infiltration. During drier seasons, there may be reductions in groundwater recharge that may cause a long-term decline in groundwater storage. Alternatively, groundwater recharge may be stabilised or even increased by frequent and prolong periods of rainfall.

5.2.8 As a precautionary measure, any below ground elements associated with the Proposed Development should be designed in such a way as to withstand any upward hydraulic pressures in the event that groundwater levels rise as a result of climate change.

5.3 Artificial Waterbodies

5.3.1 The only location with the DCO Site Boundary considered to be at risk from artificial waterbodies is from the Kiln Reservoir, along the Laceby Beck / River Freshney within Section 2 (**Figure 3**). Given that the pipeline will be below ground at this location and there is no above ground infrastructure located within this area, the risk of flooding from artificial waterbodies is considered to be low and no mitigation is required.

5.3.2 Elsewhere within the DCO Site Boundary is not considered to be at risk of flooding from artificial sources, including reservoirs.

5.4 Drainage and Sewerage Infrastructure

5.4.1 The Drainage Strategy (*ES Volume IV Appendix 11.3 (Application Document 6.4.11.3*)) confirms that a desktop study was undertaken by GroundSure to gather available information regarding drainage and sewerage infrastructure in the vicinity of the DCO Site Boundary. The study identifies that that there is no known drainage and sewerage infrastructure present within the site boundaries of the Immingham and Theddlethorpe facilities or the block valve sites.

5.4.2 The desktop survey undertaken by GroundSure does identify Anglian Water drainage and sewerage infrastructure within the wider DCO Site boundary, however, the SFRAs for the LLFAs across the study area (NLC and NELC SFRA (Ref 9), East Lindsey SFRA (Ref 11), and West Lindsey SFRA (Ref 27)) indicate that areas associated with flooding from drainage and sewerage sources are largely limited to the larger villages and urban areas with rural areas remaining unaffected. There are no historical records of drainage and/or sewerage flooding for the DCO Site Boundary, therefore the DCO Site Boundary are not considered to be at risk from drainage or sewerage infrastructure.

5.4.3 Drainage and Sewerage Infrastructure will not be considered further.

5.5 Fluvial Sources – buried pipeline

5.5.1 The DCO Site Boundary crosses Main Rivers, North-East Lindsey and Lindsey Marsh IDB maintained watercourses, Ordinary Watercourses and unnamed land drains. The EA Flood Map for Planning (Ref 1 and reproduced in **Figure 2**) indicates that the crossings lie in Flood Zones 2 and 3.

5.5.2 Where there is no modelling data available for ordinary watercourses and drains, the EA Risk of Flooding from Surface Water mapping (Ref 4) was used as a proxy to identify potential flow paths or areas where the channel may exceed the bank.

Operational Phase

5.5.3 The pipeline would be below ground across its entire route during the operational phase, therefore the risk of fluvial flooding to this aspect of the development is considered to be low and no mitigation is required.

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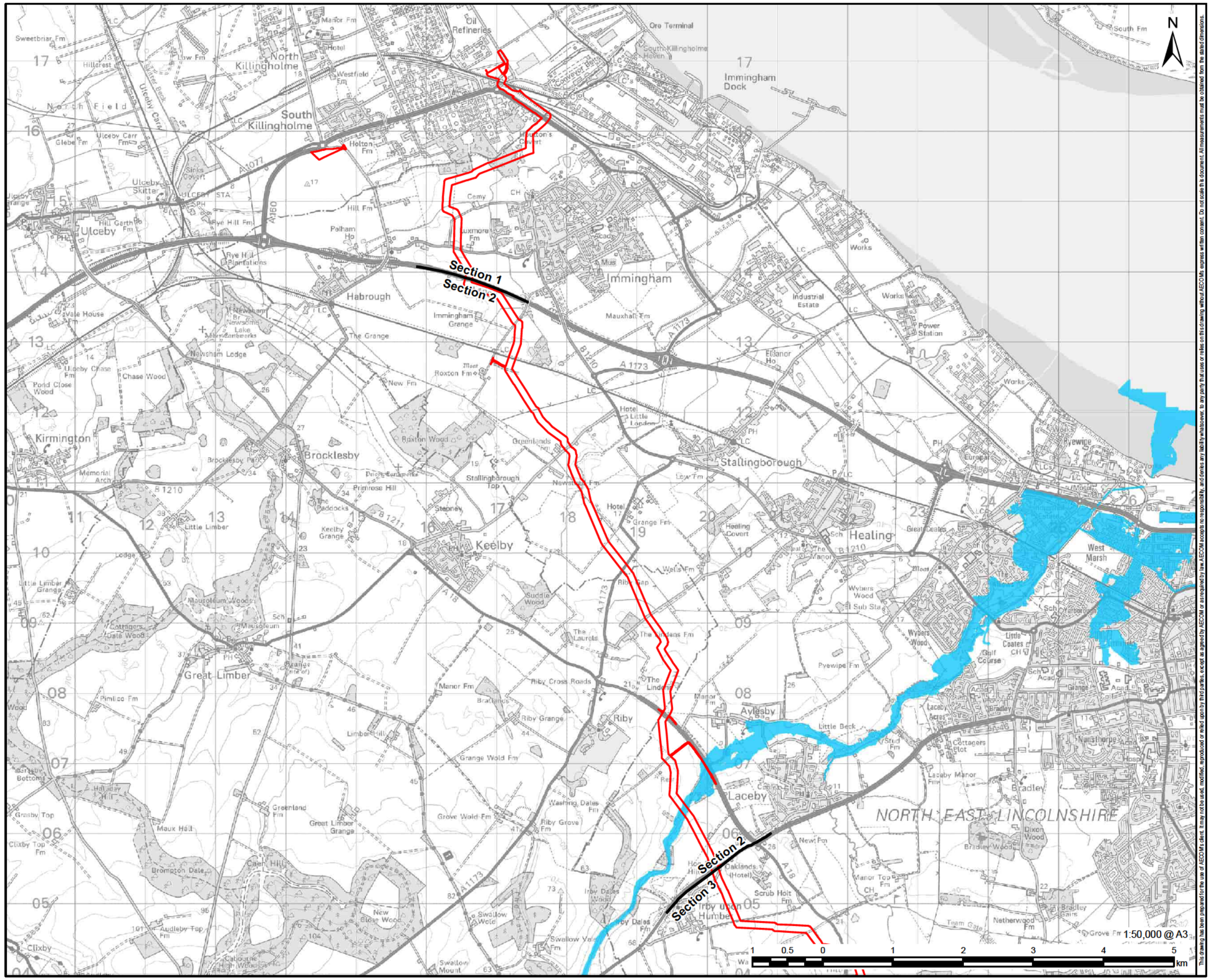

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break
- Reservoir Flood Extents

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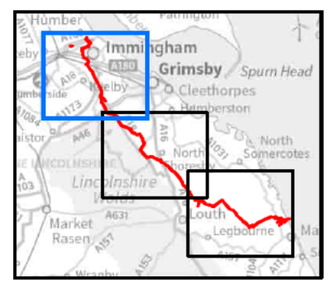


FIGURE TITLE

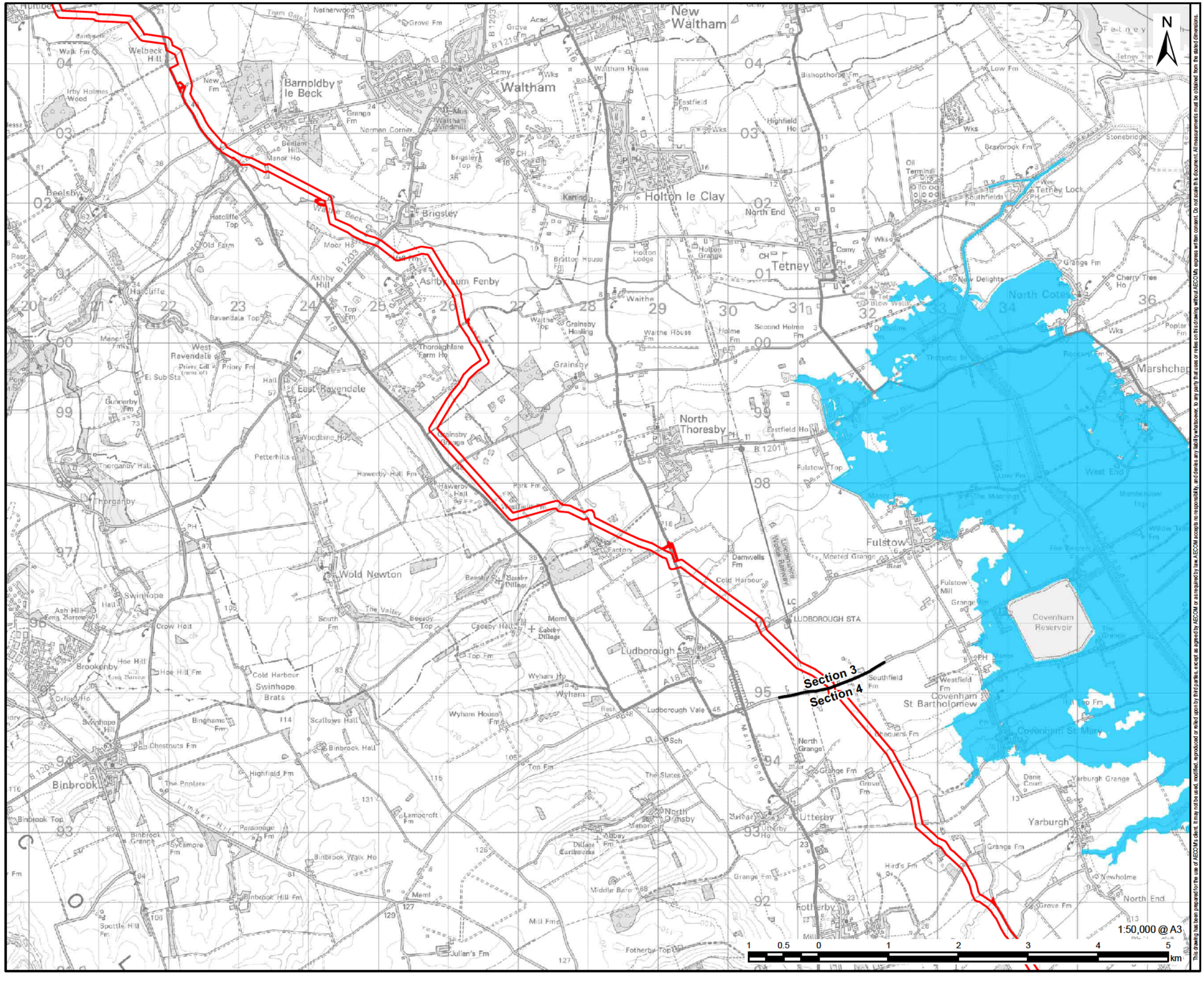
Figure 3 (1 of 3)
Environment Agency Risk of Flooding from Reservoirs

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_3



VikingCCS

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PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break
- Reservoir Flood Extents

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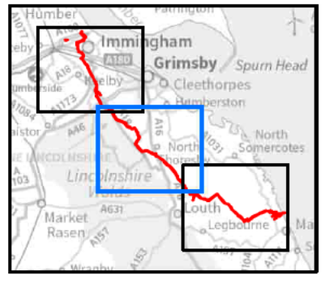

FIGURE TITLE

Figure 3 (2 of 3)
Environment Agency Risk of Flooding from Reservoirs

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_3

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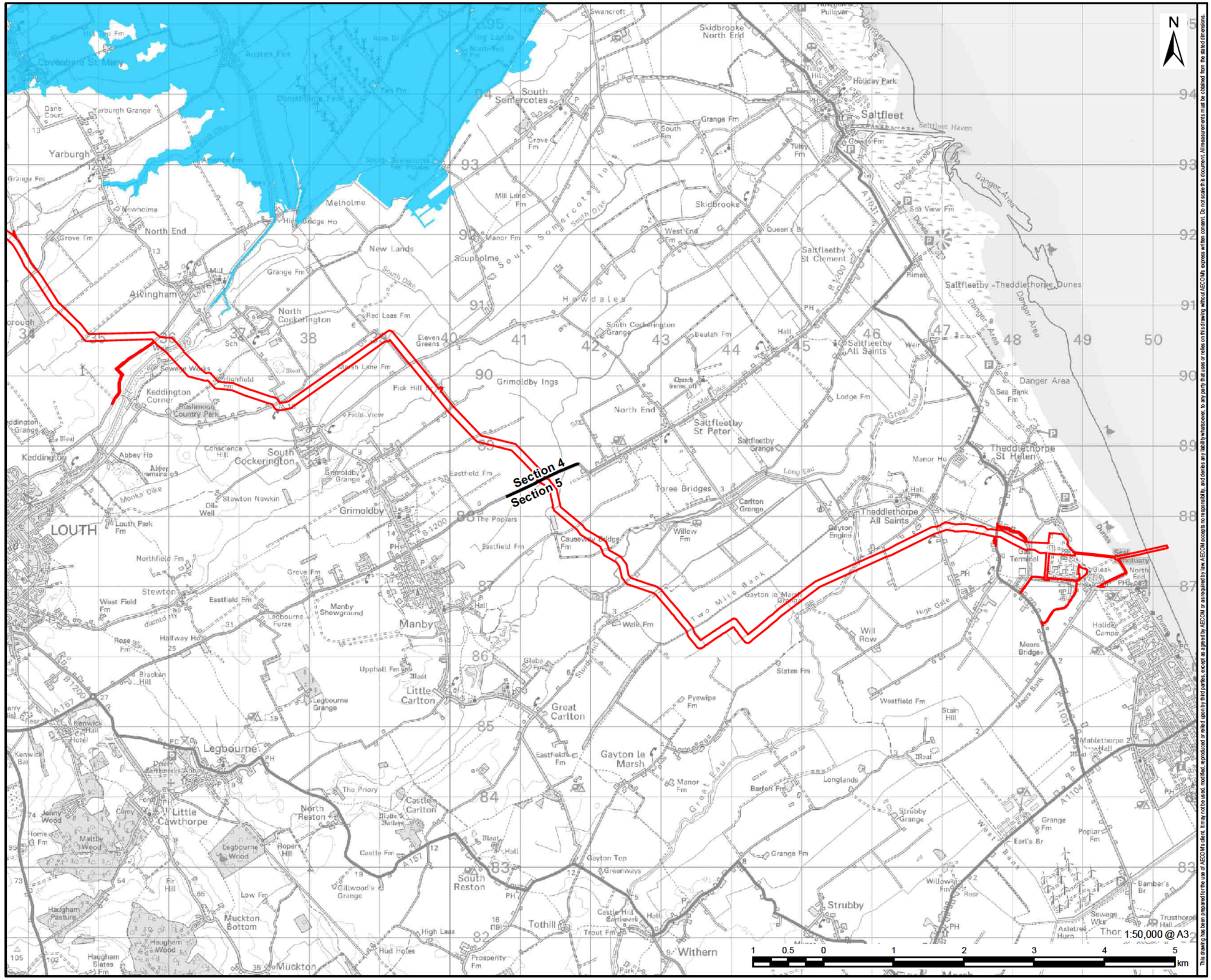

VikingCCS

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PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break
- Reservoir Flood Extents

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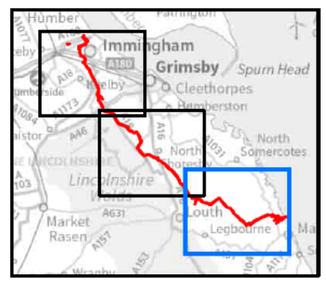


FIGURE TITLE

Figure 3 (3 of 3)
Environment Agency Risk of Flooding from Reservoirs

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_3

1:50,000 @ A3

Construction Phase including Crossing Techniques

5.5.4 The pipeline will need to cross watercourses. In some instances, a crossing is made using open cut techniques, however where open cut is impracticable or not preferred, trenchless crossing techniques are proposed. Typically, crossings of main rivers/ditches, canals, etc., are installed by trenchless methods, however, the majority of small watercourses and ditches will be crossed using open-cut methods.

5.5.5 The following crossing techniques will be used when open-cut techniques are not appropriate:

- Auger boring;
- Guided auger boring;
- Horizontal Directional Drilling (HDD); and
- Micro-Tunnelling.

5.5.6 The following temporary crossings will be installed during the construction phase to enable access:

- Flumed crossings (on Ordinary Watercourses only) installed for 12 months; and
- Bailey Bridges.

5.5.7 A crossing schedule is provided *in ES Volume IV Appendix 3.2 (Application Document 6.4.3.2)*.

5.5.8 During the construction phase of the pipeline there is a risk of flooding to the construction site, given that the works will take place within Flood Zones 2 and 3.

5.5.9 To mitigate this risk, the following mitigation measures are recommended and are secured within the Draft CEMP (*ES Volume IV Appendix 3.1 (Application Document 6.4.3.1*):

- G1: Adoption of an appropriate Flood Warning and Evacuation Plan (FWEP);
- P7: Construction works should not be undertaken during periods of heavy rainfall;
- P8: Weather forecasts and Flood Warnings should be monitored regularly during the construction phase; and
- P9: Minimal storage of materials/plant in the floodplain.

5.5.10 In addition, both during and following construction the following measures are recommended to mitigate off-site flood risk or drainage impact both during construction and in the longer-term. These are secured within the Draft CEMP (*ES Volume IV Appendix 3.1 (Application Document 6.4.3.1*):

- F5: Existing field drainage systems will be re-instated to ensure that land capability is maintained, and drainage related to flooding issues will not be worsened.
- G2: The location and condition of existing land drainage will be established, and a record compiled. Subject to landowner/occupier agreement, existing drains should be restored, or new drains established to help prevent damage to soil structure, maintain work areas in a dry condition and to enable current drainage systems to continue to operate through the construction period.
- G11: Following installation of the CO2 pipeline, topsoil and excavated material will be reinstated, and post-construction drainage system installed to ensure no detriment to the existing land drainage regime.

5.5.11 The use of trenchless techniques, including auger boring and HDD, requires excavations to be made by a mechanical excavator at both the drill entry point (launch pit) and the drill exit

point (reception pit) to contain drilling fluids at each end of the drill path. These excavations will be approximately 2m deep and 3m x 3m in area, set back from the watercourse. The working width at these locations would be typically wider than the standard 30 m working width. The pipeline will also cross the EA designated main rivers which have flood defences.

5.5.12 Flood risk in the study area is predominantly tidal and the Environment Agency do not hold any modelling data for the Ordinary Watercourses or riparian drains therefore, given the small catchment size the pluvial flood extents shown on the Risk of Flooding from Surface Water Maps (refer to **Figure 4**) can be used as a proxy to provide an indication of fluvial flood risk from small watercourses.

5.5.13 The surface water mapping shows the following:

- The Northern Construction Compound (Section 1) is predominantly located in an area at very low risk of flooding (less than a 0.1% AEP) with a small area in the north western corner located in an area shown to be at medium risk of flooding (between a 0.1% and 1.0% AEP);
- The Central Construction Compound (Section 3) is located in an area at very low risk of flooding ((less than a 0.1% AEP); and
- The Southern Construction Compound is located in area at very low risk of flooding (less than a 0.1% AEP) with small, isolated areas of low to medium risk (between a 0.1% and 1.0% AEP) attributed to surface water ponding within areas of low topography.

5.5.14 The Construction Compounds provide the main construction materials and pipeline storage areas for the pipeline. Mapping shows that the Northern Construction Compound is located in an area with a potential risk of fluvial flooding, albeit to a small section of the site. Storage of materials will be avoided in this area however there is potential for some temporary water displacement which could result in a slight increase in fluvial flood risk and impact fluvial flood flow routes. Any increase in flood risk will be localised to the Construction Compound and will not pose a significant risk to off-site receptors.

5.5.15 It is the project's general intention to avoid storage of materials within the fluvial floodplain during construction. In areas where fluvial floodplains are clearly mapped by the Environment Agency (Sections 2, 3 and 4), there will be no storage of materials within these mapped flood extents. In areas where the EA Flood Map for Planning shows combined tidal and fluvial floodplains (Section 1 and 5), and fluvial floodplains cannot be identified separately from available flood maps, a reasonable set back will be provided, further than 8m from Main Rivers, where there will be no storage of materials, subject to further discussions with the EA (for Main Rivers) or the LLFA/Internal Drainage Board (for Ordinary Watercourses), as the project design evolves through the FEED stage.

5.5.16 Note that sections of pipes may be temporarily located within the fluvial floodplain during the installation of the pipeline at open cut watercourse crossing locations whilst the pipeline is being laid out and welded in place. Sections of pipe would only be moved to the crossing locations when needed and will be installed within a short timeframe (usually within the same week). These activities will take place during the summer months to avoid times of higher flows.

5.6 Fluvial Sources – Block Valve Stations

5.6.1 With the exception of Throughfare Block Valve Station (Section 3), the Risk of Surface water flood map shows that both Washingdales Lane Block Valve Station and Louth Road Block Valve Station lie within an area at very low risk of flooding (Flood Zone 1 (<0.1% AEP)) and are therefore not considered to be at risk of flooding from fluvial sources during construction or operation.

5.6.2 The Thoroughfare Block Valve Station is shown to have a high risk of flooding from surface water. The EA RoFSW maps indicate localised ponding from a local land drain during higher return period events, with depths of up to 300mm. Construction of the Block Valve Station has the potential to displace flood water resulting in a slight increase in flood risk and impact fluvial flood flow routes, however flood water would still be routed around the station towards the north. Any increase in flood risk will be localised to the Block Valve Station and will not pose a significant risk to off-site receptors.

5.7 Fluvial Sources – Immingham Facility

5.7.1 The South Killingholme Drain is located along the northern boundary of the Immingham Facility site and flows generally from west to east joining the wider IDB drainage network to the east.

5.7.2 The Environment Agency do not hold any modelling data for the South Killingholme Drain therefore, given the small catchment size, the pluvial flood extents shown on the Risk of Flooding from Surface Water Maps (refer to **Figure 4**) can be used as a proxy to provide an indication of flood risk from small watercourses.

5.7.3 The mapping shows the Immingham Facility site is located in an area at low risk (0.1% chance of flooding each year) of flooding with water shown to pool within areas at lower topography within the site.

5.7.4 To mitigate this risk, the following mitigation measures are proposed as set out in the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)*:

- G1: Adoption of an appropriate Flood Warning and Evacuation Plan (FWEP);
- P7: Construction works should not be undertaken during periods of heavy rainfall;
- P8: Weather forecasts and Flood Warnings should be monitored regularly during the construction phase.

5.8 Fluvial Sources – Theddlethorpe Facility

5.8.1 Surface water mapping shows that both the Option 1 and Option 2 Theddlethorpe Facility Sites are located in an area at very low risk of surface water flooding (less than 0.1% AEP) and is therefore not at risk of flooding from fluvial sources.

5.9 Surface Water (Pluvial) – buried pipeline

5.9.1 The pipeline would be below ground across its entire route during the operational phase, therefore the risk of surface water flooding to this aspect of the development is considered to be low and no mitigation is required.

5.9.2 During the construction phase of the pipeline, appropriate construction practices will need to be adhered to in order to manage the risk of surface water ingress into excavations during construction, such as temporary drainage provisions and pumping, as required.

5.10 Surface Water (Pluvial) – Section 1

5.10.1 Section 1 of the DCO Site Boundary, including the access/laydown areas, are predominantly at very low risk of flooding from surface water (refer to **Figure 4**). Isolated pockets of pluvial ponding are considered to be reflective of areas of low topography.

5.10.2 The main pluvial flood risk areas coincide with watercourses and ditches, in particular South Killingholme Drain. The areas of high risk from surface water flooding are in the vicinity of

the buried pipeline and no above ground infrastructure, therefore, the risk of flooding from surface water is considered to be low and no further mitigation is required.

5.10.3 During the construction phase of the pipeline and Immingham Facility, appropriate construction practices will need to be adhered to in order to manage the risk of surface water ingress into excavations during construction, such as temporary drainage provisions and pumping as required.

5.10.4 Given that the Immingham Facility lies in an area at low risk, the risk of flooding from surface water to this aspect of the development is considered to be low. The Drainage Strategy (*ES Volume IV Appendix 11.3 (Application Document 6.4.11.3*)) will mitigate the risk of an increase in surface water runoff to the development itself, as well as mitigating any off-site impacts.

5.11 Surface Water (Pluvial) – Section 2, 3 and 4

5.11.1 Within Sections 2, 3 and 4 of the DCO Site Boundary the proposed infrastructure will predominantly be below ground (buried pipeline), except Washingdales Lane Block Valve Station (Section 2), Thoroughfare Block Valve Station (Section 3) and Louth Road Block Valve Station (Section 4).

5.11.2 Washingdales Lane Block Valve Station and Louth Road Block Valve Station lie in an area at very low risk of flooding from surface water. The risk of flooding from surface water to them is considered to be low and no mitigation is required.

5.11.3 Thoroughfare Block Valve Station, which will be installed off Thoroughfare in Ashby cum Fenby, would be constructed upon arable land that currently has a high risk of flooding from surface water. The EA RoFSW maps indicate localised ponding from a local land drain during higher return period events, with depths of up to 300mm.

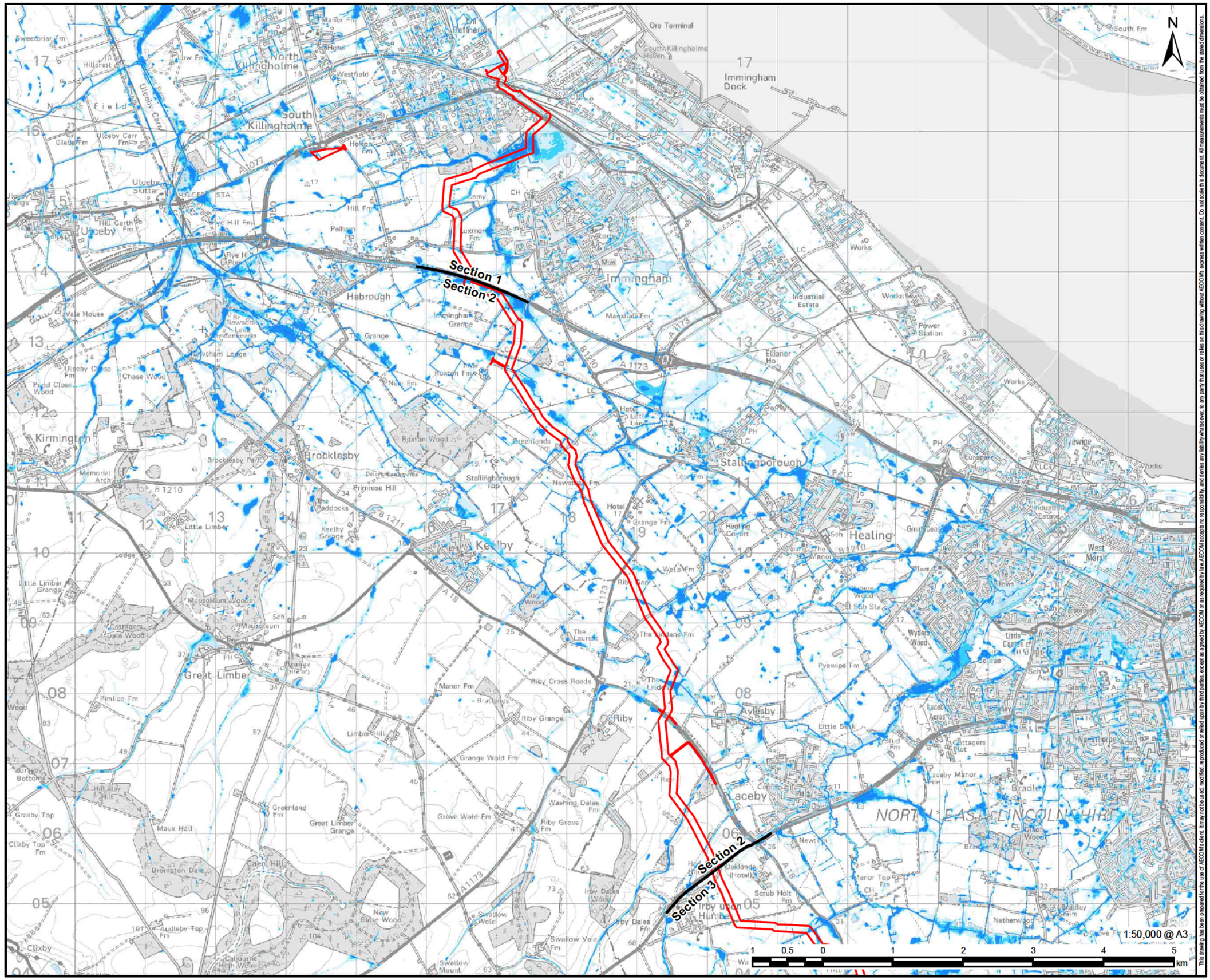
5.11.4 At Thoroughfare Block Valve Station there will be a kiosk to house the SCADA equipment and battery backup. The valve actuator will extend above ground to a level above the 1% AEP plus climate change pluvial flood level. Therefore, the risk of flooding from surface water to this aspect of the development is considered to be low.

5.11.5 During the construction phase of the pipeline and Block Valve Station 2, appropriate construction practices will need to be adhered to in order to manage the risk of surface water ingress into excavations during construction, such as temporary drainage provisions and pumping as required.

5.12 Surface Water (Pluvial) – Section 5

5.12.1 Section 5 of the DCO Site Boundary - Theddlethorpe Facility Option 1 and 2 including the access/laydown areas required is predominantly at very low risk of flooding from surface water. The main pluvial flood risk coincides with watercourses and ditches. Isolated pockets of pluvial ponding are considered to be reflective of areas of low topography, therefore the risk of flooding from surface water is considered to be low and no further mitigation is required.

Filename: \\eu.aecomnet.com\EMIAUKIUKNCL2\Jobs\60668965\V_Net_Zero_Project\900_CAD_GIS\920_GIS\02_Maps\Flood Risk Assessment\Updated DCO Deadline 2\VCCS_FRA_4_Risk of Flooding from Surface Water_v1_20240516_LC.mxd Revision: 1 Drawn: LC Checked: KB Approved: MW Date: 2024-05-16



VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Environment Agency - Risk of Flooding from Surface Water

- High - 3.3% AEP
- Medium - 1% AEP
- Low - 0.1% AEP

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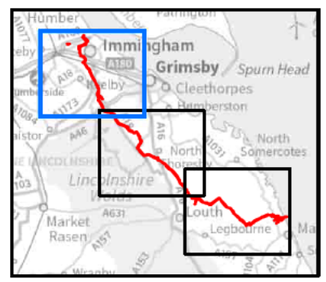


FIGURE TITLE

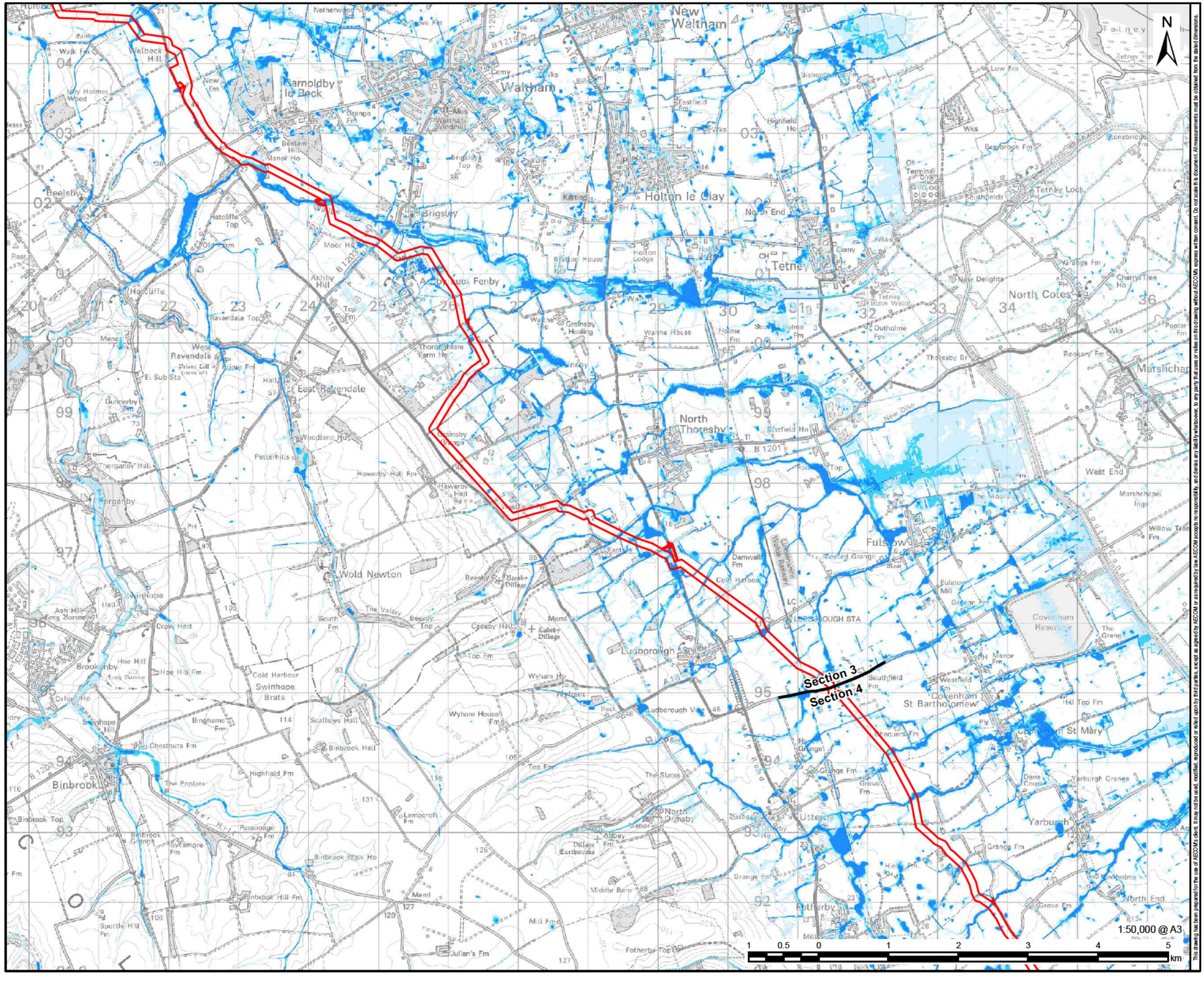
Figure 4 (1 of 3)
Environment Agency Risk of Flooding from Surface Water

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_4



VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Environment Agency - Risk of Flooding from Surface Water

- High - 3.3% AEP
- Medium - 1% AEP
- Low - 0.1% AEP

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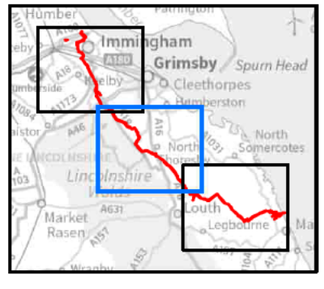


FIGURE TITLE

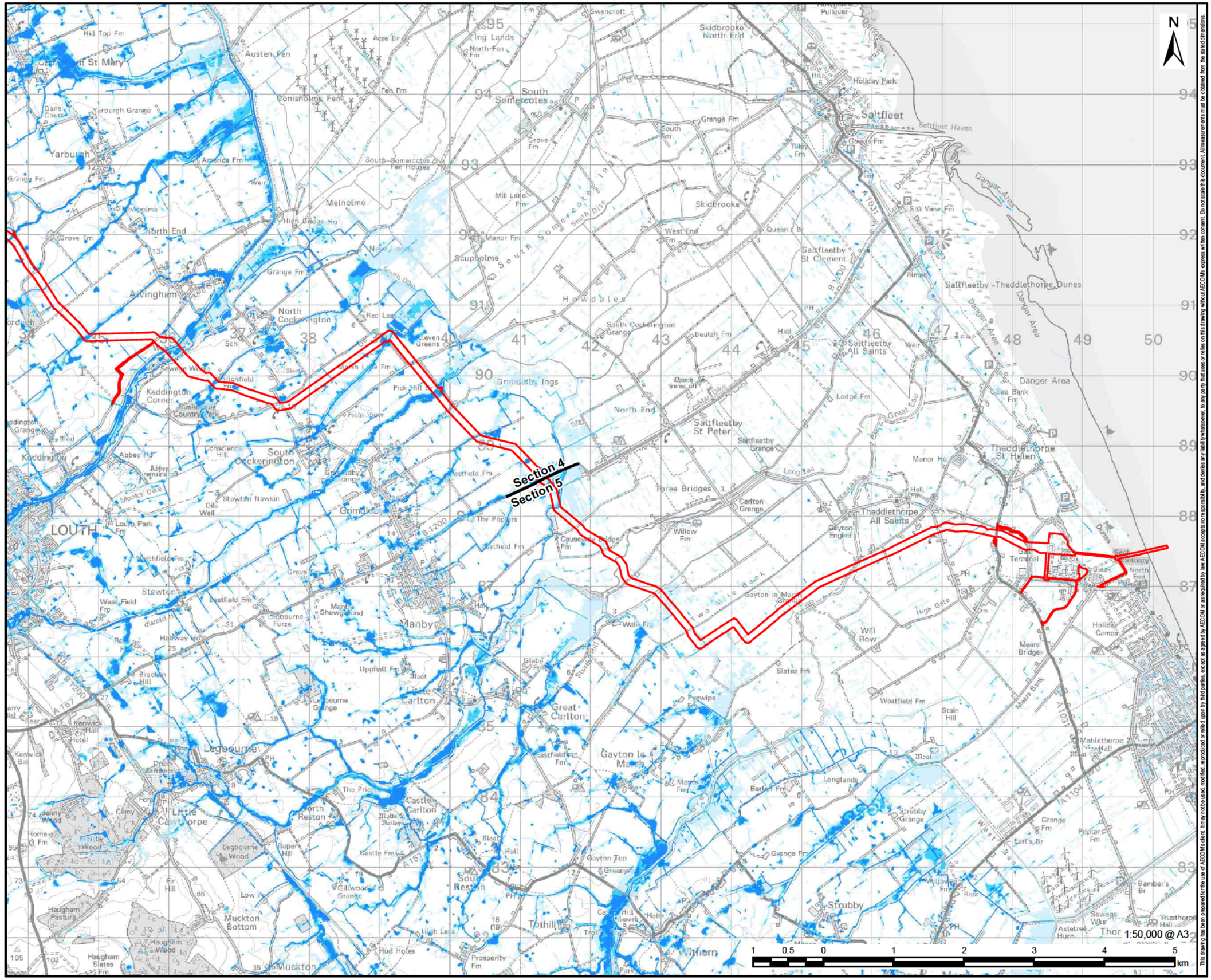
Figure 4 (2 of 3)
Environment Agency Risk of Flooding from Surface Water

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_4



VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Environment Agency - Risk of Flooding from Surface Water

- High - 3.3% AEP
- Medium - 1% AEP
- Low - 0.1% AEP

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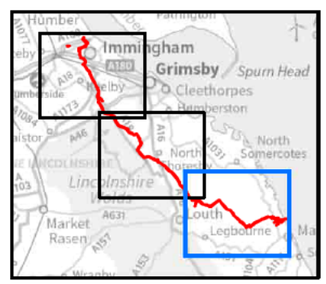

FIGURE TITLE

Figure 4 (3 of 3)
Environment Agency Risk of Flooding from Surface Water

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_4

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5.12.2 During the construction phase of the pipeline, Theddlethorpe Facility and replacement of the Dune Isolation Valve, appropriate construction practices will need to be adhered to in order to manage the risk of surface water ingress into excavations during construction, such as temporary drainage provisions and pumping, as required.

5.13 Tidal Sources

5.13.1 Section 2, 3 and 4 including the buried pipeline and Block Valve Stations are not at risk of tidal flooding and will not be considered further.

5.13.2 The assessment of Tidal sources of flooding will consider:

- Section 1 and 5 (Buried pipeline);
- Section 1 (Immingham Facility, north construction compound); and
- Section 5 (Theddlethorpe Facility (Option 1 and 2), south construction compound and replacement of the dune valve).

5.14 Tidal sources –Buried pipeline in Sections 1 and 5

5.14.1 **Figure 5** indicates that the pipeline located in Sections 1 and 5 is located outside of the overtopping flood extent during the construction period however, the pipeline in Section 5 is located within the tidal breach flood extent. In general, the risk of tidal flooding during the construction phase is considered to a low risk, however there is a residual risk of tidal flooding to Section 5 should a breach of the tidal flood defences occur.

5.14.2 To mitigate this risk, the following mitigation measures are proposed:

- G1: Adoption of an appropriate Flood Warning and Evacuation Plan (FWEP);
- P8: Weather forecasts and Flood Warnings should be monitored regularly during the construction phase (noting that a breach may occur with little or no warning).

5.14.3 The pipeline would be below ground across its entire route during the operational phase, therefore the risk of tidal flooding to this aspect of the development is considered to be low and no mitigation is required.

5.15 Tidal Sources – Section 1 (Immingham Facility) and Section 5 (Theddlethorpe Facility Option 1 and 2)

5.15.1 Set out below is the assessment of tidal flood risk for Immingham Facility (Section 1) and Theddlethorpe Facility (Section 5).

Present Day

5.15.2 Extreme sea levels were extracted from the Coastal flood boundary conditions for the UK: update 2018, shown in **Table 12** below (Ref 39). These levels use 2017 as a base date.

Table 12: Coastal flood boundary conditions (2018) Extreme Sea Levels (2017 base year)

2017 Base year	Immingham	Theddlethorpe
chainage	_3888	_3934
Base year	2017	2017
Extreme sea level 0.5% AEP event m AOD (t200)	5.06	4.74
Extreme sea level 0.5% AEP: 2.5% confidence interval (c1_t200)	4.93	4.57
Extreme sea level 0.5% AEP: 97.5% confidence interval (c2_t200)	5.41	5.12
Extreme sea level 0.1% AEP: event m AOD (t1000)	5.38	5.13
Extreme sea level 0.1% AEP: 2.5% confidence interval (c1_t1000)	5.15	4.84
Extreme sea level 0.1% AEP: 97.5% confidence interval (c2_t1000)	6.01	5.77

5.15.3 To calculate present day extreme sea levels and extreme sea levels with climate change the 97.5% confidence bound 0.5% AEP and 0.1% AEP extreme sea levels, as presented in Table 12, were increased in line with the sea level climate change allowances for the Immingham Facility and Theddlethorpe Facility as set out in Section 4.2. Extreme sea levels for 2025 (proposed development timeframe) are shown in **Table 13** and **Table 14** below.

Table 13: Coastal flood boundary conditions (2018) Extreme Sea Levels for 2025 – Higher Central

Higher Central 2025	Immingham	Theddlethorpe
chainage	_3888	_3934
Proposed Development year	2025	2025
Extreme sea level 0.5% AEP event m AOD	5.45	5.17
Extreme sea level 0.1% AEP event m AOD	6.05	5.82

Table 14: Coastal flood boundary conditions (2018) Extreme Sea Levels for 2025 – Upper End

Upper End 2025	Immingham	Theddlethorpe
Chainage	_3888	_3934
Proposed Development year	2025	2025
Extreme sea level 0.5% AEP event m AOD	5.46	5.18
Extreme sea level 0.1% AEP event m AOD	6.06	5.83

5.15.4 As there are only minor differences in these levels, the Upper End allowances for 2025 have been used as a basis for the present day extreme sea level analysis.

5.15.5 The EA Flood Map for Planning (**Ref 1** and reproduced in **Figure 1**) indicates that Immingham Facility (Section 1) and Theddlethorpe Facility (Section 5) are within tidal Flood Zone 3. The EA Flood Map for Planning indicates that parts of Section 1 and 5 are within reduction in risk areas (benefit from defences). This dataset provides an indication of areas that benefit from tidal flood defences but inconsistencies in the dataset require further analysis of area that benefits from the tidal defences. To do this an analysis of extreme sea levels, flood defence levels and EA breach and overtopping modelling has been undertaken.

Immingham Facility (Section 1)

5.15.6 The EA Asset Management Database (Ref 33) indicates that there are tidal flood defences along the River Humber comprising embankments, flood walls and flood gates. The crest level of the defences between South Killingholme and the Port of Immingham range between 4.53m AOD and 6.25m AOD, with the lowest crest at the Port of Immingham and highest crest along the frontage at South Killingholme.

5.15.7 The 2010 Northern Area Tidal Modelling study includes flood mapping of the present day (2006) overtopping scenario. This data provided by the EA is the most appropriate to use to assess present day overtopping. A review of the flood mapping (refer to **Figure 5** and **Figure 6**) indicates that during the 0.5% AEP event and 0.1% AEP event overtopping of the defences occurs but does not impact the area within the DCO Site Boundary. Overtopping occurring in 2025 may be slightly higher than that shown on **Figure 5** and **6** however it is unlikely to significantly impact the site. Therefore, it can be concluded that within Section 1, including the Immingham Facility the tidal flood risk is low.

Theddlethorpe Facility Option 1 and 2 (Section 5)

5.15.8 The EA Asset Management Database (Ref 33) indicates that there are tidal flood defences along this stretch of coastline at Theddlethorpe, The tidal flood defences consist of Dunes which range between 5.39 m AOD and 12.4 m AOD along the wider stretch of coastline. **Figure 5** and **Figure 6** indicate that the flood defences to the north of the Theddlethorpe Sites overtop for both the 0.5% AEP and 0.1% AEP event flooding land in this area, however the flood extents do not infringe on either of the Theddlethorpe Option sites.

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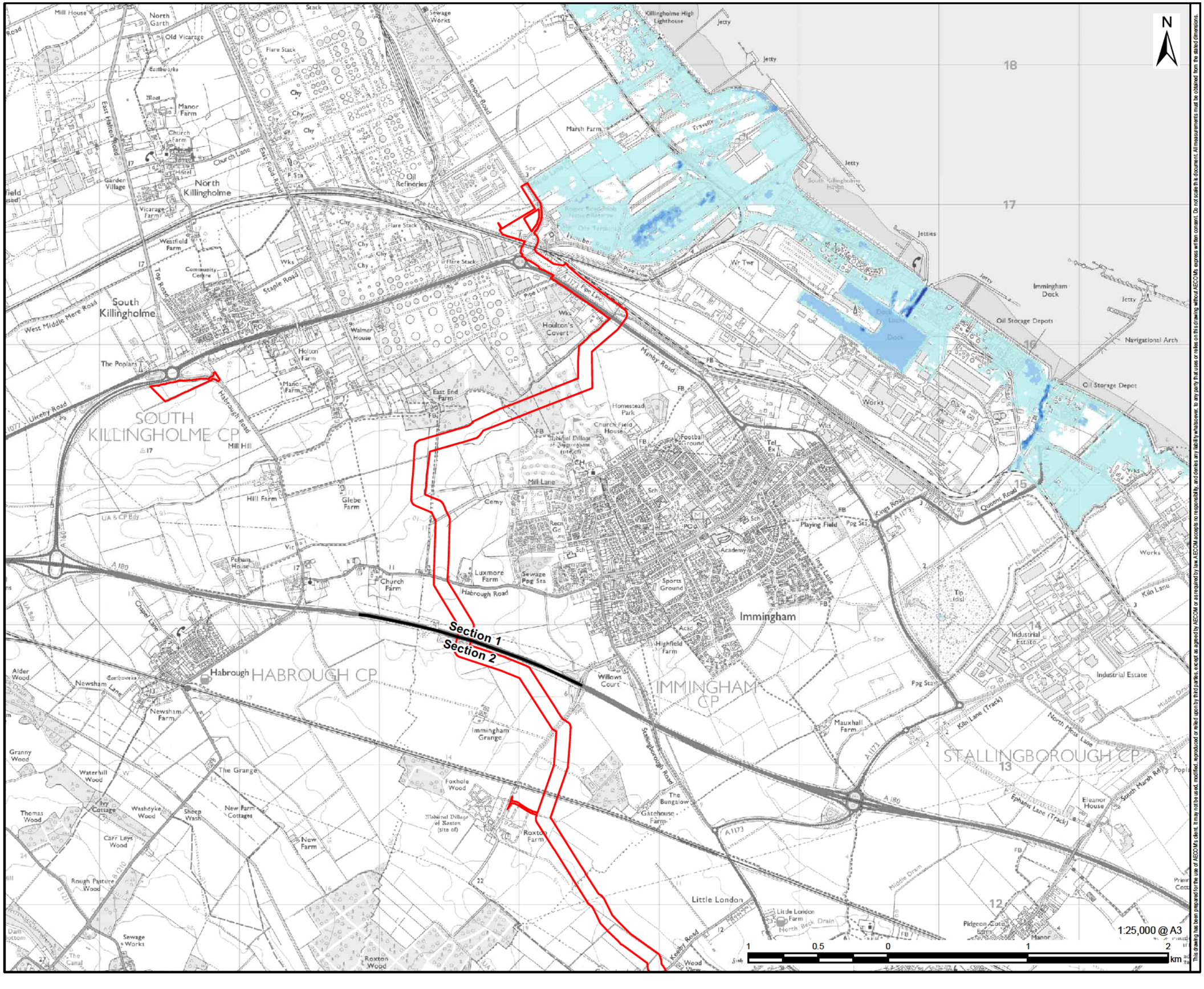

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Overtopping Depth Grid Baseline 0.5% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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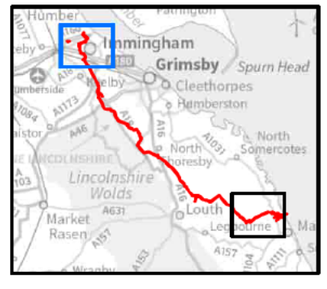

FIGURE TITLE

Figure 5 (1 of 2)
0.5% AEP Tidal Event Overtopping Depth Mapping - Present Day (2006) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_5

Filename: \\eu.aecomnet.com\EMEA\UK\NCL2\Jobs\60668965 V_Net_Zero_Project\900_CAD_GIS\920_GIS\02_Maps\Flood Risk Assessment\Updated DCO Deadline 2\VCCS_FRA_5_Tidal Overtopping Depth Grid Baseline 0.5% AEP_v1_20240516_LC.mxd

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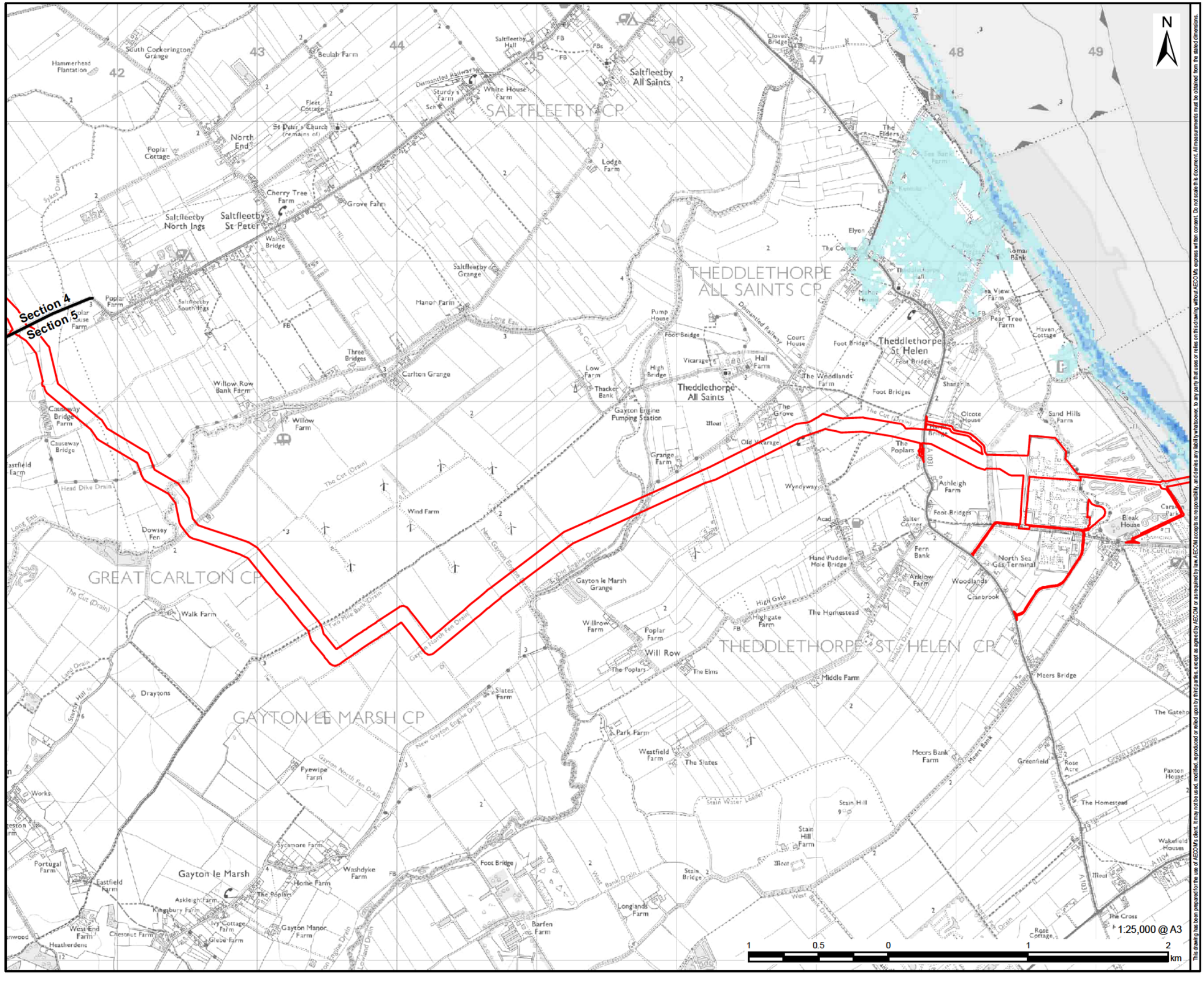

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Overtopping Depth Grid Baseline 0.5% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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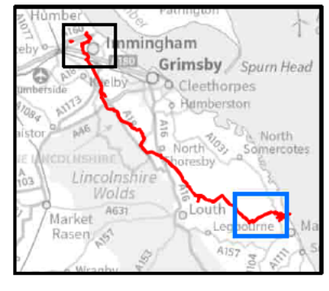

FIGURE TITLE

Figure 5 (2 of 2)
0.5% AEP Tidal Event Overtopping Depth Mapping - Present Day (2006) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_5

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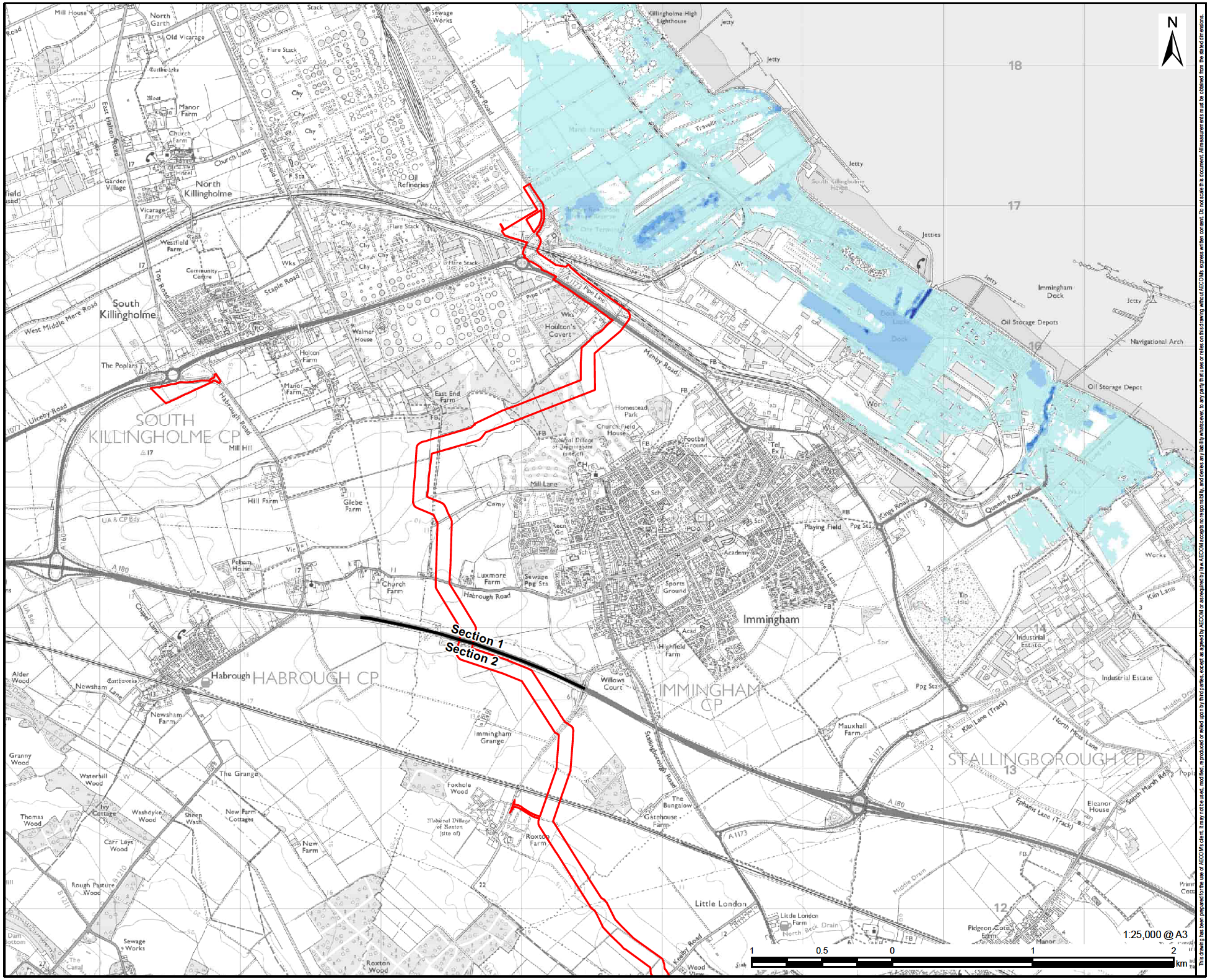

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

DCO Site Boundary
Route Section Break
Tidal Overtopping Depth Grid Baseline 0.1% AEP
Max. Depth (m)
0 - 1
1.1 - 2
2.1 - 3
3.1 - 4
4.1 - 5
>5

NOTES:

FIGURE TITLE

Figure 6 (1 of 2)
0.1% AEP Tidal Event Overtopping Depth Mapping - Present Day (2006) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_6

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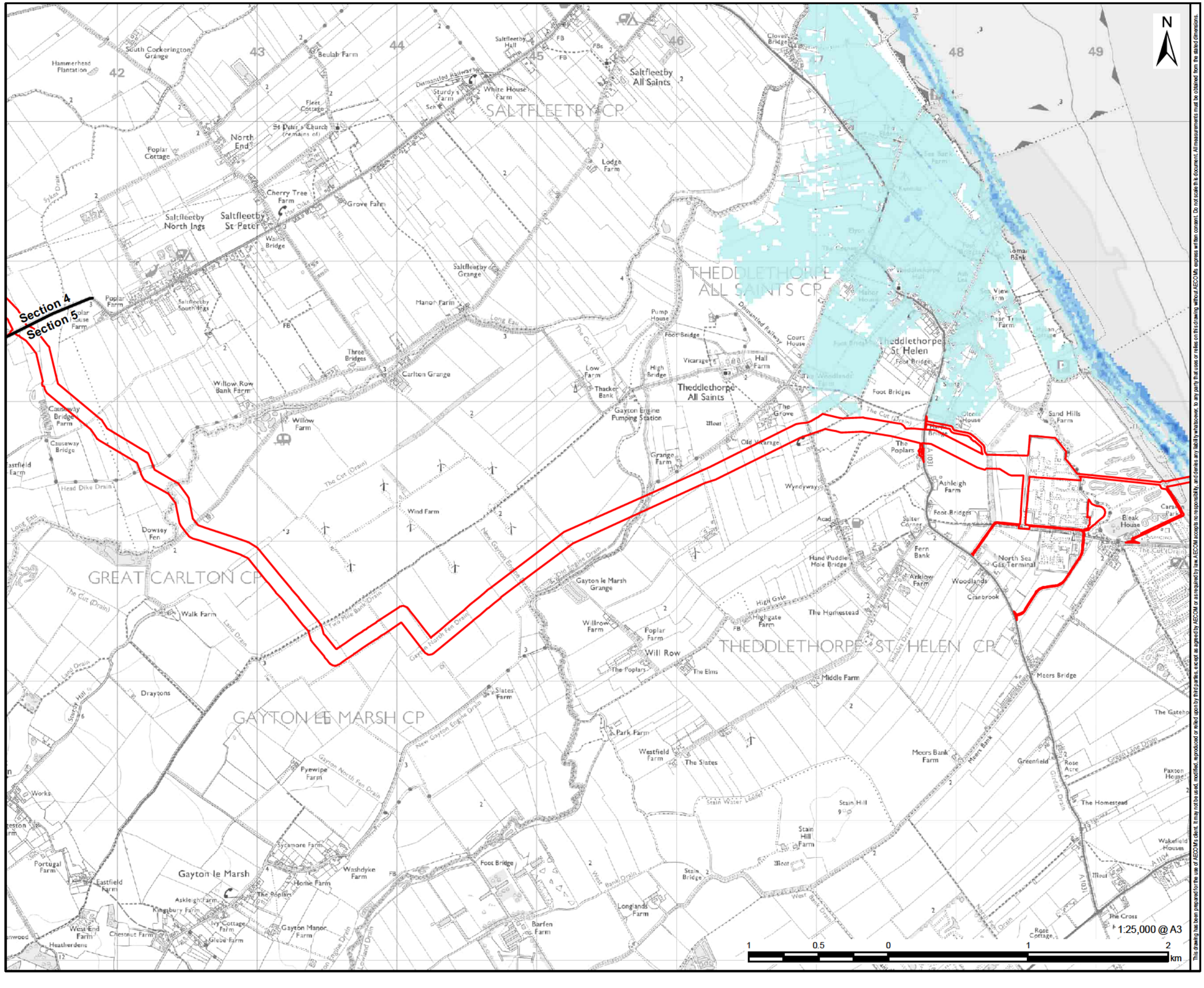

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VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Overtopping Depth Grid Baseline 0.1% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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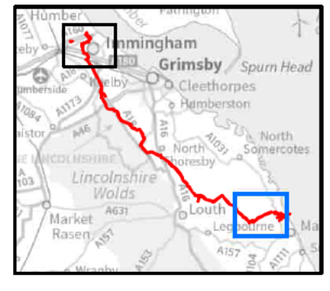

FIGURE TITLE

Figure 6 (2 of 2)
0.1% AEP Tidal Event Overtopping Depth Mapping - Present Day (2006) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_6

5.15.9 The 2010 Northern Area Tidal Modelling study includes flood mapping of the present day (2006) overtopping scenario. A review of the flood mapping indicates that during the 0.5% AEP event and 0.1% AEP event overtopping of the defences occurs along a short section of defence north of the DCO Site Boundary but does not impact the area within the DCO Site Boundary. Therefore, it can be concluded that within Section 5, including the Theddlethorpe Facility the tidal flood risk is low.

Breach of tidal Defences (Residual Risk)

5.15.10 There is a residual risk of breaching of the tidal defences. The EA 2010 Northern Area Tidal Modelling study includes modelling of a series of breaches along this stretch of coast. This is collated together to produce a composite breach map that provides an indication of flood depths. This breach scenario flood depth information for the present day (2006) 0.5% AEP and 0.1% extreme sea level (refer to **Figure 7** and **Figure 8**) identifies the following areas of the DCO Site Boundary are affected during a breach of the River Humber defences:

- Section 1 - Immingham Facility, including all above ground infrastructure north of the railway line; and
- Section 5 – Theddlethorpe Facility, including all above ground infrastructure and part of the pipeline (during construction only).

5.15.11 The modelled depths of flooding within the Immingham Facility and the Theddlethorpe Facility for the breach scenario are presented in **Table 15.** Further information with regards deriving modelled depths is provided in Annex C.

Table 15: 2010 Northern Area Tidal Modelling study – breach scenario flood depths

DCO Site Location	2006 0.5% AEP Breach depth (m)	2006 0.1% AEP Breach depth (m)
Section 1 – Immingham Facility	1.52	1.81
Section 5 – Theddlethorpe Facility Option 1	1.05	1.16
Section 5 – Theddlethorpe Facility Option 2	1.42	1.54

Construction Phase

5.15.12 During the construction phase of the pipeline in Section 5, the Immingham and Theddlethorpe Facility and replacement of the Dune Isolation Valve, tidal flooding is a residual risk, however the likelihood of a breach of the tidal defences occurring during construction period is low.

5.15.13 The Southern Construction Compound which will be used as a pipeline storage area during the construction phase is located within the tidal flood extent in proximity to the Theddlethorpe Facility. The Compound will be secured, and materials stored appropriately to prevent sections of pipeline becoming entrained in flood water and being washed off-site. The displacement of water and potential changes in flood flow paths due to construction materials being stored within the tidal floodplain would be minimal given the extent and depth of flooding across the surrounding area should a breach event occur and the increase in flood risk to off-site receptors (mainly undeveloped land) would be temporary and not significant.

5.15.14 The mitigation measures set out for fluvial flood risk with respect to flood warning and evacuation are also applicable for the mitigation of tidal flood risk during the construction phase.

Climate Change

5.15.15 Extreme sea levels were extracted from the Coastal flood boundary conditions for the UK: update 2018 (Ref 39) and the future extreme sea levels were calculated. Sea level climate change allowances for Immingham and Theddlethorpe are set out in Section 4.2. The future extreme sea levels with climate change have been calculated based on a design life of 75 years and are set out in **Table 16** and **Table 17** below.

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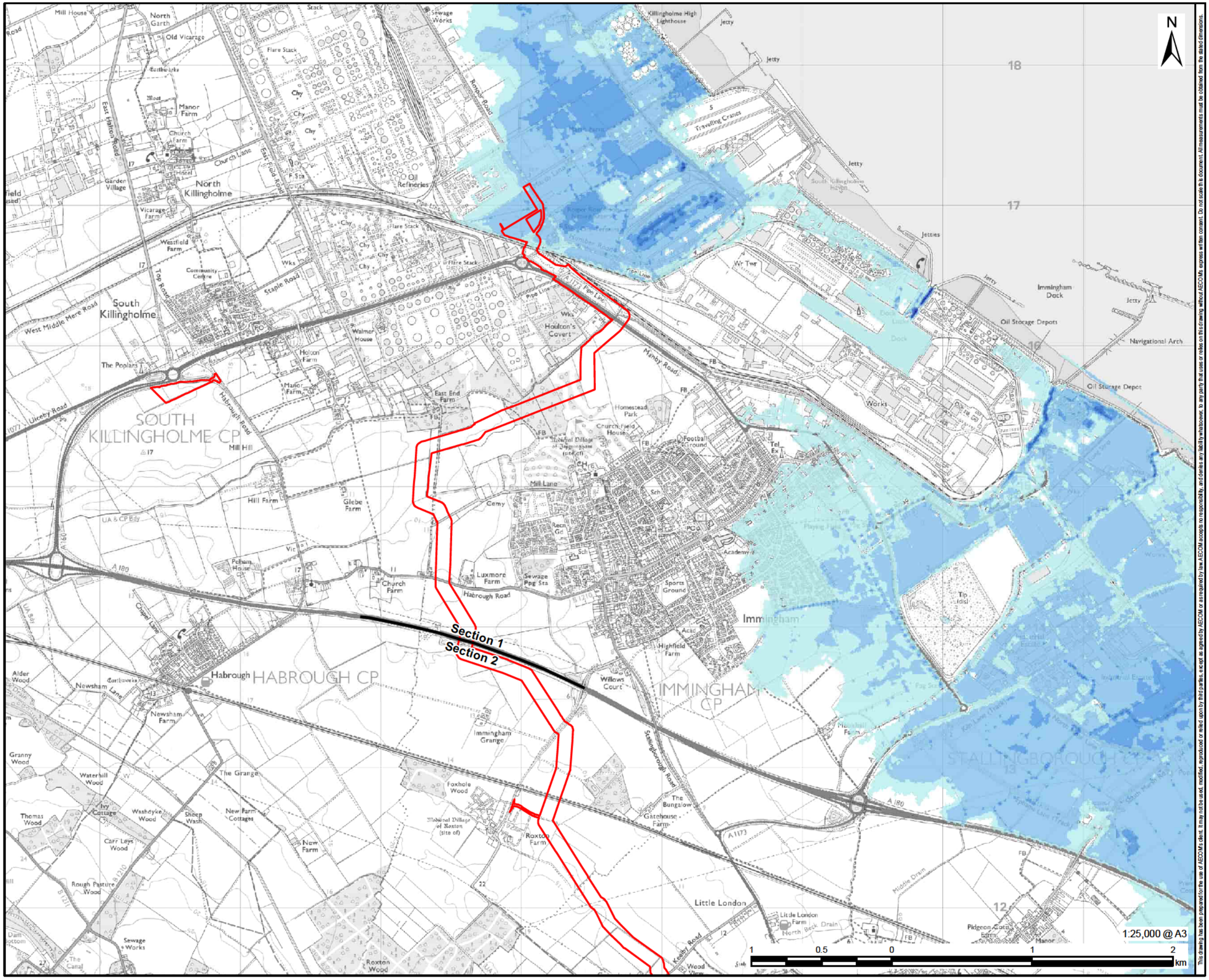

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Breach Depth Grid Baseline 0.5% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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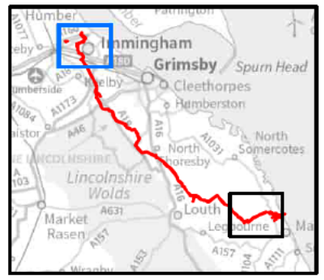

FIGURE TITLE

Figure 7 (1 of 2)
0.5% AEP Tidal Event Breach Depth Mapping - Present Day (2006) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_7

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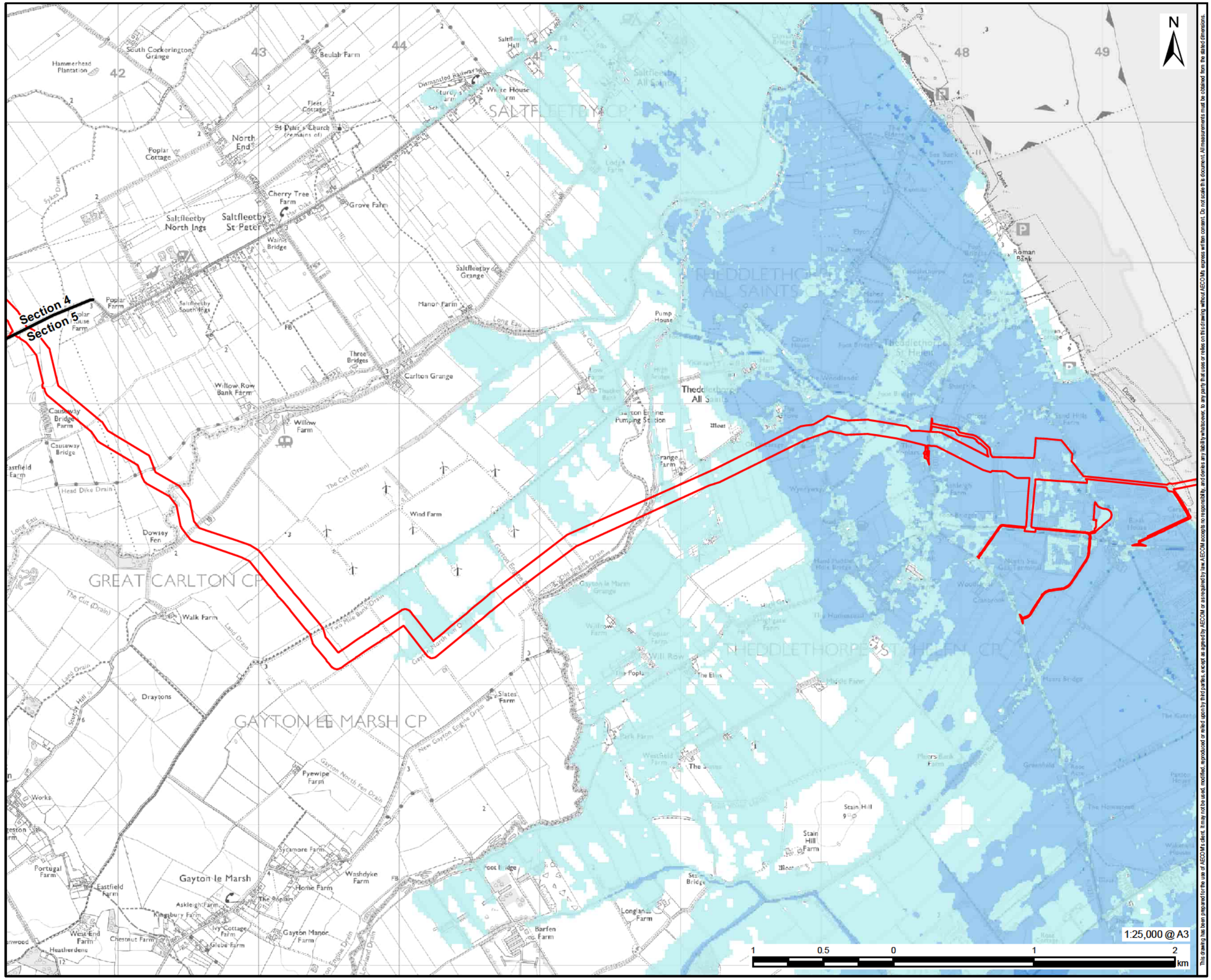

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Breach Depth Grid Baseline 0.5% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

FIGURE TITLE

Figure 7 (2 of 2)
0.5% AEP Tidal Event Breach Depth Mapping - Present Day (2006) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

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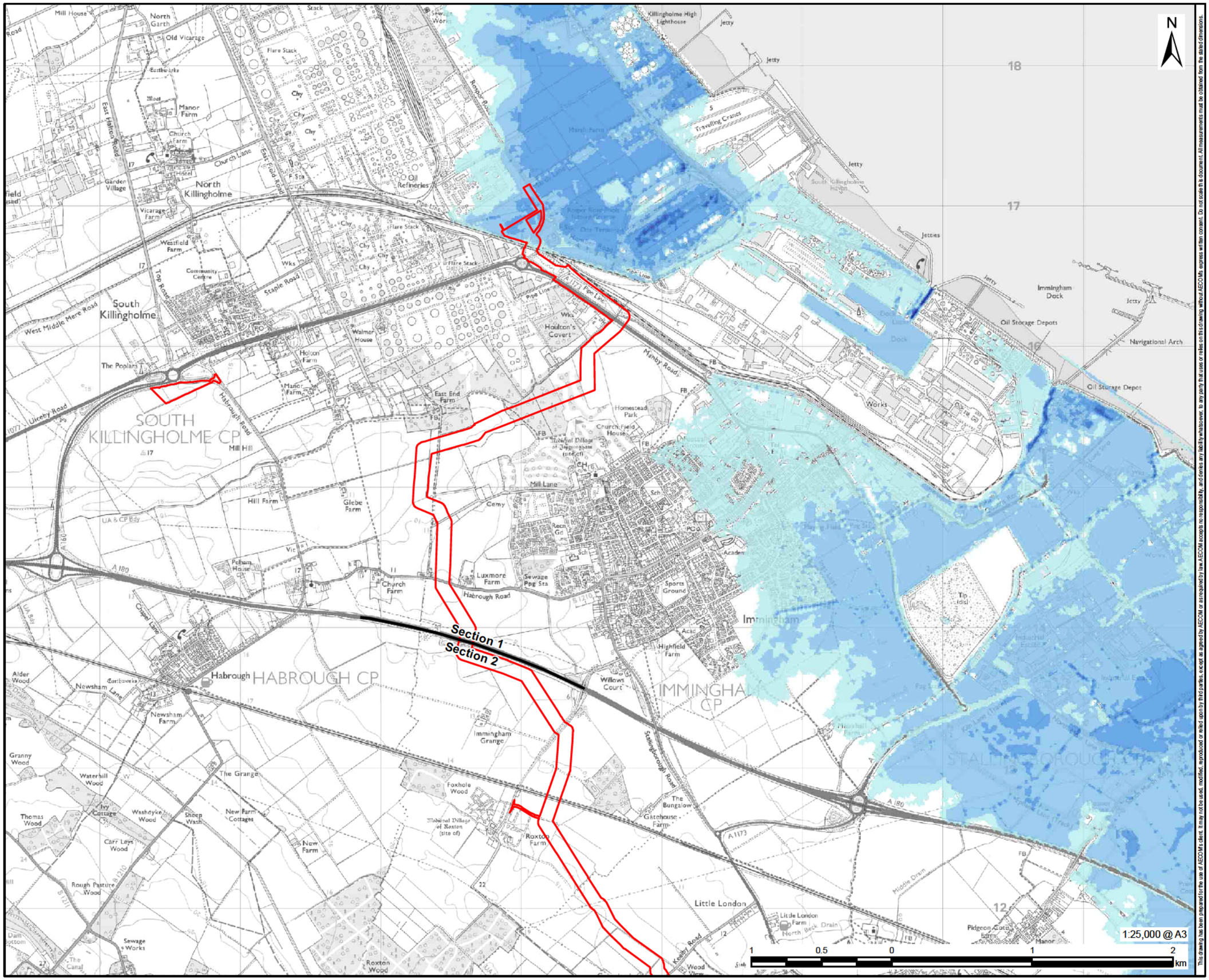

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Breach Depth Grid Baseline 0.1% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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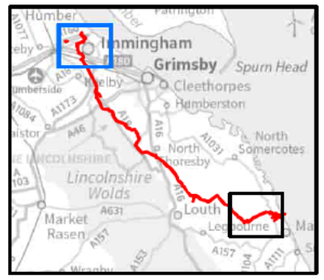

FIGURE TITLE

Figure 8 (1 of 2)
0.1% AEP Tidal Event Breach Depth Mapping - Present day (2006) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_8

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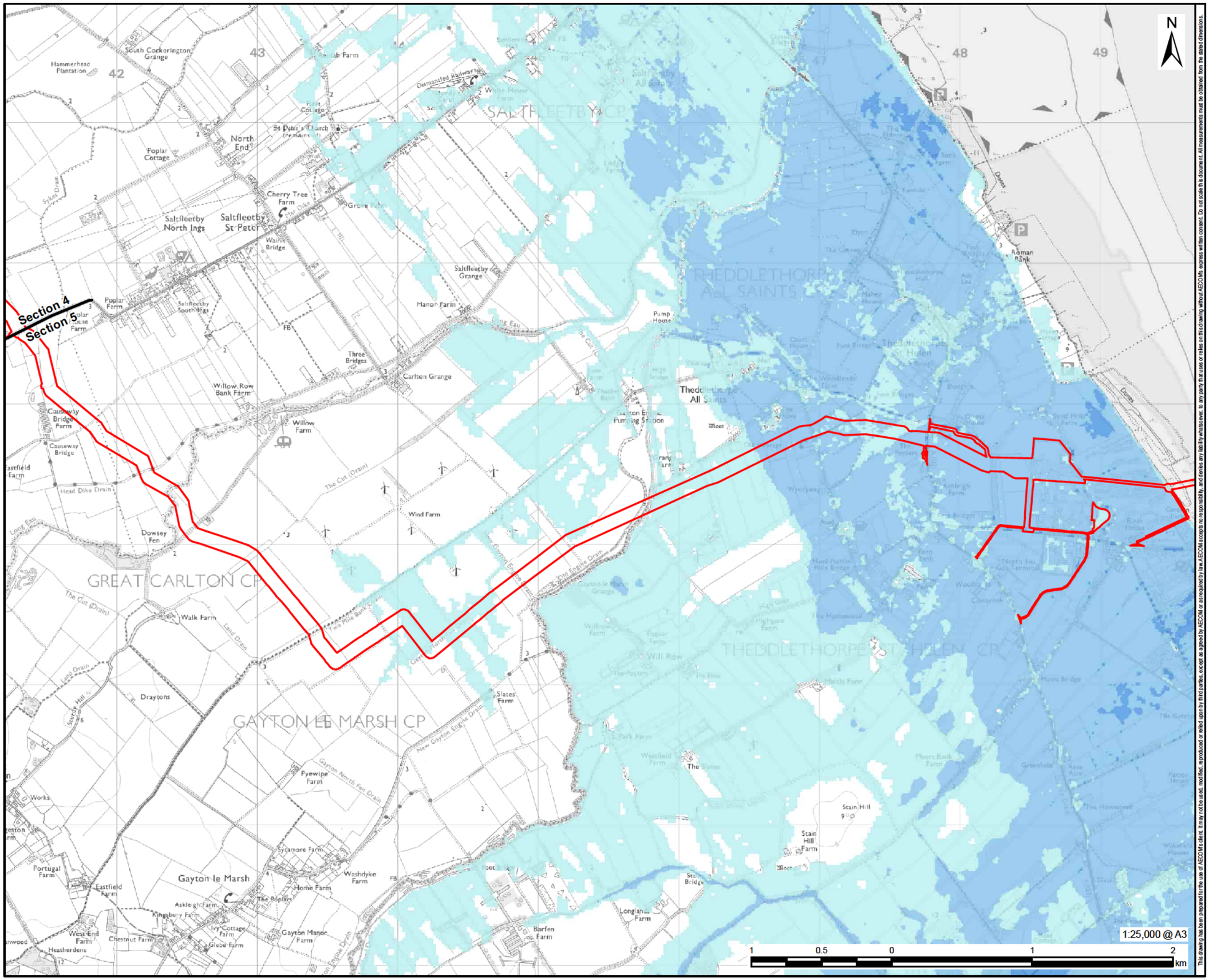

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Breach Depth Grid Baseline 0.1% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

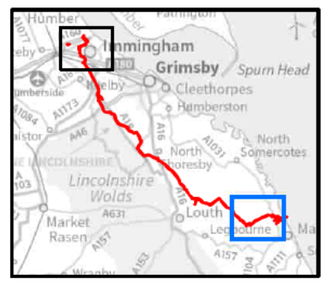

FIGURE TITLE

Figure 8 (2 of 2)
0.1% AEP Tidal Event Breach Depth Mapping - Present day (2006) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_8

Table 16: Coastal flood boundary conditions (2018) Extreme Sea Levels for 2100 – Higher Central

Higher Central 2100	Immingham	Theddlethorpe
chainage	3888	3934
Future scenario	2100	2100
Higher Central Extreme sea level 0.5% AEP event m AOD	6.14	5.88
Higher Central Extreme sea level 0.1% AEP event m AOD	6.74	6.53

Table 17: Coastal flood boundary conditions (2018) Extreme Sea Levels for 2100 – Upper End

Upper End 2100	Immingham	Theddlethorpe
chainage	3888	3934
Future scenario	2100	2100
Upper End Extreme sea level 0.5% AEP m AOD	6.39	6.13
Upper End Extreme sea level 0.1% AEP m AOD	6.99	6.78

Overtopping of the defences

5.15.16 The EA 2010 Northern Area Tidal Modelling study included modelling of overtopping of defences with sea level rise due to climate change. The results of the 2115 extreme sea level scenarios for the 0.5% AEP and 0.1% AEP event indicate flooding of the Immingham Facility (Section 1) and the Theddlethorpe Facility (Section 5). The EA provided flood depth grids from the 2010 Northern Area Tidal Modelling study (refer to **Figure 9** and **Figure 10**) and this was used to assess the typical depth of flooding during these overtopping events, the results are set out in **Table 18** below. It is noted however that the overtopping depths are higher than the modelled breach depths which is not what would typically be expected. Assessment of the approximate equivalent overtopping flood level at the Immingham site using these depths produced water levels which are higher than the estimated extreme sea level as set out in **Table 17** above. Hence there is uncertainty in the suitability of these depths to inform the Flood Risk Assessment and proposed mitigation has considered the breach flood depths in preference.

Table 18: EA 2010 Northern Area Tidal Modelling study – Future overtopping scenario flood depths

DCO Site Location	2115 0.5% AEP Overtopping depth (m)	2115 0.1% AEP Overtopping depth (m)
Section 1 – Immingham Facility	4.05	4.70
Section 5 – Theddlethorpe Facility Option 1	1.67	2.01
Section 5 – Theddlethorpe Facility Option 2	2.17	2.50

5.15.17 Shoreline Management Plans (SMP) set out the policy for managing the coastline and responding to coastal erosion and flood risks over the next 100 years. They assess potential erosion and flood risks and identify sustainable coastal defence and management options. The Shoreline Management Plan (SMP) for Saltfleet to Gibraltar point, which covers the coast adjacent to the DCO Site Boundary, has a policy of 'Hold the Line' in the short-medium term (but a 'Hold the Line/Managed Realignment' policy in the long term (from 2055-2105)) between Theddlethorpe St Helen to Gibraltar Point. The detail of how this policy would be applied in the future has not been set in detail at this point, however beyond 2055 it will likely

include some areas where flood defences would be raised, and some areas, where the consequences of flooding are assessed to be lower, being re-aligned or not raised any further. However, SMP policies are aspirational and there can be no guarantee that this is going to happen. As a consequence, the assessment of tidal flooding has been undertaken with no betterment to the current standard of protection provided by the tidal sea defences.

5.15.18 Without any improvement to the flood defences over the operational lifetime of the development the frequency of overtopping events occurring will likely increase with the Immingham and Theddlethorpe Facilities flooding during both the 0.5% AEP and 0.1% AEP flood events. The sections of pipeline within the affected areas would be below ground and therefore not at risk of flooding during an overtopping event.

5.15.19 To ensure the Immingham Facility and Theddlethorpe Facility are resilient to flooding and can be brought back online as quickly as possible, the following mitigation measures are recommended, in line with advice from the Environment Agency. These are secured within the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)*:

- **P3**: Critical electrical equipment will be raised 300mm above the higher of the 2100 0.1% AEP breach level or the extreme sea level for 2100. Indicative breach levels are 6.5m AOD (Immingham), 3.8m AOD (Theddlethorpe Option 1) and 3.6m AOD (Theddlethorpe Option 2), refer to the Breach Level Technical Note presented as Appendix C. This could be achieved by raising infrastructure on a table or, if this is not possible, then vulnerable infrastructure should be located within a watertight surround (P13);
- **G1**: Prepare a Flood Warning and Evacuation Plan which contains information on flood emergency response actions, including the locations of safe refuge provision;
- **P4**: Use of flood resistant and resilient construction materials as far as possible;
- **G29**: Facility users to sign up to the EA Flood Warning Service to receive flood warnings; and
- **G30**: No maintenance visits during periods when a Flood Warning is in force.

5.15.20 The CCR at the Immingham Facility will be the only building on-site that will be manned 24 hours a day, seven days a week. Safe refuge provision would be provided within the CCR, either within the Immingham Facility or the VPI facility. Safe refuge within the CCR will be provided as per the measure P1 above. Further information confirming the final location of the CCR and safe refuge provision will be provided as the FEED Stage progresses and will be provided in the Flood Warning and Evacuation Plan.

5.15.21 The CCR will remotely monitor all aspects of the pipeline operations and it will also be possible to open or close valves at the block valve stations and the Theddlethorpe Facility as necessary. The CCR can be operated on-site or remotely, if required. Should overtopping of the tidal defences occur in the Immingham area, but not at Theddlethorpe, (and vice versa), both the Immingham Facility and the Theddlethorpe Facility could be shut down and it is the expectation that the whole pipeline would not remain operational for the duration of the overtopping event, as the facilities which feed CO_2 into the pipeline would shut down during a flood event.

Filename: \\eu.aecomnet.com\EMI\UKI\UKNCL2\Jobs\60668955\V_Net_Zero_Project\900_CAD_GIS\920_GIS\02_Maps\Flood Risk Assessment\Updated DCO Deadline 2\VCCS_FRA_9_Tidal Overtopping Depth Grid 2115 0.5% AEP_v1_20240516_LC.mxd

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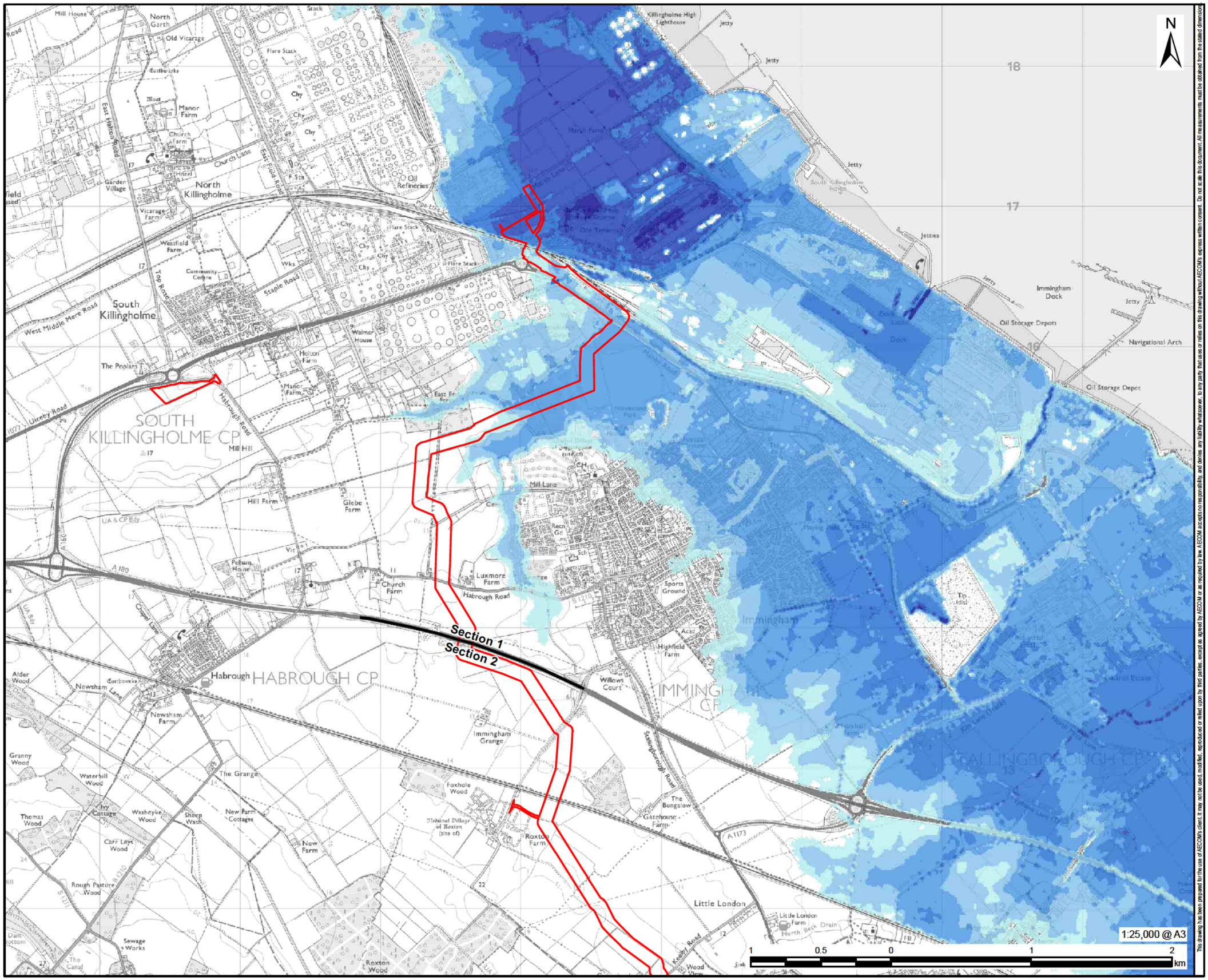

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Overtopping Depth Grid 2115
0.5% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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FIGURE TITLE

Figure 9 (1 of 2)
0.5% AEP Tidal Event Overtopping Depth Mapping
Climate Change (2115)
(2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_9

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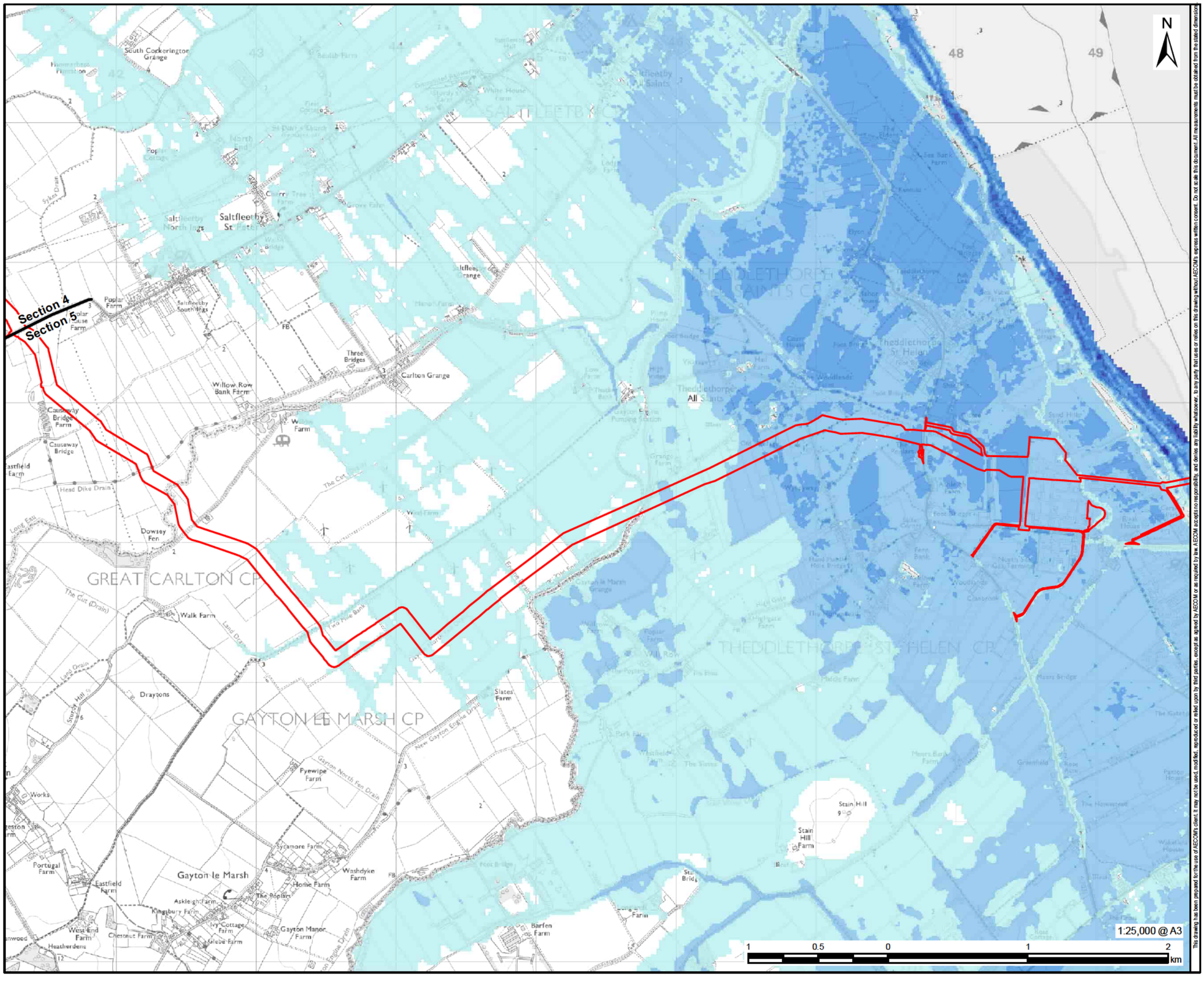

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Overtopping Depth Grid 2115
0.5% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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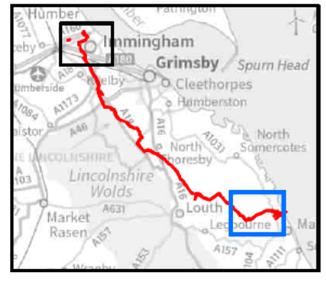

FIGURE TITLE

Figure 9 (2 of 2)
0.5% AEP Tidal Event Overtopping Depth Mapping
Climate Change (2115)
(2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_9

Filename: \\eu.aecomnet.com\EMEA\UK\UKNCL2\Jobs\60668955 V_Net_Zero_Project\900_CAD_GIS\920_GIS\02_Maps\Flood Risk Assessment\Updated DCO Deadline 2\VCCS_FRA_10_Tidal Overtopping Depth Grid 2115 0.1% AEP_v1_20240516_LC.mxd

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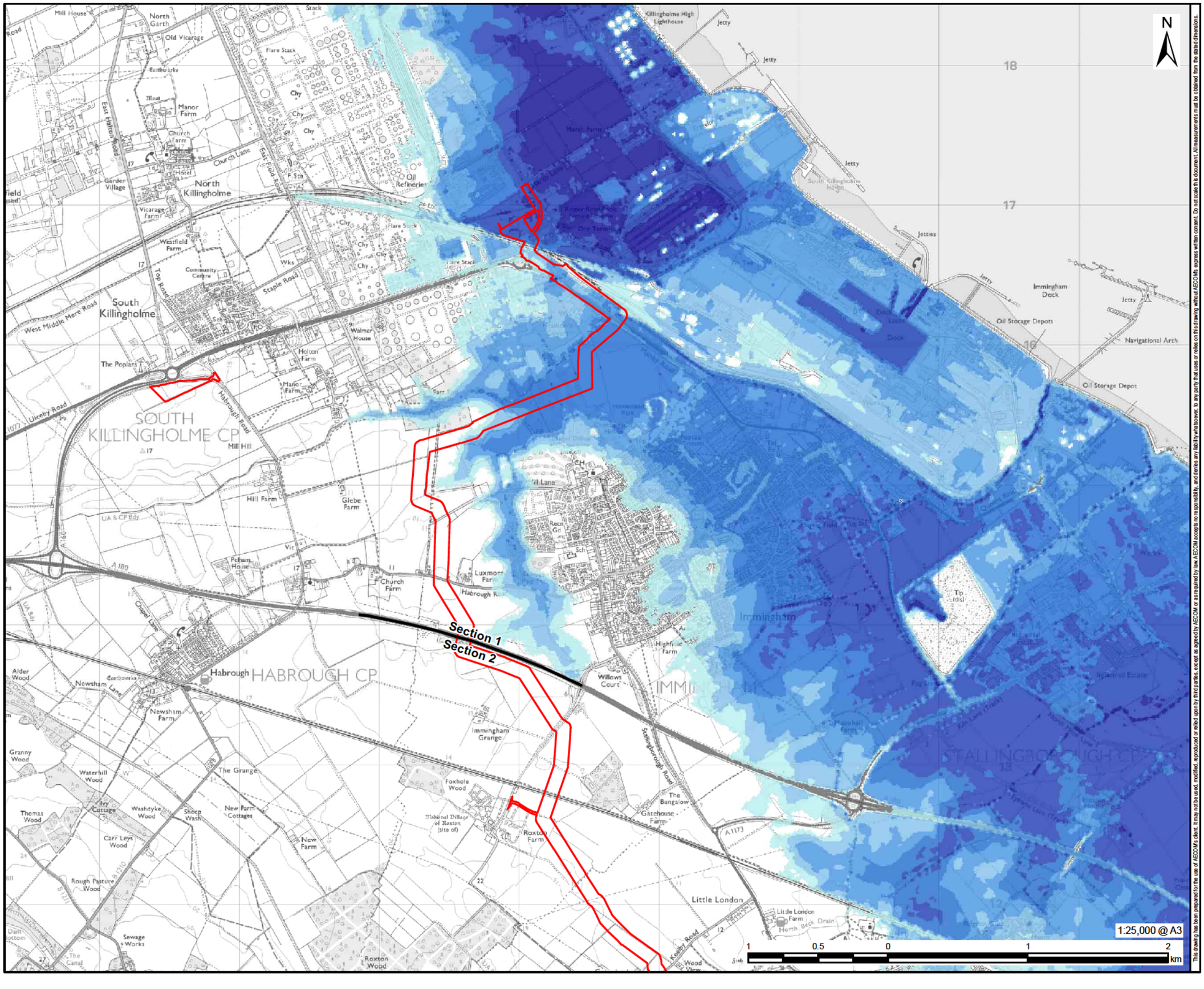

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Overtopping Depth Grid 2115
0.1% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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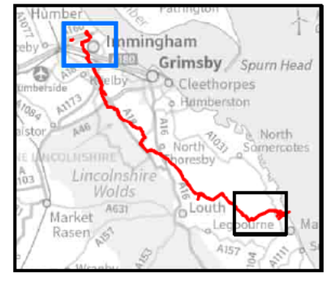

FIGURE TITLE

Figure 10 (1 of 2)
0.1% AEP Tidal Event Overtopping Depth Mapping
Climate Change (2115)
(2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_10

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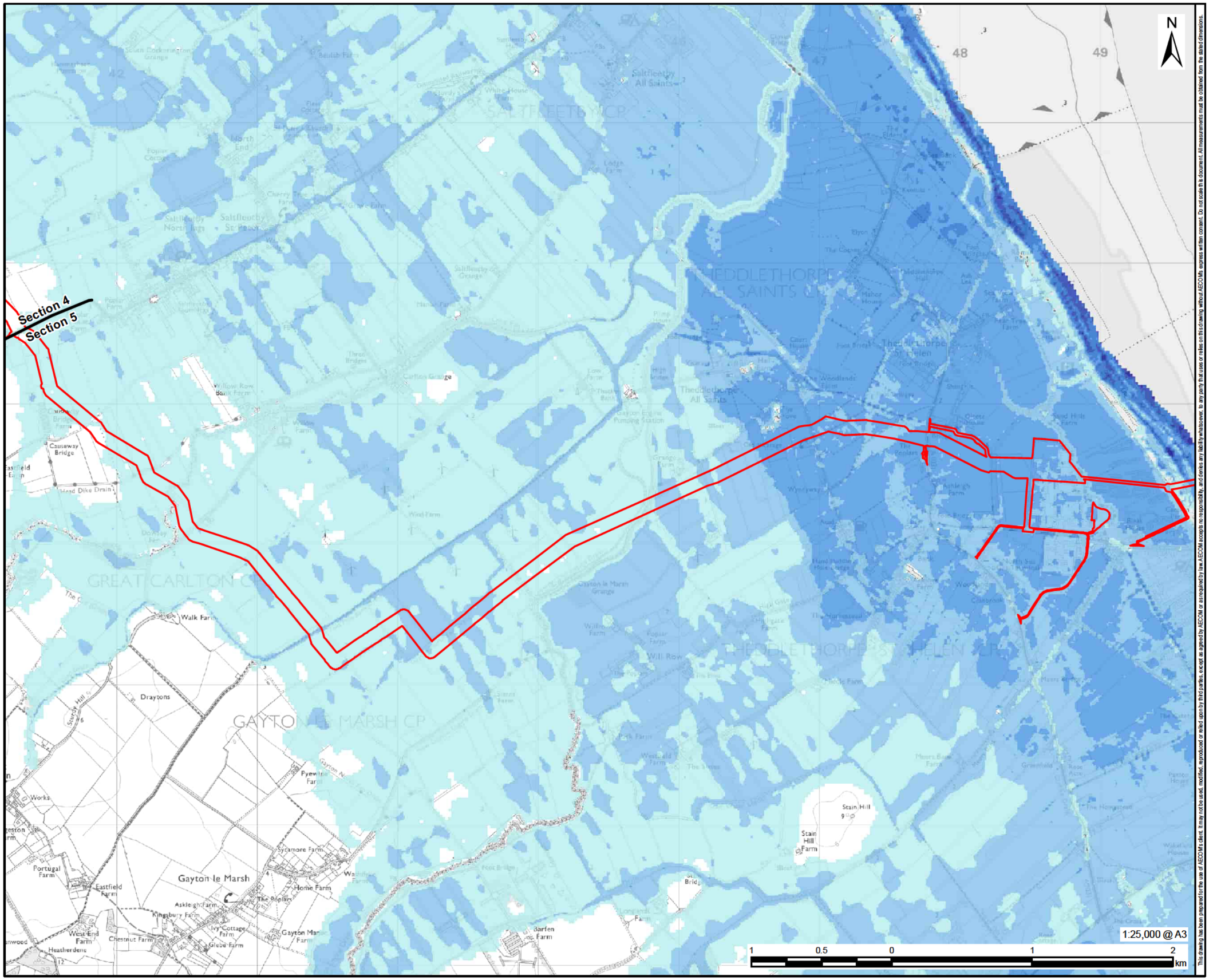

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Overtopping Depth Grid 2115
0.1% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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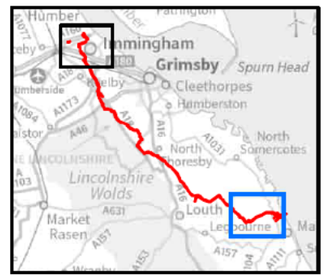

FIGURE TITLE

Figure 10 (2 of 2)
0.1% AEP Tidal Event Overtopping Depth Mapping
Climate Change (2115)
(2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_10

Climate change breach of tidal defences (Residual Risk)

5.15.22 The EA 2010 Northern Area Tidal Modelling study includes modelling of a future climate change scenario (2115) with a series of breaches of the tidal defences. This is collated together to produce a composite breach flood depth map. The flood depth information for the extreme sea level 0.5% AEP and 0.1% AEP event (refer to **Figure 11** and **Figure 12**) indicates that the following areas of the DCO Site Boundary are affected if the tidal defences were to breach:

- Section 1 – Immingham Facility; and
- Section 5 – Theddlethorpe Facility (Option 1 and 2).

5.15.23 The modelled depths of flooding within the Immingham Facility and the Theddlethorpe Facility for the climate change breach scenario were extracted from the model and are presented in **Table 19**. Further information regarding how the breach depths were derived is provided in **Annex C**.

Table 19: 2010 Northern Area Tidal Modelling study – climate change (2115) breach scenario flood depths

DCO Site Location	2115 0.5% AEP Breach depth (m)	2115 0.1% AEP Breach T depth (m)
Section 1 – Immingham Facility	3.03	3.25
Section 5 – Theddlethorpe Facility Option 1	1.67	2.01
Section 5 – Theddlethorpe Facility Option 2	1.98	2.06

Operational Phase

5.15.24 During the operational phase, the Immingham Facility and Theddlethorpe Facility will be at a residual risk of tidal flooding from a breach of the defences. The pipeline operation would be managed from the CCR (currently premised to be at the Immingham Facility, however it is expected that the CCR is more likely to be co-located within the existing CCR at VPI Immingham).

5.15.25 The CCR will remotely monitor all aspects of the pipeline operations and it will also be possible to open or close valves at the block valve stations and the Theddlethorpe Facility as necessary. The CCR can be operated on-site or remotely, if required. Should a breach in the tidal defences occur in the Immingham area, but not at Theddlethorpe, (and vice versa), both the Immingham Facility and the Theddlethorpe Facility could be shut down and it is the expectation that the whole pipeline will not remain operational for the duration of the breach event, as the facilities which feed CO_2 into the pipeline would shut down during a flood event.

5.15.26 To ensure the Immingham Facility and Theddlethorpe Facility are resilient to flooding and can be brought back online as quickly as possible, the following mitigation measures are recommended, in line with advice from the Environment Agency. These are secured within the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)*:

- **P3**: Critical electrical equipment will be raised 300mm above the higher of the 2100 0.1% AEP breach level or the extreme sea level for 2100. Indicative breach levels are 6.5m AOD (Immingham), 3.8m AOD (Theddlethorpe Option 1) and 3.6m AOD (Theddlethorpe Option 2), refer to the Breach Level Technical Note presented as Appendix C. This could be achieved by raising infrastructure on a table or, if this is not possible, then vulnerable infrastructure should be located within a watertight surround

(P13)**G1**: A Flood Warning and Evacuation Plan should be produced, including the locations of safe refuge provision, and implemented;

- **P2**: Use of flood resistant and resilient construction materials;
- **G29**: Facility users to sign up to the EA Flood Warning Service to receive flood warnings; and
- **G30**: No maintenance visits during periods when a Flood Warning is in force.

5.15.27 The CCR at the Immingham Facility will be the only building on-site that will be manned 24 hours a day, seven days a week. Safe refuge provision would be provided within the CCR, at the Immingham Facility. Safe refuge within the CCR will be provided as per the measure G1 above. Further information confirming the final location of the CCR and safe refuge provision will be provided as the FEED Stage progresses and will be provided in the Flood Warning and Evacuation Plan.

H++ Sensitivity Test

5.15.28 Section 1 – Immingham Facility and Section 5 – Theddlethorpe Facility Option Sites are at risk of tidal flooding from overtopping events and residual risk of tidal flooding should a breach in the tidal flood defences occur over their operational lifetime.

5.15.29 In addition to the climate change assessment above, a credible maximum climate change scenario has been assessed as a sensitivity test. Table 20 below shows the calculated extreme sea levels based on the Coastal flood boundary conditions for the UK (2018) and the recommended H++ sea level rise.

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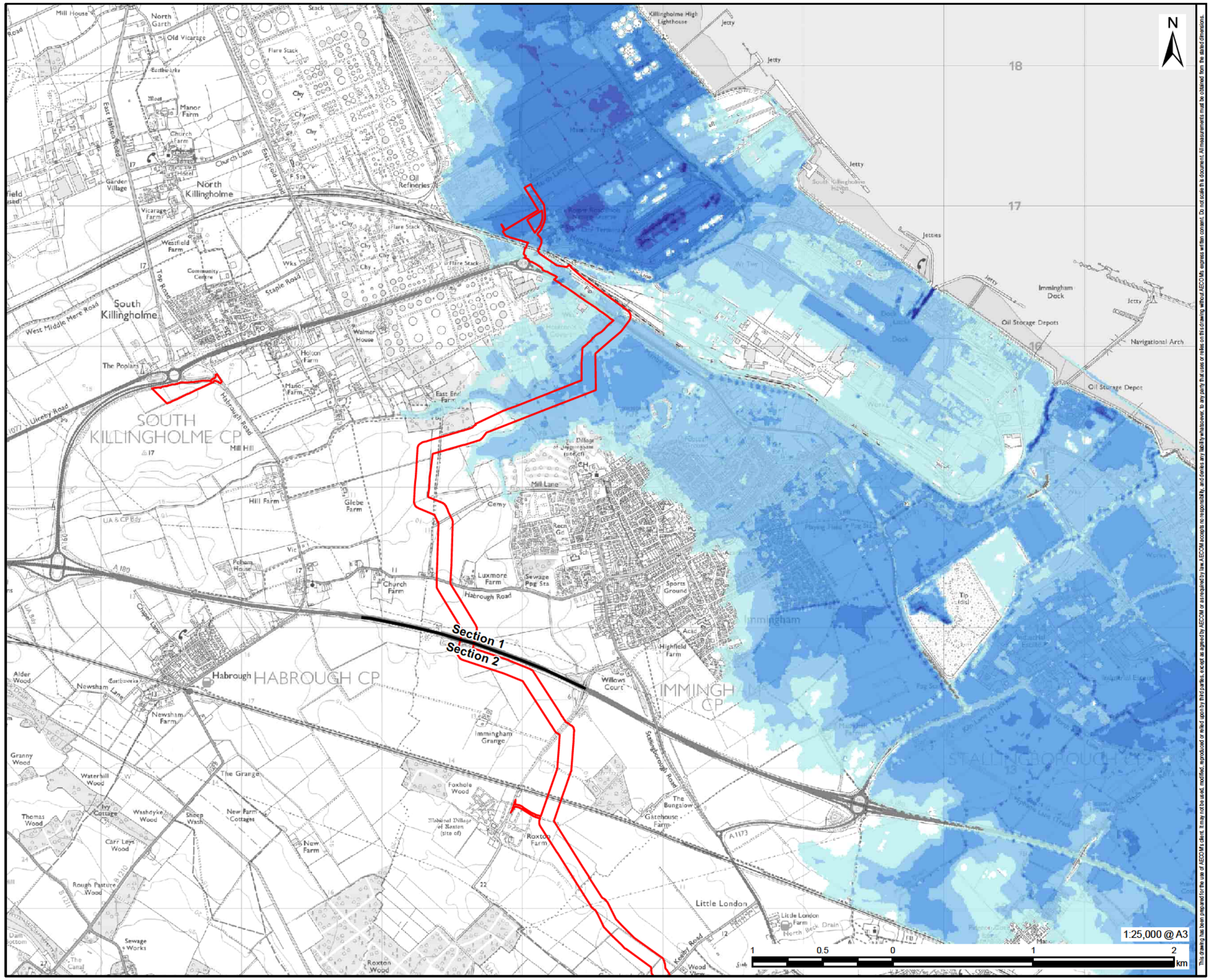

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Breach Depth Grid 2115 0.5% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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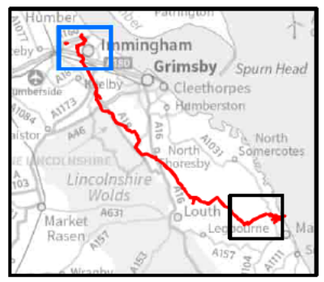

FIGURE TITLE

Figure 11 (1 of 2)
0.5% AEP Tidal Event Breach Depth Mapping - Climate Change (2115) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_11

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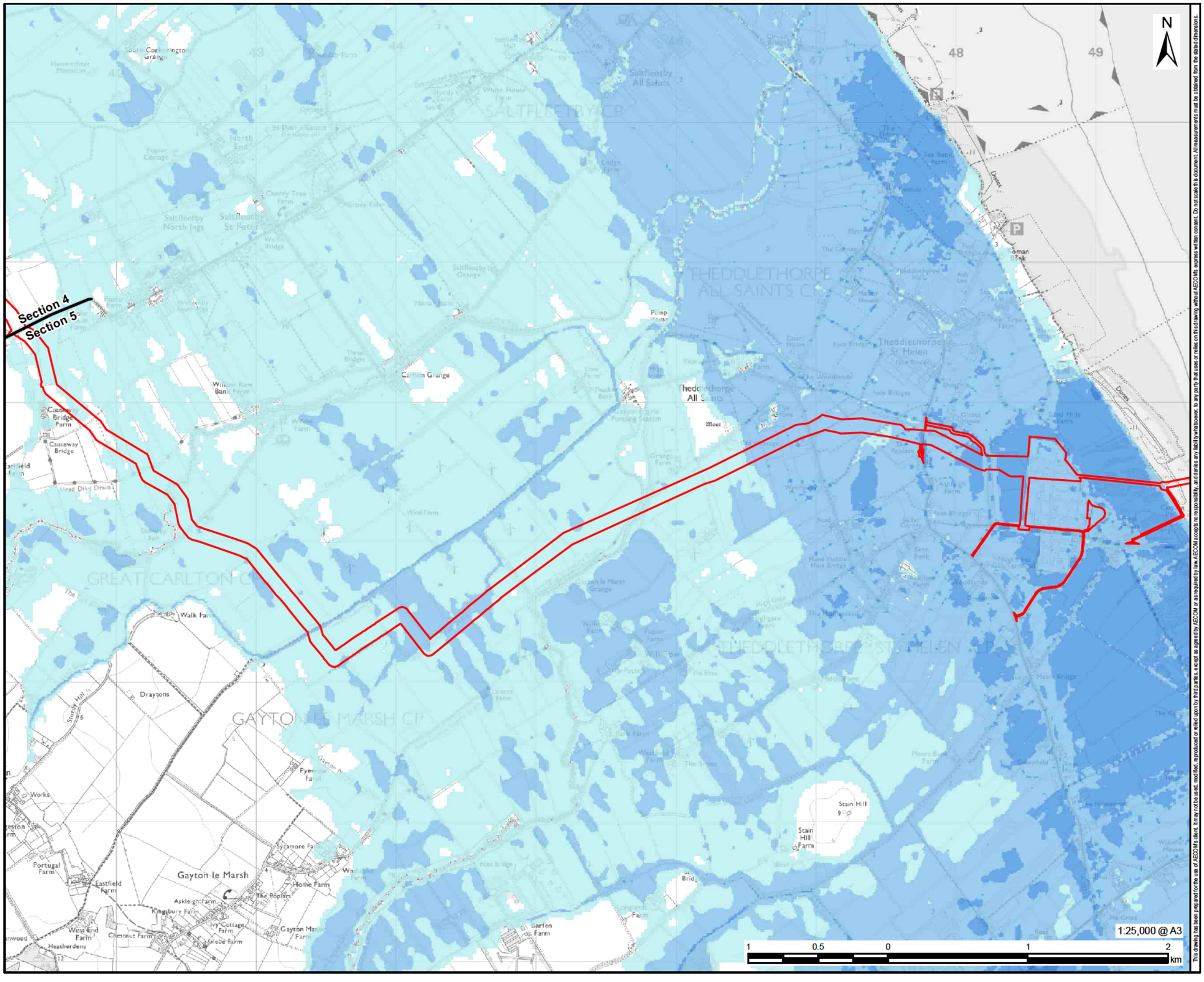

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Breach Depth Grid 2115 0.5% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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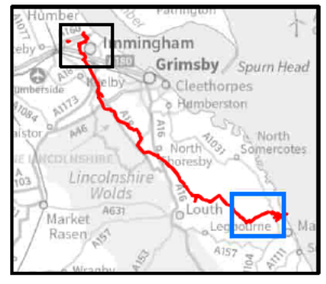

FIGURE TITLE

Figure 11 (2 of 2)
0.5% AEP Tidal Event Breach Depth Mapping - Climate Change (2115) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_11

Revision: 1 Drawn: LC Checked: KB Approved: MW Date: 2024-05-16

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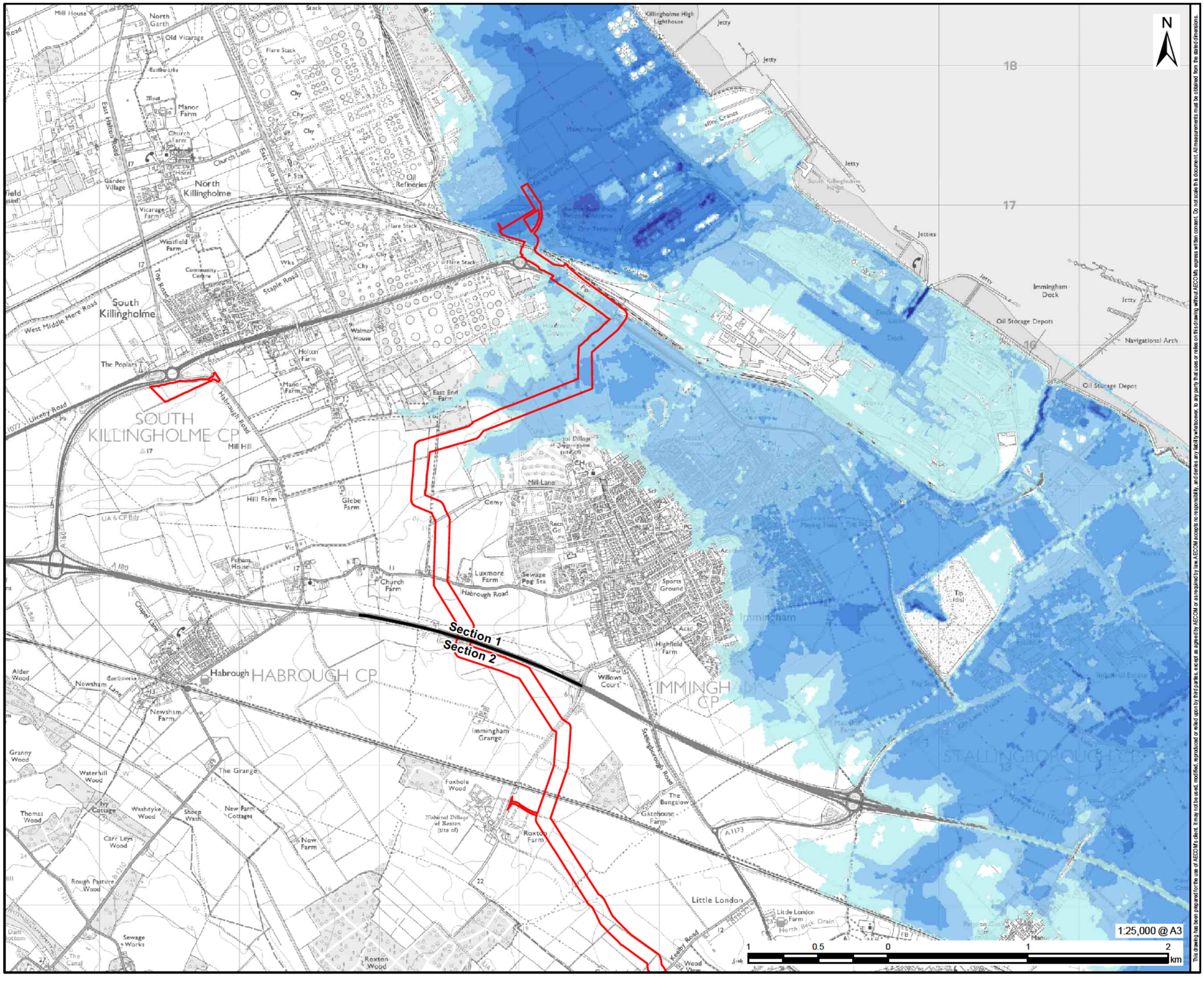

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Breach Depth Grid 2115 0.1% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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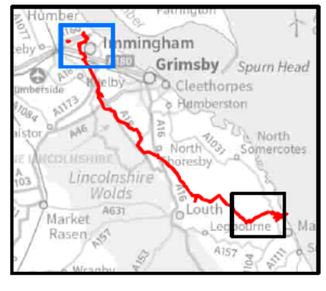

FIGURE TITLE

Figure 12 (1 of 2)
0.1% AEP Tidal Event Breach Depth Mapping - Climate Change (2115) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_12

Revision: 1 Drawn: LC Checked: KB Approved: MW Date: 2024-05-16

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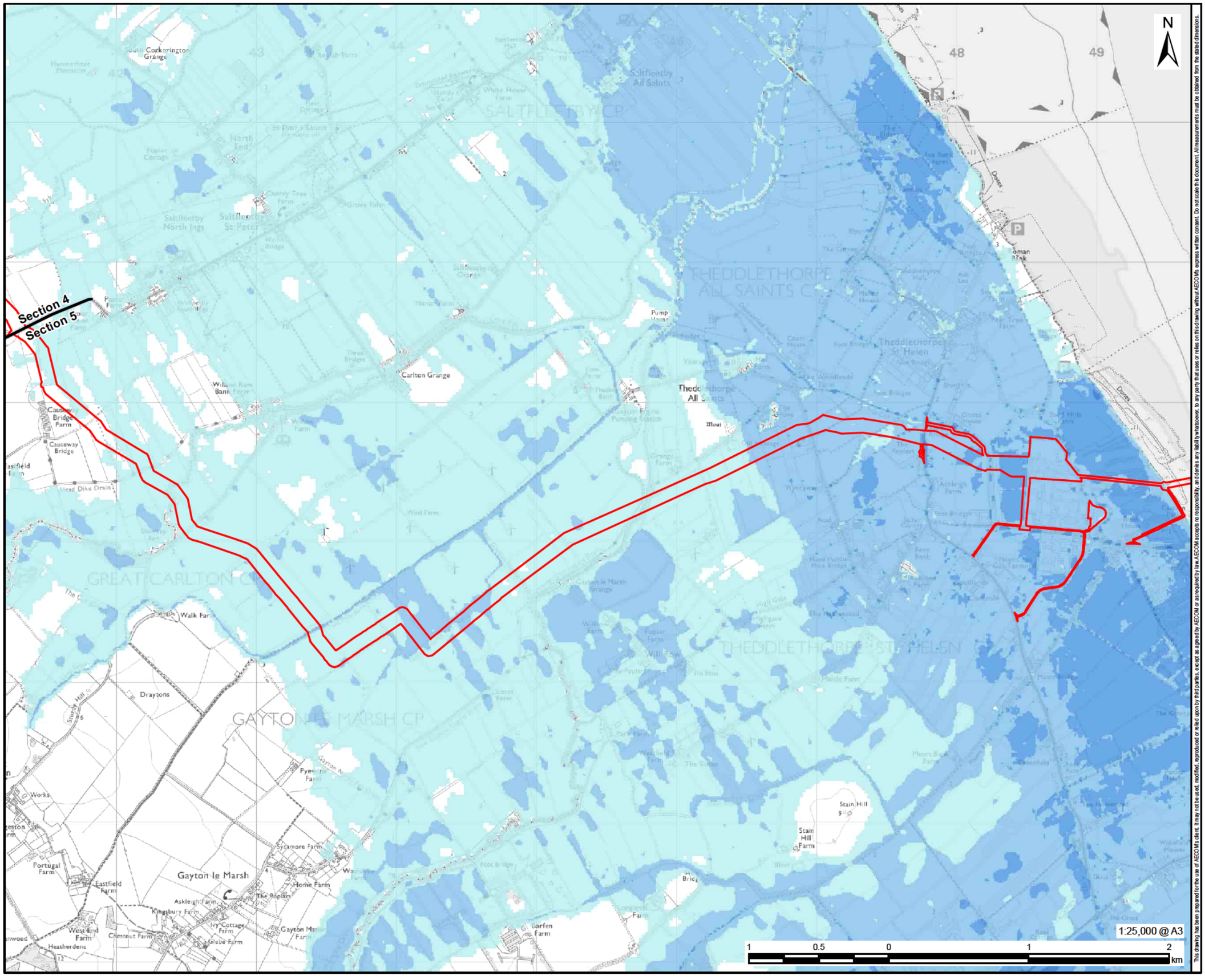

VikingCCS

AECOM

PROJECT

Viking CCS Pipeline

LEGEND

- DCO Site Boundary
- Route Section Break

Tidal Breach Depth Grid 2115 0.1% AEP

Max. Depth (m)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- >5

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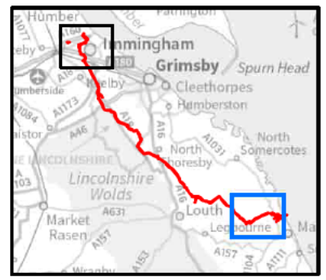

FIGURE TITLE

Figure 12 (2 of 2)
0.1% AEP Tidal Event Breach Depth Mapping - Climate Change (2115) (2010 Northern Area Tidal Modelling Study)

ISSUE PURPOSE

FLOOD RISK ASSESSMENT

PROJECT NUMBER / REFERENCE

60668955 / VCCS_240516_FRA_12

Table 20: H++ credible maximum climate change scenario (sensitivity test) extreme sea level based on Coastal flood boundary conditions for the UK (2018)

2100 H++	Immingham	Theddlethorpe
chainage	_3888	_3934
Future scenario	2100	2100
H++ (0.1% AEP event) m AOD	7.91	7.67

5.15.30 Considering the H++ scenario, the risk of tidal flooding at the site remains from overtopping or a breach in the tidal defences. Should a breach event occur both the depth and extent of flooding would increase at the Immingham and Theddlethorpe Facilities and across the surrounding areas.

5.15.31 Critical electrical equipment would be sensitive to changes in different climate change scenarios where water levels would be higher than the 2100-year breach level used to define mitigation through measure P1 above. Elements of the Proposed Development may have to be replaced which could affect the turnaround time required to bring the Proposed Development back online and operational. However, as elements of the Proposed Development are replaced (new technology, natural wear and tear) there are opportunities for an adaptive approach to be taken and these new elements to include flood resistance and resilience based on climate change requirements at the time of replacement.

5.15.32 The depth of flooding could well exceed the safe refuge level for the CCR at Immingham. Should a significant tidal flood event occur it is likely a severe flood warning would be in force. Flood warning cannot be relied upon for a breach scenario however high tidal water levels are more likely to cause a breach in the flood defences. In which case there would be an opportunity to close down and evacuate the Immingham Facility.

5.15.33 The initial design lifetime of the Proposed Development is considered to be 25 years, however, should market conditions and technologies allow, it is understood that the operational life of the Proposed Development could be extended. The assessment of flood risk has therefore been undertaken for a period of 75 years. It must be noted that if climate change predictions did follow the H++ track and an adaptive approach is not possible then the lifetime of scheme may be reduced.

5.15.34 The below ground pipeline remains at low risk of flooding from tidal sources during a H++ event, given its location below ground, has a low sensitivity to climate change scenarios.

6 Flood Risk from the Development

Groundwater Sources

6.1.1 Given the scale and nature of the construction works and relative to the surrounding groundwater catchment, the ability of the construction phase to impact sub-surface flow regimes or groundwater storage capabilities is considered to be low and no mitigation is required.

Artificial Sources

6.1.2 The Kiln Reservoir, along the Laceby Beck / River Freshney within Section 2 is the only location with the DCO Site Boundary considered to be at risk from artificial waterbodies Given that the pipeline will be below ground at this location and there is no above ground infrastructure located within this area the risk to artificial sources of flood risk are low and no mitigation is required.

Drainage and Sewer Infrastructure

6.1.3 The study identifies that there is no known drainage and sewerage infrastructure present within the site boundaries of the Immingham and Theddlethorpe Facilities or the Block Valve Stations, however Anglian Water's water supply and drainage/sewerage infrastructure is present within the wider DCO Site Boundary.

6.1.4 The SFRAs for the LLFAs across the study area (NLC and NELC SFRA (Ref 9), East Lindsey SFRA (Ref 11), and West Lindsey SFRA(Ref 27)) indicate that flood risk from drainage and sewer infrastructure is low across the DCO Site Boundary and therefore no mitigation is required. Protective provisions are being developed with Anglian Water to protect drainage and sewerage assets under their jurisdiction.

Fluvial sources

6.1.5 The pipeline would be below ground across its entire route during the operational phase, therefore the risk of fluvial flooding from this aspect of the development is considered to be low and no mitigation is required.

6.1.6 Details of construction techniques are provided in Section 5.5 above.

6.1.7 The use of trenchless techniques, including auger boring and HDD, requires excavations to be made by a mechanical excavator at both the drill entry point (launch pit) and the drill exit point (reception pit) to contain drilling fluids at each end of the drill path. These excavations will be approximately 2m deep and 3m x 3m in area, set back from the watercourse. The working width at these locations would be typically wider than the standard 30 m working width. The pipeline will also cross the EA designated main rivers which have flood defences.

6.1.8 To mitigate the impacts of the construction phase on watercourses that will be crossed by the pipeline, the following measures are recommended. These are secured within the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)*:

- **P5:** Water from de-watering will not be pumped into a watercourse, be allowed to directly enter a watercourse, or be discharged to ground. Flume pipes will be sized to reflect the span width and the estimated flow characteristics of the watercourse under peak flow conditions;
- **P10:** During the installation of the trenchless crossings, a Hydrological Impact Appraisal will be undertaken for each drilling pit prior to works taking place to ensure that there are no impacts on flows within adjacent watercourses;
- **P11:** The integrity of the flood defences will be maintained by only using trenchless techniques for main rivers crossings and installing any temporary crossings for Ordinary Watercourses bank top to bank top;
- **P12**: Access will be maintained to allow the EA/IDB/LLFA to continue defence maintenance activities; and
- **P13**: Works within the easement of IDB drains and ordinary watercourses will require consent from the North East Lindsey IDB/LLFA.

6.1.9 In addition, during and following construction the following measures are recommended to mitigate off-site flood risk or drainage impacts both during construction and in the longer-term. These are secured within the Draft CEMP (*ES Volume IV Appendix 3.1 (Application Document 6.4.3.1*):

- **F5**: Existing field drainage systems will be re-instated to ensure that land capability is maintained, and drainage related to flooding issues will not be worsened.
- **G2**: The location and condition of existing land drainage will be established, and a record compiled. Subject to landowner/occupier agreement, existing drains should be restored,

or new drains established to help prevent damage to soil structure, maintain work areas in a dry condition and to enable current drainage systems to continue to operate through the construction period.

- **G11**: Following installation of the CO2 pipeline, topsoil and excavated material will be reinstated, and post-construction drainage system installed to ensure no detriment to the existing land drainage regime.

6.1.10 The Construction Compounds provide the main construction materials and pipeline storage areas for the pipeline. Mapping shows that the Northern Construction Compound is located in an area with a potential risk of fluvial flooding, albeit to a small section of the site. Storage of materials will be avoided in this area however there is potential for some temporary water displacement which could result in a slight increase in fluvial flood risk and impact fluvial flood flow routes. Any increase in flood risk will be localised to the Construction Compound and will not pose a significant risk to off-site receptors.

6.1.11 It is the project's usual intention to avoid storage of materials within the fluvial floodplain during construction. In areas where fluvial floodplains are clearly mapped by the Environment Agency (Sections 2, 3 and 4), there will be no storage of materials within these mapped flood extents. In areas where the EA Flood Map for Planning shows combined tidal and fluvial floodplains (Section 1 and 5), and fluvial floodplains cannot be identified separately from available flood maps, a reasonable set back will be provided, further than 8m from Main Rivers, where there will be no storage of materials, subject to further discussions with the EA (for Main Rivers) or the LLFA/Internal Drainage Board (for Ordinary Watercourses), as the project design evolves through the FEED stage.

6.1.12 Note that sections of pipes may be temporarily located within the fluvial floodplain during the installation of the pipeline at open cut watercourse crossing locations whilst the pipeline is being laid out and welded in place. Sections of pipe would only be moved to the crossing locations when needed and will be installed on the same day. These activities will take place during the summer months to avoid times of higher flows.

6.2 Fluvial Sources – Block Valve Stations

6.2.1 The Thoroughfare Block Valve Station is shown to have a high risk of flooding from surface water. The EA RFSW maps indicate localised ponding from a local land drain during higher return period events, with depths of up to 300mm. Construction of the Block Valve Station has the potential to displace flood water resulting in a slight increase in flood risk and impact fluvial flood flow routes, however flood water would still be routed around the station towards the north. Any increase in flood risk will be localised to the Block Valve Station and will not pose a significant risk to off-site receptors.

6.3 Surface Water (Pluvial)

6.3.1 The above ground infrastructure and associate laydown areas include Immingham Facility, north construction compound, Block Valve Stations, the central construction compound, Theddlethorpe Facility, (Option 1 and 2), south construction compound and replacement of the dune valve. They have the potential to increase the impermeable surface at the site. As, such the volume of surface water runoff generated, if left unmitigated, could increase runoff.

6.3.2 To mitigate this risk, the following mitigation measures, in addition to those outlined in Paragraph 6.1.9 above, are recommended. These are secured through the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)*:

- **P1**: A surface water drainage system (refer to Drainage Strategy in *ES Volume IV Chapter Appendix 11.3 (Application Document 6.4.11.3*) to intercept and attenuate all runoff up to and including the 1% AEP + 40% climate change allowance via methods

such as via infiltration into an infiltration trench at restricted greenfield rate, filter drains or detention basin (P9).

- **P2**: During the construction phase, appropriate construction practices will need to be adhered to in order to manage the risk of surface water run-off, such as temporary drainage provisions and pumping, as required.

6.3.3 Figure 4 indicates that the Immingham Facility is located in an area at low risk of surface water flooding. During high return period events it is possible that surface water could be displaced as a result of the development however any change in flood flow routes or surface water levels would remain local to the site.

6.3.4 Thoroughfare Block Valve Station, which will be installed off Thoroughfare in Ashby cum Fenby, would be constructed upon arable land that currently has a high risk of flooding from surface water. The EA RoFSW maps show localised ponding from a local land drain during higher return period events, with depths of up to 300mm and indicates that this fluvial flooding may be caused by surface water generated within the site.

6.3.5 The Drainage Strategy (*ES Volume IV Appendix 11.3 (Application Document 6.4.11.3*)) will mitigate the risk of an increase in surface water runoff to the development itself, as well as mitigating any off-site impacts.

6.4 Tidal Sources

6.4.1 Although there are tidal flood defences present along the coast to the east of the Project there remains a risk of tidal flooding due to overtopping or a breach of the flood defences.

6.4.2 Should an overtopping or breach event occur over the lifetime of the development along the tidal defences near Immingham or Theddlethorpe, the onset of flooding would be extremely quick, especially at the Theddlethorpe Facility which is in close proximity to the dunes which form the flood defence in this area.

6.4.3 Both the Immingham and Theddlethorpe Facilities may flood during a breach or overtopping event and it is likely that flood water would be displaced as a consequence of the development. At the Immingham Facility any displacement of floodwater, given the size of the site, would be localised and it is likely, given the extent and depth of flooding along the South Humber Bank near Immingham that any increase in the risk of flooding off-site to surrounding land would be minimal as these areas are flooded to the same depth as the Site. Any increase in flood water level is likely to be insignificant. Changes to flood flow routes is restricted due to the railway embankment along the west of the site.

6.4.4 At the Theddlethorpe Facility any displacement of floodwater or change in flood flow route would again be localised and any increase in the risk of flooding off-site to surrounding land, which is predominantly undeveloped, would be minimal as these areas would be flooded to the same depth as the Site. Any increase in flood water level is likely to be insignificant.

6.5 Decommissioning

6.5.1 An initial Draft Decommissioning Strategy has been developed for the Proposed Development and is presented in *ES Volume IV: Appendix 3.5 (Application Document 6.4.3.5)*. At the end of the design life all above-ground equipment (block valve stations and the Immingham and Theddlethorpe Facilities) would be decommissioned and removed down to ground level.

6.5.2 The base case is that all underground infrastructure would remain in-situ; however all connection and access points would be sealed or grouted to ensure disconnection. The risk of flooding from all sources during the decommissioning phase is expected to be similar, or

significantly less than the flood risk during the construction phase assessed in Section 5 and Section 6 of this FRA.

6.5.3 A Decommissioning Environmental Management Plan (“DEMP”) will be prepared prior to the decommissioning phase to explain how flood risk impacts associated with the decommissioning of Scheme will be minimised or avoided.

6.5.4 The DEMP will consider in detail all potential flood risks and contain guidance on how these risks can be removed, mitigated or managed. This will include, for example, details of how surface water drainage should be managed at the Site during decommissioning and demolition.

7 Conclusion

7.1.1 AECOM has prepared this FRA in accordance with the NPS (specifically policies EN1, EN3 and EN4), NPPF and associated Flood Risk and Coastal Change PPG, for the Viking CCS Pipeline.

7.1.2 The following conclusions can be made regarding flood risk to and from the Proposed Development.

Tidal

7.1.3 During the construction phase of the Immingham and Theddlethorpe Facilities, the works will take place within Flood Zone 3, therefore the following mitigation measures are recommended. These are secured within the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1))*:

- **P2**: Appropriate construction management practices; and
- **G1**: Adoption of an appropriate Flood Warning and Evacuation Plan (FWEP).

7.1.4 During the operation phase, the Immingham and Theddlethorpe Facilities will be at risk of tidal flooding from overtopping and a breach of defences. During the modelled 2115 0.1% breach scenario, the Immingham Facility could be inundated to a depth of 3.25m and the Theddlethorpe Facility could be inundated to a depth of 2.06 m. Should flooding occur due to a breach event in the Immingham area, but not at Theddlethorpe, (or vice versa), both the Immingham Facility and the Theddlethorpe Facility would be shut down and these facilities will not remain operational as the facilities which feed CO_2 into the pipeline would also shut down during a flood event.

7.1.5 Given the extent and depth of flooding associated with an overtopping or breach event any displacement of flood water due to the Project would remain local to the Immingham and Theddlethorpe Facilities. Any increase in the risk of flooding would be minimal as the surrounding areas are likely to be flooded to the same depth as the Site. As such, the impact of the Project on tidal flooding is considered to be insignificant.

7.1.6 To ensure the Immingham and Theddlethorpe Facilities are resilient to flooding and can be brought back online as quickly as possible, the following mitigation measures are recommended, in line with advice from the Environment Agency. These are secured within the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1))*:

- **P3**: Critical electrical equipment will be raised 300mm above the higher of the 2100 0.1% AEP breach level or the extreme sea level for 2100. Indicative breach levels are 6.5m AOD (Immingham), 3.8m AOD (Theddlethorpe Option 1) and 3.6m AOD (Theddlethorpe Option 2), refer to the Breach Level Technical Note presented as Appendix C. This could be achieved by raising infrastructure on a table or if this is not possible then vulnerable infrastructure should be located within a watertight surround (P13)**G1**: A Flood Warning and Evacuation Plan should be provided;
- **P4**: Use of flood resistant and resilient construction materials to be used as far as practicable;
- **G29**: Facility users to sign up to the EA Flood Warning Service to receive flood warnings; and
- **G30**: No maintenance visits during periods when a Flood Warning is in force.

7.1.7 Safe refuge provision would be provided within the CCR as per measure P1 above, either within the Immingham Facility, or alternatively, co-located within the existing CCR at VPI Immingham.

Fluvial

7.1.8 Sections 1 and 5 of the DCO Site Boundary are generally at low risk of flooding from fluvial sources. The Immingham Facility Site is located in an area considered to be at 0.1% chance of flooding in any year with water (pluvial/fluvial) shown to pool in areas of topographical low points within the site boundary.

7.1.9 Sections 2, 3 and 4 of the DCO Site Boundary are predominantly at risk of flooding from fluvial sources, while the watercourse crossings in Sections 1 and 5 are also at risk of flooding from fluvial sources.

7.1.10 All main river crossings will be undertaken using trenchless techniques, while smaller, ordinary watercourse crossings are likely to be made using open cut techniques.

7.1.11 As stipulated in commitment P5 of the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1)), d*uring the construction phase the Immingham Facility is at risk of flooding from the South Killingholme Drain. This drain will be diverted in association with the Humber Zero project. To mitigate the impact of the construction phase on watercourses that will be crossed by the pipeline throughout the DCO Site Boundary, the following mitigation measures are recommended:

- Water will not be pumped into a watercourse, be allowed to directly enter a watercourse, or be discharged to ground;
- Flume pipes will be sized to reflect the span width and the estimated flow characteristics of the watercourse under peak flow conditions; and
- During the installation of the auger bore crossings, a Hydrological Impact Appraisal will be undertaken for each drilling pit prior to works taking place to ensure that there are no impacts on flows within adjacent watercourses.

7.1.12 To mitigate the impacts of the construction phase on the crossings with flood defences, in Sections 3, 4 and 5 of the DCO Site Boundary, the following mitigation measures are recommended. These are secured through commitment P6 in the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1))*:

- The integrity of the flood defences will be maintained by only using trenchless techniques for main rivers crossings and installing any temporary crossings for Ordinary Watercourses bank top to bank top (P11); and
- Access will be maintained to allow the EA/IDB/LLFA to continue defence maintenance activities.

7.1.13 To mitigate the risk of impacting flows and displacing floodwater during the construction phase, the following mitigation measures are recommended. These are secured through commitment P7 in the Draft CEMP *(ES Volume IV Appendix 3.1 (Application Document 6.4.3.1))*:

- Works within the easement of IDB drains and ordinary watercourses will require consent from the North East Lindsey IDB/LLFA;
- Construction works should not be undertaken during periods of heavy rainfall;
- Weather forecasts and Flood Warnings should be monitored regularly during the construction phase;
- Minimal storage of materials/plant in the floodplain; and

- A surface water drainage system to intercept and attenuate all runoff generated (refer to the Drainage Strategy in *ES Volume IV Appendix 11.3 (Application Document 6.4.11.3*)).

7.1.14 The Construction Compounds provide the main construction materials and pipeline storage areas for the pipeline. Mapping shows that the Northern Construction Compound is located in an area with a potential risk of fluvial flooding, albeit to a small section of the site. Storage of materials will be avoided in this area however there is potential for some temporary water displacement which could result in a slight increase in fluvial flood risk and impact fluvial flood flow routes. Any increase in flood risk will be localised to the Construction Compound and will not pose a significant risk to off-site receptors.

7.1.15 It is the project aspiration to avoid storage of materials within the fluvial floodplain during construction. In areas where fluvial floodplains are clearly mapped by the Environment Agency (Sections 2, 3 and 4), there will be no storage of materials within these mapped flood extents. In areas where the EA Flood Map for Planning shows combined tidal and fluvial floodplains (Section 1 and 5), and fluvial floodplains cannot be identified separately from available flood maps, a reasonable set back will be provided, further than 8m from Main Rivers, where there will be no storage of materials, subject to further discussions with the EA (for Main Rivers) or the LLFA/Internal Drainage Board (for Ordinary Watercourses), as the project design evolves through the FEED stage.

7.1.16 Note that sections of pipes may be temporarily located within the fluvial floodplain during the installation of the pipeline at open cut watercourse crossing locations whilst the pipeline is being laid out and welded in place. Sections of pipe would only be moved to the crossing locations when needed and will be installed on the same day. These activities will take place during the summer months to avoid times of higher flows.

7.1.17 During the operation phase the pipeline would be below ground across its entire route, therefore the risk of fluvial flooding to this aspect of the development and from the development to surrounding areas is considered to be low and no mitigation is required.

7.1.18 The Block Valve Stations in Sections 2, 3 and 4 of the DCO Site Boundary lie in Flood Zone 1 and are therefore not considered to be at risk of flooding from fluvial sources.

Groundwater

7.1.19 During the construction phase, appropriate construction practices will need to be adhered to in order to manage the risk of groundwater ingress into excavations during construction, such as dewatering and pumping techniques, as required.

7.1.20 The pipeline route would be below ground across its entire route and therefore has the potential to encroach within the groundwater table. The pipeline will need to be designed appropriately to take into account hydrostatic pressure and the floatation risk to the pipeline from elevated groundwater.

7.1.21 As a precautionary measure, any below ground elements associated with the DCO Site Boundary should be designed in such a way as to withstand any upward hydraulic pressures in the event that groundwater levels rise as a result of climate change.

7.1.22 Given the scale and nature of the construction works and pipeline relative to the surrounding groundwater catchment, the ability of the construction phase to impact sub-surface flow regimes or groundwater storage capabilities is considered to be low and no mitigation is required.

Surface Water

7.1.23 The DCO Site Boundary are considered to be at low risk of flooding from surface water.

7.1.24 Thoroughfare Block Valve Station is at high risk of flooding from surface water. The EA RoFSW maps indicate localised ponding from a local land drain during higher return period events, with depths of up to 300mm.The valve actuator will extend above ground to a level above the 1% AEP plus climate change pluvial flood level.

7.1.25 During the construction phase of the pipeline, Immingham and Theddlethorpe Facilities and Block Valve Stations, appropriate construction practices will need to be adhered to, in order to manage the risk of surface water ingress into excavations during construction, such as temporary drainage provisions and pumping as required.

7.1.26 The pipeline would be below ground across its entire route during the operational phase, therefore the risk of surface water flooding to this aspect of the development is considered to be low and no mitigation is required.

7.1.27 A surface water drainage system to intercept and attenuate all runoff generated (refer to the Drainage Strategy in *ES Volume IV Appendix 11.3 (Application Document 6.4*.11.3)) will mitigation impacts from the development to elsewhere during both the construction and operation phases.

Artificial Waterbodies

7.1.28 The Proposed Development is not considered to be at risk of flooding from artificial sources.

Drainage and Sewerage Infrastructure

7.1.29 A desktop study undertaken by GroundSure identifies that there is no known drainage and sewerage infrastructure present below the DCO Site Boundary, therefore the Proposed Development is not considered to be at risk from drainage and sewerage infrastructure sources.

Decommissioning

7.1.30 For the decommissioning stage the pipeline will be left in-situ along its entire length, therefore the impacts associated with the decommissioning phase are related to the removal of above-ground facilities. The scale and nature of activities undertaken during decommissioning would be similar to, and significantly lesser, than those previously undertaken for construction. A Decommissioning Environmental Management Plan (DEMP) will be produced prior to the decommissioning phase and will include mitigation for flood risk.

The Sequential and Exception Tests

7.1.31 An assessment has been undertaken in accordance with the methodology and criteria provided on the application of the Sequential Test and Exception Test contained within the NPPF PPG. The DCO Site Boundary is predominantly in Flood Zone 1, however, the DCO Site Boundary crosses six main rivers which have associated Flood Zone 2 and Flood Zone 3 extents, as defined in the EA's 'Flood Map for Planning'. The Immingham Facility and Theddlethorpe Facility lie predominantly within Flood Zone 3.

7.1.32 The Proposed Development is for the transportation of compressed CO_2 and includes above ground structures. Given the flood risk vulnerability classification of the Proposed Development as Essential Infrastructure, it is necessary to consider the application of the Exception Test.

7.1.33 It is concluded that the Proposed Development accords with the first part of the Exception Test in that it provides wider sustainability benefits to the community that outweigh flood risk.

7.1.34 It is also considered that the second part of the Exception Test is complied with, as it has been demonstrated that the infrastructure will be safe for the duration of its lifetime, without increasing flood risk elsewhere.

7.1.35 For the reasons outlined in *ES Volume II Chapter 2: Design Evolution and Alternatives*, there is a rationale need for the Proposed Development in the locations identified and where possible this has included previously developed sites (such as at Immingham and Theddlethorpe).

7.1.36 The Proposed Development complies with the Sequential and Exception Tests set out in the NPPF PPG and EN-1.

Summary

7.1.37 The FRA has demonstrated that it will be possible to manage flood risks to and from the Proposed Development in compliance with the NPS, NPPF and accompanying Planning Practice Guidance.

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Annex A Consultation Responses

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To: Lee, Frances
Cc: Lincs & Northants, Customer Enquiries; Sylvester [redacted]
Subject: RE: Viking CCS Pipeline (V-Net Zero) Additional Flood Risk Data Request CCN/2023/294005
Attachments: EA Conditional Licence.pdf

Dear Fran,

Enquiry regarding: Viking CCS Pipeline (V-Net Zero) Additional Flood Risk Data Request

Thank you for your enquiry which was received on 4th January 2023.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

Please find a sharefile link to the product 5 and 6 data below FR4-M. The attached conditional licence must be used with this information.

Sharefile Link: [redacted]

With regards to whether the H++ allowances are required in the climate change section, please see the response below.

We have previously provided advice on this matter in our response to the Statutory Consultation for the project undertaken in accordance with Section 42 of the Planning Act 2008; Please refer our letter to the Applicant dated 22 December 2002 in which we advised (in relation to Appendix 11.4 of the Preliminary Environmental Information Report):

Section 11.9 confirms that it may be necessary to assess the credible maximum climate change and refer to the H++ scenario for sea level rise only. The relevant National Policy Statements also suggest a 'credible maximum' is applied to account for future flood risk. The range of climate allowances that should be considered is explained at Flood risk assessments: climate change allowances - GOV.UK (www.gov.uk), including the 'credible maximum'

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent, quoting the CCN reference number.

Kind Regards,

Frederic Stuhldreer
Flood Risk Officer
FCRM Partnerships and Strategic Overview – South Humber and East Coast

Environment Agency | Ceres House, Searby Road, Lincoln, LN2 4DW

From: Lincs & Northants, Customer Enquiries <LNenquiries@environment-agency.gov.uk>
Sent: 06 January 2023 13:30
To: [redacted]@aecom.com>
Cc: [redacted]@aecom.com; [redacted] <[redacted]@aecom.com>; Coastal L&N, PSO <PSO_Coastal@environment-agency.gov.uk>
Subject: FW: Viking CCS Pipeline (V-Net Zero) Additional Flood Risk Data Request CCN/2023/294005

Dear Fran,

Product data for site at Viking CCS Pipeline (V-Net Zero) CCN/2023/294005

Thank you for your request for flood risk data of 4 January 2023.

We have passed your request to our Partnerships and Strategic Overview Team who will assess what information is available and most relevant to your site. They will confirm this and provide the data in their final reply.

Under Environmental Information Regulations we have up to 20 working days to send the information to you. However we will aim to provide a response to you before this time but you can expect to receive the data by no later than 1 February 2023.

If you have any queries in the meantime, please do not hesitate to contact me.

Kind regards,

Rosie
Customers & Engagement Officer
LNenquiries@environment-agency.gov.uk
Lincolnshire and Northamptonshire Area
Environment Agency | Ceres House, 2 Searby Rd, Lincoln LN2 4DW

From: [redacted] <[redacted]@aecom.com>
Sent: 04 January 2023 09:46
To: [redacted] <[redacted]@environment-agency.gov.uk>
Cc: [redacted]@aecom.com>; [redacted] <[redacted]@aecom.com>
Subject: Viking CCS Pipeline (V-Net Zero) Additional Flood Risk Data Request

> You don't often get email from [redacted]@aecom.com. Learn why this is important

Hello Rebecca,

Happy New Year. I am working with Kate Barnett on the Flood Risk Assessment for the Viking CCS Pipeline project.

Please can I request the following additional data to support the next phase of our flood risk assessment?

- Tidal data: extreme water levels, flood defence data, breach mapping etc for the length of the entire pipeline (usually a Product 4 and Product 8 request)
- Do we know the limits of tidal influence for main rivers / ordinary watercourses?

- Are the H++ allowances required in the climate change section?
- Any key flood risk management infrastructure? – this likely can be picked up using the asset management database / flood defence layer but please confirm
- Restrictions (permits etc?) to inform crossing schedule
- GIS rasters showing fluvial flood extents, depths and velocities (separate from tidal influence)
- GIS rasters showing tidal flood extents, depths and velocities
- Any modelling reports available for fluvial or tidal modelling
- As you noted below, details of any tidal or fluvial flood defences, including level of protection, any condition assessments

The map below shows the location of the pipeline (red), with the blue lines marking the section breaks. The flood risk assessment will likely assess each section in turn, rather than assess the pipeline as a whole.

Please let me know if you require any additional information to support this request.

Thank you in advance,

Fran

Frances Lee BSc (Hons), MSc
Pronouns: [redacted]

Flood and Coastal Consultant, Water, UK
M +[redacted]
[redacted]3@aecom.com

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Dear Fran

Re: Viking CCS Pipeline (V-Net Zero) Additional Flood Risk Data Request

Thank you for your email. We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

Please find a sharefile link below that will enable you to download the Products 5 data for 2009 Louth Catchment FMI Summary Report, 2016 River Freshney and New Cut Drain Hydraulic Modelling Report, 2017 Saltfleet & Great Eau Model Report, 2020 Stallingborough & Oldfleet Report with Appendix A – G, 2010 NTM Volume 1 - Overview Report, 2010 NTM Volume 2 - Tide Surge and Wave Analysis Report, 2010 NTM Volume 3 - Overtopping Flood Mapping Report, 2010 NTM Volume 4 - Breach Flood Mapping Report, 2010 NTM Volume 5 - Without Defences Flood Mapping Report, 2010 NTM Volume 6 - Flood Forecasting and Warning Improvements and the products 6 data for Louth Canal 2009 Fluvial Extents (baseline, climate change and undefended), 2009 Louth Canal Nodes shapefile, River Freshney 2016 Fluvial Extents (baseline, climate change and undefended), 2016 Freshney Nodes, Saltfleet and Great Eau 2017 Fluvial Extents (baseline, climate change and undefended), 2017 Saltfleet and Great Eau Nodes, Satllingborough and Oldfleet 2020 Fluvial Extents (baseline, climate change and undefended), 2020 Stallingborough and Oldfleet Nodes, 2010 NTM Breach Outputs (baseline and climate change), 2010 NTM East Coast Overtopping Outputs (baseline and climate change) and 2010 NTM Humber Overtopping Outputs (baseline and climate change).

[redacted]

Please note this link will expire in 30 days.

The following information is not available under the Open Government Licence but we may be able to licence it to you under the Environment Agency Conditional Licence:

Please refer to the tables below for the permitted use of the supplied information.

Name	Product 5
Description	Report name 2009 Louth Catchment FMI Summary Report, 2016 River Freshney and New Cut Drain Hydraulic Modelling Report, 2017 Saltfleet & Great Eau Model Report, 2020 Stallingborough & Oldfleet Report with Appendix A – G, 2010 NTM Volume 1 - Overview Report, 2010 NTM Volume 2 - Tide Surge and Wave Analysis Report, 2010 NTM Volume 3 - Overtopping Flood Mapping Report, 2010 NTM Volume 4 - Breach Flood Mapping Report, 2010 NTM Volume 5 - Without Defences Flood Mapping Report, 2010 NTM Volume 6 - Flood Forecasting and Warning Improvements
Licence	Environment Agency Conditional Licence
Conditions	1. You may use the Information for your internal or personal purposes and may only sublicense others to use it if you do so under a written licence which includes the terms of these conditions and the agreement and in particular may not allow any period of use longer than the period licensed to you.

	2. Notwithstanding the fact that the standard wording of the Environment Agency Conditional Licence indicates that it is perpetual, this Licence has a limited duration of 5 years at the end of which it will terminate automatically without notice. 3. We have restricted use of the Information as a result of legal restrictions placed upon us to protect the rights or confidentialities of others. In this instance it is because of third party data. If you contact us in writing (this includes email) we will, as far as confidentiality rules allow, provide you with details including, if available, how you might seek permission from a third party to extend your use rights. 4.1 The Information may contain some data that we believe is within the definition of "personal data" under the Data Protection Act 1998 but we consider that we will not be in breach of the Act if we disclose it to you with conditions set out in this condition and the conditions above. This personal data comprises names of individuals or commentary relating to property that may be owned by an individual or commentary relating to the activities of an individual. 4.2 Under the Act a person who holds and uses or passes to others personal data is responsible for any compliance with the Act and so we have no option but to warn you that this means you have responsibility to check that you are compliant with the Act in respect of this personal data. 5. The location of public water supply abstraction sources must not be published to a resolution more detailed than 1 km². Information about the operation of flood assets should not be published. 6.1 Where we have supplied model data which may include model inputs or outputs you agree to supply to the Environment Agency copies of any assessments/studies and related outputs, modifications or derivatives created pursuant to the supply to you of the Information, all of which are hereinafter referred to as "the Data". 6.2 You agree, in the public interest to grant to the Environment Agency a perpetual royalty free non-exclusive licence to use the Data or any part thereof for its internal purposes or to use it in any way as part of Environment Agency derivative products which it supplies free of charge to others such as incorporation into the Environment Agency's Open Data mapping products.
Attribution	Contains Environment Agency information © Environment Agency and/or database rights. May contain Ordnance Survey data © Crown copyright 2022 Ordnance Survey 100024198.

Name	Product 6
Description	Model Output Data for Louth Canal 2009 Fluvial Extents (baseline, climate change and undefended), 2009 Louth Canal Nodes shapefile, River Freshney 2016 Fluvial Extents (baseline, climate change and undefended), 2016 Freshney Nodes, Saltfleet and Great Eau 2017 Fluvial Extents (baseline, climate change and undefended), 2017 Saltfleet and Great Eau Nodes, Satllingborough and Oldfleet 2020 Fluvial Extents (baseline, climate change and undefended), 2020 Stallingborough and Oldfleet Nodes, 2010 NTM Breach Outputs (baseline and climate change), 2010 NTM East Coast Overtopping Outputs (baseline and climate change) and 2010 NTM Humber Overtopping Outputs (baseline and climate change)
Licence	Environment Agency Conditional Licence
Conditions	1. You may use the Information for your internal or personal purposes and may only sublicense others to use it if you do so under a written licence which includes the terms of these conditions and the agreement and in particular may not allow any period of use longer than the period licensed to you. 2. Notwithstanding the fact that the standard wording of the Environment Agency Conditional Licence indicates that it is perpetual, this Licence has a limited duration of 5 years at the end of which it will terminate automatically without notice. 3. We have restricted use of the Information as a result of legal restrictions placed upon us to protect the rights or confidentialities of others. In this instance it is because of third party data. If you contact us in writing (this includes email) we will, as far as confidentiality rules allow, provide you with details including, if available, how you might seek permission from a third party to extend your use rights. 4.1 The Information may contain some data that we believe is within the definition of "personal data" under the Data Protection Act 1998 but we consider that we will not be in breach of the Act if we disclose it to you with conditions set out in this condition and the conditions above. This personal data comprises names of individuals or commentary relating to property that may be owned by an individual or commentary relating to the activities of an individual. 4.2 Under the Act a person who holds and uses or passes to others personal data is responsible for any compliance with the Act and so we have no option but to warn you that this means you have responsibility to check that you are compliant with the Act in respect of this personal data. 5. The location of public water supply abstraction sources must not be published to a resolution more detailed than 1km². Information about the operation of flood assets should not be published. 6.1 Where we have supplied model data which may include model inputs or outputs you agree to supply to the Environment Agency copies of any assessments/studies and related outputs, modifications or

	derivatives created pursuant to the supply to you of the Information, all of which are hereinafter referred to as “the Data”. 6.2 You agree, in the public interest to grant to the Environment Agency a perpetual royalty free non-exclusive licence to use the Data or any part thereof for its internal purposes or to use it in any way as part of Environment Agency derivative products which it supplies free of charge to others such as incorporation into the Environment Agency's Open Data mapping products.
Information Warnings	Please be aware that model data is not raw, factual or measured but comprises of estimations or modelled results based on the data available to us. Please be aware that we are currently reviewing the 2016 River Freshney Undefended Model and as a result the extents could change in the future.
Attribution	Contains Environment Agency information © Environment Agency and/or database rights.

However, you MUST first check the supporting information and the above link to determine if the conditions on use are suitable for your purposes. If they aren’t, this information is not provided with a licence for use, and the data is provided for read right only.

If you are not satisfied with our response to your request for information you can contact us within 2 calendar months to ask for our decision to be reviewed.

Kind regards,

Lee, Frances

Subject: FW: Data request
Attachments: LMDB_Shapefiles_ToSend.zip; 20210518AN01BuildingsStructuresPlantingAndFencingRev4.pdf; 20210518AN02CulvertsAndBridgesRev4.pdf; 20210518AN03EnvironmentalConsiderationsRev6.pdf; 20210518AN05ServiceCrossingsRev4.pdf; WMCApplicationForConsent.pdf

From: Planning LMDB <planning@lmdb.co.uk>
Sent: 31 August 2022 09:21
To: Barnett, Kate <[redacted]@aecom.com>
Subject: [EXTERNAL] RE: Data request

Good morning [redacted]

Please find the shape files and a Consent application form attached. I have also added copies of the Advice Notes which should be of relevance to the work (environmental considerations, structures, crossings, culverts, installations in proximity to Board maintained drains).

Please send any details along as things develop, of any works within Lindsey Marsh Board area and our extended area. Anything within 9m of a Board maintained drain and any works which involve crossing, culverting or building near a drain require the Board's consent. Details of distances are given within the attached documents.

Kind regards

[redacted]

[redacted]
Admin Assistant (Planning and Consenting)

Water Management Consortium

Wellington House, Manby Park, Manby, LOUTH, Lincolnshire, LN11 8UU.
Telephone: 01507 328095

From: Barnett, Kate [redacted]@aecom.com>
Sent: 08 August 2022 16:09
To: Enquiries LMDB <enquiries@lmdb.co.uk>
Subject: Data request

Dear Sir/ Madam,

AECOM sent through the following data request in May, however the response may have gone through to an email address that is no longer valid. Therefore I am sending through the same data request in the hope that the information can be obtained, apologies if the information has already been send through.

AECOM is commissioned to conduct an environmental impact assessment involving the development of an onshore buried pipeline to transport Carbon Dioxide (CO_2). Below is a map showing the indicative proposed location of the

scheme and a 5km buffer (in blue) below. AECOM will be assessing potential environment impacts on watercourses, including some of those within the Lindsey Marsh Internal Drainage Board (IDB).

To assist with the project it would be appreciated if you could provide AECOM with the following data that concerns all watercourses within the indicative project footprint in the Lindsey Marsh IDB:

- Maps of watercourses
- Flood defence assets
- Details of management of the watercourses
- Any flood models for the watercourses (Model set up, data employed).

For any data supplied, please can you provide details of locations as a NGR if available.

If you have any queries regarding this data request, please do get in touch!

Kind regards,

Kate

Kate Barnett MSc BEng(Hons) CIWEM
Principal Water Scientist
Water Environment, UK & Ireland
M [redacted]
[redacted]t@aecom.com

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Lindsey Marsh Drainage Board
Wellington House, Manby Park, Manby, Louth, Lincolnshire, LN11 8UU

Telephone: 01507 328095

E-Mail: enquiries@lmdb.co.uk

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Lindsey Marsh Drainage Board
Wellington House, Manby Park, Manby, Louth, Lincolnshire, LN11 8UU

Telephone: 01507 328095

E-Mail: enquiries@lmdb.co.uk

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Lindsey Marsh Drainage Board
Wellington House, Manby Park, Manby, Louth, Lincolnshire, LN11 8UU

Telephone: 01507 328095

E-Mail: enquiries@lmdb.co.uk
~~~~~

Lee, Frances

From: Nick Downing [redacted]g@witham3idb.gov.uk>
Sent: 04 May 2022 12:19
To: [redacted]
[redacted]
Subject: [EXTERNAL] Data Request - North East Lindsey IDB
Attachments: NEL IDB - Shapefiles.zip

Hi Amber,

Attached is the requested data with the NRG included with the shapefiles. I have also included a shapefile which shows the North East Lindsey IDB maintained boundary within the buffer zone.

- Maps of watercourses
  See attached
- Flood defence assets
  2 x Pumping Station (Middle Drain and Immingham) – Also see attached
- Details of management of the watercourses
  The watercourses are flailed annually with a tractor flail unit – Excavator used to cut weed growth from the channel (also annually)
- Any flood models for the watercourses (Model set up, data employed).
  No

Please let me know if you have any further questions.

Many thanks,

Nick Downing
Environment and GIS Officer

WITHAM AND HUMBER DRAINAGE BOARDS

Witham First District Internal Drainage Board
Witham Third District Internal Drainage Board
Upper Witham Internal Drainage Board
North East Lindsey Drainage Board

[redacted]

Witham House,
Meadow Lane,
North Hykeham,
LN6 9QU

From: Bentley, Amber <[redacted]@aecom.com>
Sent: 03 May 2022 08:21
To: Enquiries <Enquiries@witham3idb.gov.uk>
Subject: Data Request

Dear Sir/ Madame,

AECOM is commissioned to conduct an environmental impact assessment involving the development of an onshore buried pipeline to transport Carbon Dioxide (CO_2). Below is a smap showing of the indicative proposed location of the scheme and a 5km buffer (in blue) below. A shapefile of the 5km buffer zone is attached. Following the scoping report, AECOM will be assessing possible environment impacts on watercourses, including some of those within the North East Lindsey Internal Drainage Board (IDB).

To assist with the project it would be appreciated if you could provide AECOM with the following data that concerns all watercourses within the indicative project footprint in the North East Lindsey IDB:

- Maps of watercourses
- Flood defence assets
- Details of management of the watercourses
- Any flood models for the watercourses (Model set up, data employed).

For any data supplied, please can you provide details of locations as a NGR.

If you have any queries regarding this data request, please do get in touch!

Kind regards,
Amber

Amber Bentley
[redacted]

Graduate Water Scientist, EUR - UK & Ireland
[redacted]

AECOM
11th Floor Colmore Building
Colmore Circus Queensway
B4 6AT, Birmingham, United Kingdom
T +44 (0)121 262 1900

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Minutes

Meeting name
Viking CCS Meeting with EA

Meeting date
29th June 2023

Location
Via Teams

AECOM project number
60668955

Subject
Flood defence breach information and associated mitigation measures.

Time
3pm

Project name
Viking CCS Pipeline

Prepared by
Jo Somerton

Attendees
Annette Hewson, Planning, Environment Agency.
Rebecca Sylvester, Flood Risk/Permitting, Environment Agency.
Paul Davies, On-shore Dev Mgr, Harbour Energy.
Noel Cunningham, On-shore Senior Constrcuction Mgr.
Nigel Pilkington, PM, Aecom.
Jo Somerton, Flood Risk Tech Lead, Aecom.
Frances Lee, Flood Risk, Aecom.

Circulation list
All Attendees

Ref	Action	Responsible	Due by	Initial
01	Introductions made	<Name here>	<Date here>	**<Initials>**
02	NP/PD provided a brief overview of the Viking CCS project including tight timescales for development in line with VPI Humber Zero project on adjacent site which will supply the pipeline with CO_2 and stressing environmental importance of the project in terms of Immingham area being the largest producer of CO_2 and the proposals contributing to meeting Net Zero objectives.			
03	FL provided an overview of the current breach flood water levels sent by the EA as part of their Product 6 data package alongside breach mapping for both the VPI Immingham and Theddlethorpe reception sites.			
04	JS raised the question with regards accuracy of the breach information for the VPI Immingham Reception Site given the breach flood depths on the adjacent Humber Zero site were 1.5m and 2.5m (2006 and 2115 0.1% AEP events respectively) based on information discussed at a recent Humber Zero meeting. RS agreed that the flood depths/levels seemed higher than she had expected and would go back and investigate the data for Immingham and Theddlethorpe further/ discuss with colleagues and let Aecom know the outcomes of this investigation.	Rebecca Sylvester	ASAP	**RS**
05	Discussion around mitigation and vulnerability classification of 'essential infrastructure' requirement of remaining operational. No ground raising is proposed on the Sites therefore infrastructure would need to raised on a table or located within a watertight surround. JS outlined that the adjacent Humber Zero Site that will supply CO_2 to the Viking CCS will be shut down should a flood event occur and therefore no CO_2 will be produced for pipeline transport during this time. Therefore, it was			

Ref	Action	Responsible	Due by	Initial
	proposed that the pipeline would also shut down during a flood event.			
06	In terms of mitigation and raising of critical infrastructure both AH and RS stated that the mitigation approach should be a decision made by Harbour Energy based on the business related/commercial risk of shutting the operation down and driven by the ability of the operation to be brought back on-line following a flood event. NC explained that Harbour Energy were only looking at raising the level of the kiosk within the Reception Sites.			
07	RS asked if there would be any proposed works within the dunes area at Theddlethorpe. NP/PD explained that only works to provide a install a replacement electrical connection/ cable for the valve, located just shoreside of the dunes is required. RS explained that as the dune systems act as the flood defence in this area, a permit may be required for working within 16m of a tidal flood defence. Also, consultation/permits will be required from Natural England.			
08	RS queried the proposed watercourse crossings stating that the PEI Report noted that all but one Main River Crossings (Greyfleet Drain) were proposed using trenchless techniques. NP confirmed that all Mian River crossings would now be trenchless.			
09	NP explained that the PEI Report had stated that fluming would be used at watercourse crossings but that this had now changed, and bridges were being proposed. RS noted the possibility that bridges, if placed bank- top to bank-top, may be exempt from the Flood Risk Activity permit requirements. RS to check if this is the case re permit exemptions, otherwise this would require a bespoke permit.	Rebecca Sylvester	ASAP	**RS**
10	NP agreed to send RS an updated shapefile for the project and the latest watercourse crossing schedule.	Nigel Pilkington	ASAP	**NP**
11	RS asked how the FRA was taking into account the credible maximum scenario. JS explained that the H++ scenarios were being assessed in the FRA as a sensitivity test for the worst case climate change scenario which was welcomed by RS.			
12	AH asked if project timescales allowed for the EA to review the FRA before submission and noted that the EA would require 21 days to undertake this element but with holidays/workloads this period may be longer. NP explained that this was unlikely given the August submission date we are working towards, however if this was to change it may be possible to provide the assessment. AH/RS indicated that anything that could be sent through and reviewed now can be sent across.			
13	No other business/ close of meeting.			

Annex B Regional and Local Planning policy

1.1 Regional Policy

Humber River Basin District Flood Risk Management Plan

1.1.1 The Environment Agency is required to prepare Flood Risk Management Plan's (FRMPs) for all of England covering flooding from Main Rivers, the sea and reservoirs.

1.1.2 The Humber River Basin District FRMP (Ref **1**) has been published by the EA and sets out objectives to manage flood risk for the period 2015 to 2021. The Proposed Development is located in the Louth, Grimsby and Ancholme Management Catchment.

Anglian River Basin District Flood Risk Management Plan

1.1.3 The Anglian River Basin District FRMP (Ref **2**) has been published by the EA and sets out objectives to manage flood risk for the period 2015 to 2021. The Proposed Development is located in the Witham Management Catchment.

Grimsby and Ancholme Catchment Flood Management Plan

1.1.4 The role of Catchment Flood Management Plans (CFMP) are to identify flood risk management policies which will assist all key decision makers in the catchment to deliver sustainable flood risk management for the long term. The Grimsby and Ancholme CFMP (Ref **3**) considers all types of inland flooding, from rivers, ground water, surface water and tidal flooding, but not flooding directly from the sea (coastal flooding).

1.1.5 The CFMP splits the Grimsby and Ancholme catchment into 5 sub-areas which have similar physical characteristics, sources of flooding and level of risk. The most appropriate approach to managing flood risk for each of the sub-areas is identified and one of six generic flood risk management policies is allocated to the area.

1.1.6 The Proposed Development is located in sub-areas 1 and 4. Sub-area 1 identifies that flooding from rivers is the main source of flood risk in this area. The vision and preferred policy for this sub-area is Policy Option 2, where the preferred approach is to reduce bank and channel maintenance to help improve the flow between the river and its floodplain. Sub-area 4 identifies that flooding from rivers and tide-locked IDB watercourses is the main source of flood risk in this area. The vision and preferred policy for this sub-area is Policy Option 4, where the preferred approach is to conduct a flood risk study to investigate how further action can be taken to manage flood risk into the future.

Louth Coastal Catchment Flood Management Plan

1.1.7 The role of Catchment Flood Management Plans (CFMP) are to identify flood risk management policies which will assist all key decision makers in the catchment to deliver sustainable flood risk management for the long term. The Louth Coastal CFMP (Ref **4**) considers all types of inland flooding, from rivers, ground water, surface water and tidal flooding, but not flooding directly from the sea (coastal flooding).

1.1.8 The CFMP splits the Louth Coastal catchment into 7 sub-areas which have similar physical characteristics, sources of flooding and level of risk. The most appropriate approach to managing flood risk for each of the sub-areas is identified and one of six generic flood risk management policies is allocated to the area.

1.1.9 The Proposed Development is located in sub-areas 3 and 5. Sub-area 3 identifies that flooding from embanked watercourses, due to defence failure is the main source of flood risk in this area. The vision and preferred policy for this sub-area is Policy Option 4, where the preferred approach is to store water upstream, along Waithe Beck, combined with an improvement of current maintenance activities. Sub-area 5 identifies that flooding from rivers is the main source of flood risk in this area. The vision and preferred policy for this

sub-area is Policy Option 3, where the preferred approach is to continue with the current flood risk management activities in the short-term, but consider alternative, more appropriate ways to manage flood risk in the long term.

Flamborough Head to Gibraltar Point Shoreline Management Plan

1.1.10 The purpose of a Shoreline Management Plan is to identify the most sustainable approach to managing the flood and coastal erosion risks to the coastline in the short-term (0-20 years), medium term (20 to 50 years) and long term (50 to 100 years).

1.1.11 In the Flamborough Head to Gibraltar Point SMP (Ref **5**), the Proposed Development falls into the following Policy Units:

- **Policy Unit L East Immingham to Cleethorpes**: preferred policy is to hold defences in their current position and their function will be maintained.
- **Policy Unit M Humberston Fitties**: preferred policy is to maintain the first line of defences at current crest levels and improve the second line of defence in the Chalet Park to counter potential sea level rise, up to 2055. Between 2055 to 2105, the second line of defences will be held in their current position and their function and the standard of protection against flooding will be maintained.
- **Policy Unit N South of Humberston Fitties to Theddlethorpe St Helen**: preferred policy is to hold the defences in their current position and their flood defence function will be maintained. Embankments may be raised and improved to counter sea level rise as required, to maintain the standard of protection.

1.2 Local Policy

1.2.1 The Proposed Development lies within the following administrative areas:

- North Lincolnshire Council (NLC);
- North East Lincolnshire Council (NELC);
- West Lindsey District Council (WLDC); and
- East Lindsey District Council (ELDC).

1.2.2 The local development plans for these areas, which EN-1 confirms may be 'important and relevant' in the determination of a DCO application, currently comprises the following documents:

- North Lincolnshire Council Local Development Framework (adopted 2011);
- North East Lincolnshire Council Local Plan 2013 to 2032 (Adopted 2018);
- North Kesteven District Council Central Lincolnshire Local Plan (Adopted 2017); and
- East Lindsey District Council Local Plan (Adopted 2018).

1.2.3 The North Lincolnshire Council Local Development Framework sets out the vision and overall development strategy for the Council's area and how it will be achieved for the period 2006 until 2026. Specific policies are highlighted in **Table 1**.

Table 1: Relevant NLC Local Planning Policies

Document	Policy / Guidance
North Lincolnshire Council Local	***Policy CS2: Delivering More Sustainable Development***

Document	Policy / Guidance
Development Framework	All future development in North Lincolnshire will be required to contribute towards achieving sustainable development. Developments should be constructed and operated using a minimum amount of non-renewable resources, including increasing the use of renewable energy in construction and operation. ***Policy CS18: Sustainable Resource Use and Climate Change*** The council will actively promote development that utilises natural resources as efficiently and sustainably as possible. This includes: Supporting the necessary improvement of flood defences and surface water infrastructure required against the actions of climate change and preventing development in high flood risk areas wherever practicable and possible. Meeting required national reductions of predicted CO2 emissions by at least 34% in 2020 and 80% in 2050 by applying the following measures on development proposals. Requiring all industrial and commercial premises greater than 1000 square metres to provide 20% of their expected energy demand from on-site renewable energy until the code for such buildings is applied nationally. Where developers consider these Codes and targets cannot be met on the basis of viability, they will be required to provide proof through open book discussions with the council at the planning application stage. Ensuring that development and land use in areas close to the Humber Estuary and rivers responds appropriately to the character of the area, in the interests of preserving and making best use of limited resources. Ensuring development and land use helps to protect people and the environment from unsafe, unhealthy and polluted environments, by protecting and improving the quality of the air, land and water. Supporting renewable sources of energy in appropriate locations, where possible, and ensuring that development maximises the use of combined heat and power, particularly at the South Humber Bank employment site and where energy demands for more than 2MW are required for development. Supporting new technology and development for carbon capture and the best available clean and efficient energy technology, particularly in relation to the heavy industrial users in North Lincolnshire, to help reduce CO2 emissions. Promote the use of a greenspace strategy and a green infrastructure plan, where applicable, which could help reduce the effects of climate change. ***Policy CS19: Flood Risk*** The council will support development proposals that avoid areas of current or future flood risk, which do not increase the

Document	Policy / Guidance
	risk of flooding elsewhere. This will involve a risk based sequential approach to determine the suitability of land for development that uses the principle of locating development, where possible, on land that has a lower flood risk, and relates land use to its vulnerability to flood. Development in areas of high flood risk will only be permitted where it meets the following prerequisites: It can be demonstrated that the development provides wider sustainability benefits to the community and the area that outweigh flood risk. The development should be on previously used land. If not, there must be no reasonable alternative developable sites on previously developed land. A flood risk assessment has demonstrated that the development will be safe, without increasing flood risk elsewhere by integrating water management methods into development. Development proposals in flood risk areas which come forward in the remainder of North Lincolnshire shall be guided by the Strategic Flood Risk Assessment for North Lincolnshire and Northeast Lincolnshire. This will ensure that proposals include site specific flood risk assessments which take into account strategic flood management objectives and properly apply the Sequential and, where necessary, Exception Tests. In addition, development will be required, wherever practicable, to incorporate Sustainable Urban Drainage Systems (SUDS) to manage surface water drainage. The Council will also seek to reduce the increase in flood risk due to climate change through measures to reduce carbon dioxide emissions.

1.2.4 The North East Lincolnshire Council Local Plan sets out the vision and overall development strategy for the Council's area and how it will be achieved for the period 2013 until 2032. Specific policies are highlighted in **Table 2**.

Table 2: NELC Local Planning Policies

Document	Policy / Guidance
North East Lincolnshire Council Local Plan	***Policy 33: Flood Risk*** Development proposals should have regard to the requirements of the flood risk sequential test and, if necessary, the exception test. The regeneration benefits of development in areas of high flood risk should also be considered in light of the Council's Guidance Note on the application of the Sequential and Exception Tests in North East Lincolnshire, and the Environment Agency's Standing Advice. In order to minimise flood risk impacts and mitigate against the likely effects of climate change, development proposals should demonstrate that:

Document	Policy / Guidance
	Where appropriate, a site-specific flood risk assessment has been undertaken, which takes account of the best available information related to all potential forms of flooding; There is no unacceptable increased risk of flooding to the development site or to existing properties; The development will be safe during its lifetime; Sustainable Drainage Systems (SuDS) have been incorporated into the development unless their use has been deemed inappropriate; Opportunities to provide natural flood management and mitigation through green infrastructure have been assessed and justified, based upon sound evidence, and, where appropriate, incorporated, particularly in combination with delivery of other aspects of green infrastructure in an integrated approach across the site; Arrangements for the adoption, maintenance and management of any mitigation measures have been established and the necessary agreements are in place; Access to any watercourse or flood defence asset for maintenance, clearance, repair or replacement is not adversely affected; and, The restoration, improvement or provision of additional flood defence infrastructure represents an appropriate response to local flood risk, and does not conflict with other Plan policies. ***Policy 34: Water Management*** Development proposals that have the potential to impact on surface and ground water should consider the objectives and programme of measures set out in the Humber River Basin Management Plan. Development proposals should consider how water will be used on the site and ensure that appropriate methods for management are incorporated into the design. Development proposals should demonstrate that: Adequate and sustainable water supplies are available to support the development proposed; Provisions are made for the efficient use of water, including is reuse and recycling. Proposals for residential development will be expected to demonstrate that a water efficiency standard of 110 litres per person per day can be achieved; and Adequate foul water treatment already exists or can be provided in time to serve the development. Appropriate and sustainable sewerage systems should be provided for the collection and treatment of foul and surface water to ensure new development does not overload the existing sewerage infrastructure, minimising the need to discharge water into sewers, particularly combined sewers. Where development is proposed within a Source Protection Zone, the potential for any risk to groundwater resources and groundwater quality must be assessed and it must be

Document	Policy / Guidance
	demonstrated that these would be protected throughout the construction and operational phase of development.

1.2.5 The Central Lincolnshire Local Plan sets out the vision and overall development strategy for the Council's area and how it will be achieved for the period 2012 until 2036. Specific policies are highlighted in **Table 3**.

Table 3: Relevant Central Lincolnshire Local Planning Policies

Document	Policy / Guidance
Central Lincolnshire Local Plan	***Policy LP1: A Presumption in Favour of Sustainable Development*** At the heart of the strategy for Central Lincolnshire is a desire to deliver sustainable growth. When considering development proposals, the Central Lincolnshire districts of West Lindsey, Lincoln City and North Kesteven will take a positive approach that reflects the presumption in favour of sustainable development contained in the National Planning Policy Framework. The districts will always work proactively with applicants to find solutions which mean that proposals can be approved wherever possible, and to secure development that improves the economic, social and environmental conditions in Central Lincolnshire. ***Policy LP14: Managing Water Resources and Flood Risk*** All development proposals will be considered against the NPPF, including application of the sequential and, if necessary, the exception test. Through appropriate consultation and option appraisal, development proposals should demonstrate: • That they are informed by and take account of the best available information from all sources of flood risk and by site specific flood risk assessments where appropriate; • That there is no unacceptable increased risk of flooding to the development site or to existing properties; • That the development will be safe during its lifetime, does not affect the integrity of existing flood defences and any necessary flood mitigation measures have been agreed with the relevant bodies; • That the adoption, ongoing maintenance and management of any mitigation measures have been considered and any necessary agreements are in place; • How proposals have taken a positive approach to reducing overall flood risk and have considered the potential to contribute towards solutions for the wider area; and • That they have incorporated Sustainable Drainage Systems (SuDS) into the proposals unless they can be shown to be impractical. Development proposals that are likely to impact on surface or ground water should consider the requirements of the Water Framework Directive.

Document	Policy / Guidance
	Policy LP18: Climate Change and Low Carbon Living Development proposals will be considered more favourably if the scheme would make a positive and significant contribution towards one or more of the following (which are listed in order of preference): • Reducing demand: by taking account of landform, location, layout, building orientation, design, massing and landscaping, development should enable occupants to minimise their energy and water consumption, minimise their need to travel and, where travel is necessary, to maximise opportunities for sustainable modes of travel; • Resource efficiency: development should (a) take opportunities to use sustainable materials in the construction process, avoiding products with a high embodied energy content; and (b) minimise construction waste; • Energy production: development could provide site based decentralised or renewable energy infrastructure. The infrastructure should be assimilated into the proposal through careful consideration of design. Where the infrastructure may not be inconspicuous, the impact will be considered against the contribution it will make; • Carbon off-setting: development could provide extensive, well designed, multi-functional woodland (and, if possible, include a management plan for the long term management of the wood resource which is produced), fenland or grassland. The Central Lincolnshire Biodiversity Opportunity Mapping (or subsequent relevant document) should be used to guide the most suitable habitat in a particular area. Proposals which address one or more of the above principles (whether in relation to an existing development or as part of a wider new development scheme) which are poorly designed and/or located and which have a detrimental impact on the landscape, the amenity of residents, or the natural and built environment, will be refused.

1.2.6 The East Lindsey District Council Core Strategy sets out the vision and overall development strategy for the Council's area and how it will be achieved up to 2031. Specific policies are highlighted in **Table 4**.

Table 4: Relevant ELDC Local Planning Policies

Document	Policy / Guidance
East Lindsey District Council Core Strategy	***Strategic Policy 2: Sustainable Development*** When considering development proposals the Council will take a positive approach that reflects the presumption in favour of sustainable development contained in the National Planning Policy Framework. It will always work proactively with applicants jointly to find solutions which mean that proposals can be approved wherever possible, and to secure development that improves the economic, social and environmental conditions in the area. Planning applications that accord with the policies in this Local Plan

Document	Policy / Guidance
	(and, where relevant, with polices in neighbourhood plans) will be approved without delay, unless material considerations indicate otherwise. ***Strategic Policy 16: Inland Flood Risk*** The Council will support development for business, leisure and commercial uses in areas of inland flood risk where it can be demonstrated that accommodating the development on a sequentially safer site would undermine the overall commercial integrity of the existing area. Such developments must incorporate flood mitigation measures in their design. The Council will not support development in identified flood storage areas. All new development must show how it proposes to provide adequate surface water disposal, including avoiding impacting on surface water flow routes or ordinary watercourses. The Council will expect this to involve the use of Sustainable Urban Drainage Systems along with other appropriate design features, including the retention of any existing water features on a site. Surface water connections to the combined or surface water system should only be made in exceptional circumstances where it can be demonstrated that there are no feasible alternatives and where there is no detriment to existing users. The Council will support improvements to the existing flood defences, the creation of new flood defences, infrastructure associated with emergency planning, washlands and flood storage areas. Where required by national planning policy development proposals in areas at risk of flooding must be accompanied by a site-specific flood risk assessment. ***Strategic Policy 17: Coastal East Lindsey*** The coastal policy applies to the following settlements: Addlethorpe, Anderby, Chapel St Leonards, Croft, Ingoldmells, Mablethorpe, New Leake, North Cotes, North Somercotes, Saltfleetby All Saints, Saltfleetby St Clements, Saltfleetby St Peter, Skegness, Skidbroook cum Saltfleet, South Somercotes, Sutton on Sea, Theddlethorpe All Saints, Theddlethorpe St Helen and Trusthorpe. The Council will give a high priority to development that extends and diversifies all-year round employment opportunities, contributes directly to the local economy, infrastructure or extends and diversifies the tourism market. The Council will support improvements to the existing flood defences, the creation of new flood defences and infrastructure associated with emergency planning. Development will need to demonstrate that it satisfies the Sequential and Exception Test as set out in Annex 2 of this Plan. All relevant development will need to provide adequate flood mitigation. ***Strategic Policy 27: Renewable and Low Carbon Energy*** Large-scale renewable and low carbon energy development, development for the transmission and interconnection of electricity, and infrastructure required to support such development, will be supported where their individual or cumulative impact is, when weighed against the benefits, considered to be acceptable. Water environment and water quality is one of these impacts.

Document	Policy / Guidance
	Strategic Policy 28: Infrastructure Infrastructure schemes will be supported provided they are essential in the national interest; contribute to sustainable development and respect the distinctive character of the district. Infrastructure schemes should be accompanied by an impact assessment that shows how the proposal impacts on the landscape or local setting of the area, including individual and cumulative effects. It should identify what steps have been taken to minimize its effects and the alternative options that have been considered. The Council will support the delivery of infrastructure where it contributes to sustaining local communities. The Council will only support proposals for development where it has been shown that adequate capacity is available or can be provided by the utility providers to meet the additional loads associated with serving the development.

1.3 Other Relevant Policy and Guidance

Local Flood Risk Management Strategies

1.3.1 The following strategies cover the pipeline route:

- North Lincolnshire Council Local Flood Risk Management Strategy;
- North East Lincolnshire Local Flood Risk Management Strategy; and
- Lincolnshire County Council Joint Lincolnshire Flood Risk and Water Management Strategy.

1.3.2 The vision of the NLC LFRMS is "to provide the necessary framework for fostering partnerships between Flood Risk Management Partners, particularly in delivering flood risk management schemes". The vision of the NELC LFRMS is "to identify the areas where we expect to face the greatest flood risks now and in the future to build resilience with the community to be better prepared for flooding". The vision of the Joint Lincolnshire Flood Risk and Water Management Strategy is "to manage the impact of flood risk to people, businesses and the environment across Lincolnshire".

1.3.3 Each of the strategies assess local flood risk (from surface water, groundwater and ordinary watercourses) within the boroughs and set objectives for managing the risk. The strategies detail mechanisms for achieving the objectives and seeks to reduce the risk of flooding.

Strategic Flood Risk Assessments

1.3.4 A Strategic Flood Risk Assessment (SFRA) provides the central source of all relevant flood risk information. An SFRA is required to initiate the sequential risk-based approach to the allocation of land for development in the Council's Local Plans and to identify whether the application of the Exception Test is likely to be necessary.

1.3.5 The North and North East Lincolnshire and East Lindsey (SFRA's indicate that the majority of flood risk in the region comes from the sea and tidal estuary, with the greatest risk developing when meteorological conditions create a surge to the tide. Tide locking (prevention of fluvial flow discharging due to high tide levels) is also a contributing flood risk factor on many watercourses that flow into the River Humber or North Sea. The West Lindsey SFRA indicates that the majority of flood risk in this region comes from the overflowing of watercourses.

Preliminary Flood Risk Assessments

1.3.6 In their roles as LLFAs, NLC, NELC and LCC have produced Preliminary Flood Risk Assessment (PFRA) reports to meet their statutory duties to manage local flood risk and deliver the requirements of the Flood Risk Regulations 2009. The Regulations require LLFAs, through the PFRA process, to determine whether there is a significant risk in their area based on local flooding (surface water, groundwater, ordinary watercourses and canals) and identify the part of the area affected by these risks.

1.3.7 The purpose of a PFRA report is to provide a strategic assessment of flood risk from local sources including surface water, groundwater, ordinary watercourses and canals. The reports are high-level exercises using readily available data held by the Councils and partnering organisations. The reports look at historical flood events and consider the potential future flood events that may have a significant consequence on human health, economic activity and the environment including cultural heritage.

Lincolnshire County Local Standards for Sustainable Drainage

1.3.8 The Lincolnshire County Council Sustainable Drainage Design and Evaluation Guide has been produced by a working group of 16 local authorities across England. This document forms the local standards for the Local Authorities and, together with the National Standards, strongly promotes the use of SuDS which help to reduce surface water runoff and mitigate flood risk.

1.3.9 The document indicates the minimum standards to ensure a satisfactory scheme is constructed under the Flood and Water Management Act 2010 (FMWA), although they are not intended to preclude any requirement for a higher standard that may be deemed necessary. Adherence to the standards set out in the document will ensure that the Local Authority is willing to maintain the new systems on completion.

1.3.10 Local principles and requirements include:

1. The developer should consider all sources of flood risk both to and from the proposed development, and good sustainable drainage solutions, as an integrated design approach. Lincolnshire County Council, as highway and lead local flood authority (HFA), will then provide a combined response in line with its statutory duties;
2. The distribution and layout of buildings and infrastructure on site can greatly influence the potential for creating flood pathways and affect flood risk to property. A number of hierarchical key stages and steps should be taken to reflect the principles and strategic objectives of the development and establish appropriate infrastructure prior to proceeding to the outline and detailed design stages; and
3. Early consideration of infrastructure requirements is essential, and close discussion with potential adopting authorities is necessary to guide integrated planning and ensure effective ongoing maintenance arrangements.

Building Standards Regulations 2000 Part H

1.3.11 The Building Standards Regulations 2000 Part H requires that surface water runoff be preferentially discharged first to soakaway, then to surface watercourse and finally to sewer.

1.4 References

Ref 1 Humber River Basin District FRMP

Ref 2 Anglian River Basin District FRMP

Ref 3 Grimsby and Ancholme CFMP

Ref 4 Louth Coastal CFMP

Ref 5 Flamborough Head to Gibraltar Point SMP

Ref 6 North Lincolnshire Council Local Development Framework

Annex C Technical Note

VikingCCS

Viking CCS Pipeline

9.26 Breach Water Level Depth Technical Note – Revision A (Clean)

Document Reference: EN070008/EXAM/9.26

Applicant: Chrysaor Production (U.K.) Limited,
a Harbour Energy Company
PINS Reference: EN070008
Planning Act 2008 (as amended)
The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2)(q)
Date: July 2024

Harbour Energy | AECOM

Technical Note

Project name Viking CCS Pipeline	**Project number** 60668955	**Client** Harbour Energy	**Subject** Breach Flood Water Depth Analysis
Date June 2024	**Issued by** AECOM	**Reason for issue** Additional Information for Environment Agency	**Prepared by** Jo Somerton Becci Ward
Checked by Peter Robinson Cathryn Spence Claire Storer	**Approved by** Michael Williams		

1. Introduction

The Environment Agency provided comments with regards the Viking CCS Flood Risk Assessment (FRA) in the Statement of Common Ground which include the following:

"Table 15: The level of flood risk is unclear as this paragraph states average breach depths rather than potential maximum breach depths (2006 0.5% and 0.1% breach maximum depths are greater), and

Table 18: Climate change: the level of flood risk is unclear as this paragraph states average breach depths rather than potential maximum breach depths (2006 0.5% and 0.1% breach maximum depths are greater)".

Following further discussions with the Environment Agency on 7th March 2024 it was agreed that AECOM would provide further details as to how the breach flood depths for the current day and climate change scenarios have been derived to inform the FRA.

This technical note outlines the methodology used to establish the use of average maximum flood depths across the sites rather than the maximum breach flood water depths within the sites.

This Technical Note was updated in June 2024 in response to Environment Agency comments on the previous version issued as part of the Examination Timetable Deadline 2 submission where they noted it is helpful that breach depths were used to derive a breach flood level at Immingham and that this would be useful for the Theddlethorpe Facility sites also. The Environment Agency noted that proposed mitigation and freeboard could then be related to levels expressed in m AOD. This update, has as requested, derived approximate breach flood levels for the two Theddlethorpe Facility sites.

2. Environment Agency Breach Water Depths

In June 2023 the Environment Agency, as part of an additional data request from AECOM, provided the breach flood water depth modelling outputs from the 2010 Northern Area Tidal Modelling Study for the Immingham and Theddlethorpe Facility locations. The breach flood water depths were compared against ground levels for the same areas from the Digital Terrain Model (DTM).

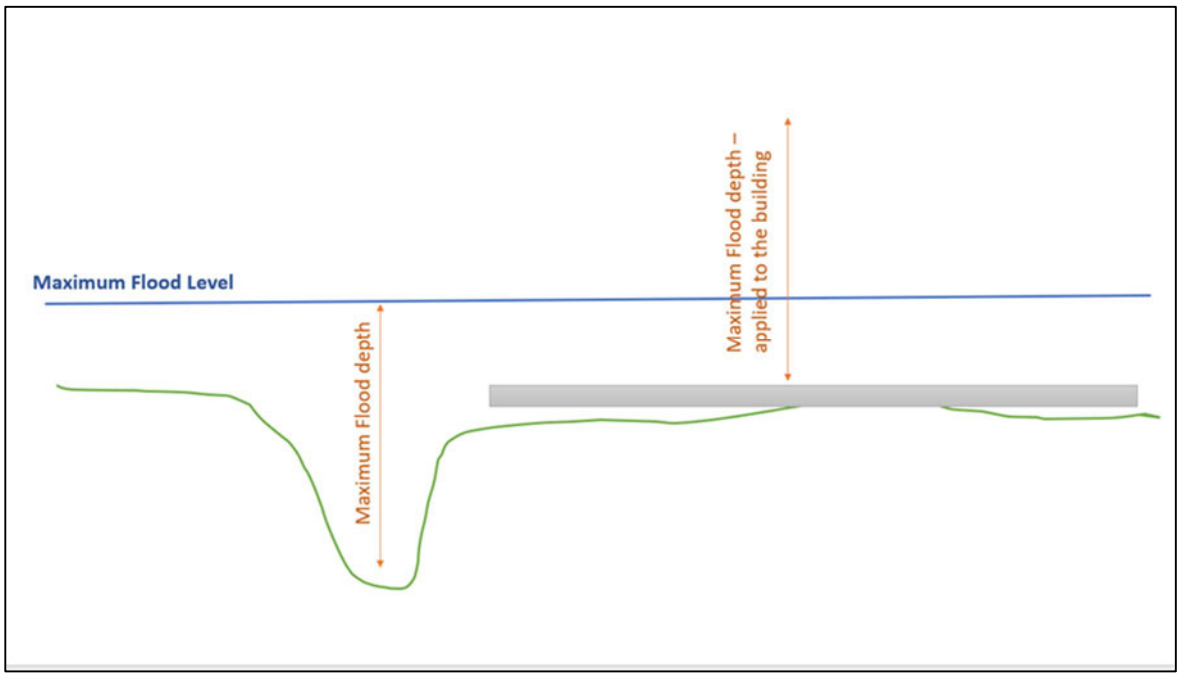
The modelled breach flood depths for the Yr 2115 in the 2010 Northern Area Tidal Modelling Study are based on the current standard of protection provided by the tidal flood defences. No allowance has been included for the raising of the flood defences in line with climate change.

3. Breach Water Depth Analysis

The DTM used in the EA breach model is on a coarse grid and not directly comparable to the current LIDAR DTM for the site. It has, therefore, not been possible to derive the maximum flood levels at the sites. Undulations in the underlying DTM mean that in some places the modelled flood depth is artificially high and not representative of the typical maximum flood depth at the sites.

Analysis of the breach flood water depth modelling output indicated that the maximum flood depths in the 2010 Northern Area Tidal Modelling Study were generated in the areas of lowest topography within the site boundaries. The Sites for the proposed Facilities are generally flat, therefore small areas of low topography were generating artificially high flood depths when applied to the average site topographic level and, therefore, were not representative of breach flood water levels across the site. Figure 3-1 shows how the maximum flood depth, when applied to the average site level can overestimate the breach flood water level.

Figure 3-1. Application of the Maximum Flood Depth



Average (maximum) breach flood depths were therefore calculated for the modelled present day (2006) and climate change (2115) scenarios.

3.1 Immingham Facility

The proposed Immingham Facility is located at the northern end of the Scheme on an area of disused land to the south of the VPI Immingham site. The existing land comprises a gravelled area with sparse vegetation cover.

Ground levels within the Immingham Facility site range from a minimum of 2.45m AOD towards the east to a maximum of 5.48m AOD along the site periphery to the west in proximity to the railway embankment. The site therefore generally slopes from west to east.

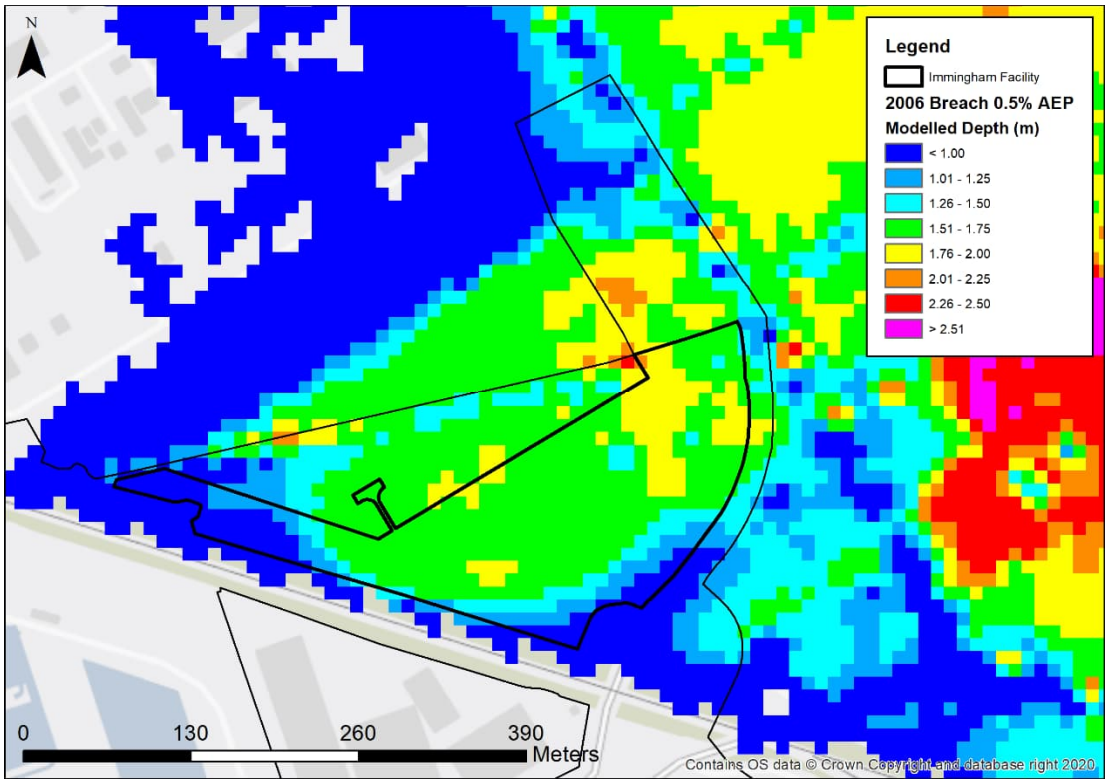


Figure 3-2. Maximum Flood Depths 0.5% AEP Breach Model – Immingham Facility

Table 3.1 Flood Depth Statistics for Immingham

Breach Event Scenario	Average Ground Level (m AOD)	Minimum Depth (m)	Average Depth (m)	Maximum Depth (m)
Immingham Breach 200	3.294	0.398	1.517	2.013
Immingham Breach 1000		0.530	1.812	2.309
Immingham Breach 200CC		1.071	3.033	3.534
Immingham Breach 1000 CC		1.168	3.253	3.755

Figure 3-2 shows that the majority of flooding at the Immingham Facility for a 0.5% AEP breach flood event has a depth between 1.5m – 1.75m and a smaller area has a depth between 1.75m – 2.0m, with small isolated areas outside this range. The other events show a similar pattern, with the range between minimum and maximum depth across the site dependent on the underlying topography as is expected the breach flood level (m AOD) will be reasonably consistent across the site.

The calculated average depth was validated for the 0.1% AEP climate change event by checking against the flood depths at locations across the site highlighted in yellow in Figure 3-3 as shown in Table 3.3. Whilst there is a range of modelled depths the approximate equivalent water level is similar across the site, ranging from 6.2 to 6.3m AOD. The equivalent derived flood level using the average depth is similar, and slightly higher, and thus the average depth provides a suitable basis to inform mitigation for the scheme and the required facility levels in relation to existing ground levels. Specific design levels will be derived during later stages of design when the building positions have been fixed.

Table 3.3 Flood Depth Checks - Immingham

Point location	Modelled Depth (m)	Model Ground Level (m AOD)	Derived approximate water level (m AOD)
13143	2.69	3.61	6.3
12899	3.47	2.74	6.2
11815	3.02	3.32	6.3

Point location	Modelled Depth (m)	Model Ground Level (m AOD)	Derived approximate water level (m AOD)
11667	3.47	2.78	6.3
11522	3.45	2.85	6.3
11622	3.56	2.64	6.2
11600	3.49	2.74	6.2
Average	*3.25*	*3.29*	*6.5*

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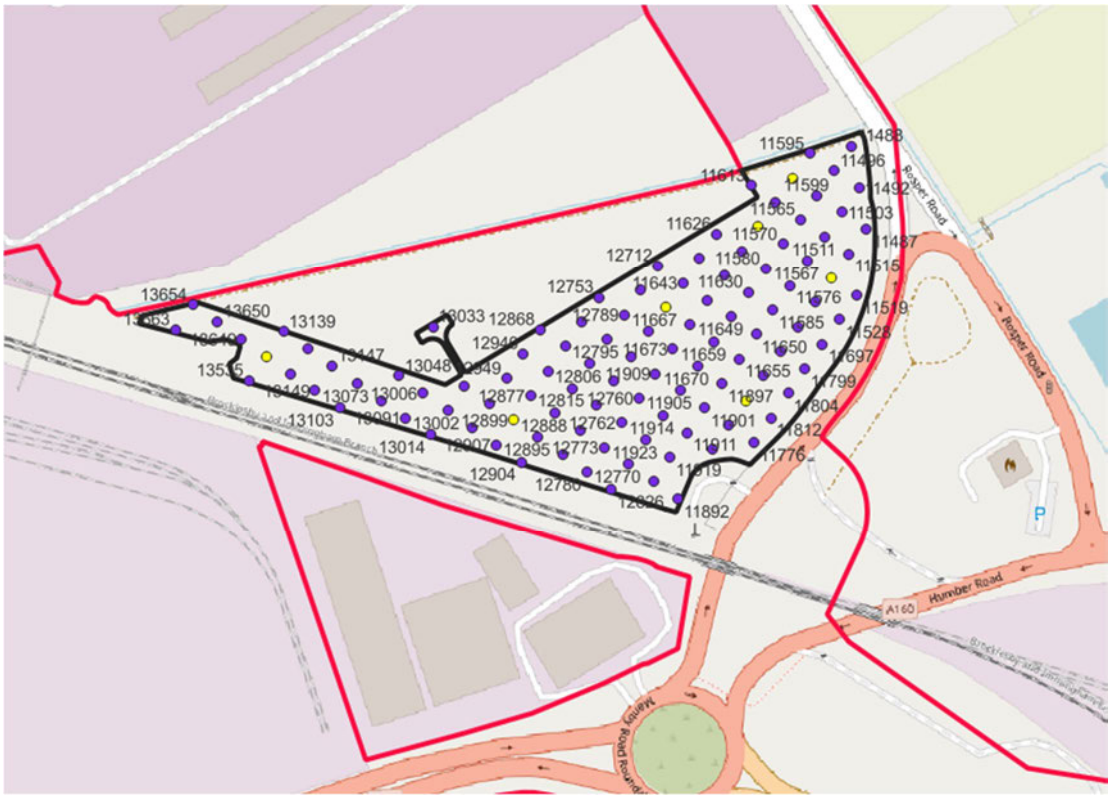


Figure 3-3 Flood depth validation points

3.2 Theddlethorpe Facility

There are currently two options for locating the Theddlethorpe Facility. Further details are provided below.

3.2.1 Theddlethorpe Facility – Option 1

The first site option for the proposed Theddlethorpe Facility is located on the former Theddlethorpe Gas Terminal site. The site is currently cleared with a mixture of hard standing, stoned areas and pipeline stubs.

Ground levels within the Site are generally flat and range from a minimum of 1.66m AOD to a maximum of 2.4m AOD towards the western and southern site area.

Figure 3-4. Maximum Flood Depths 0.5% AEP Breach Model – Theddlethorpe Facility Option 1

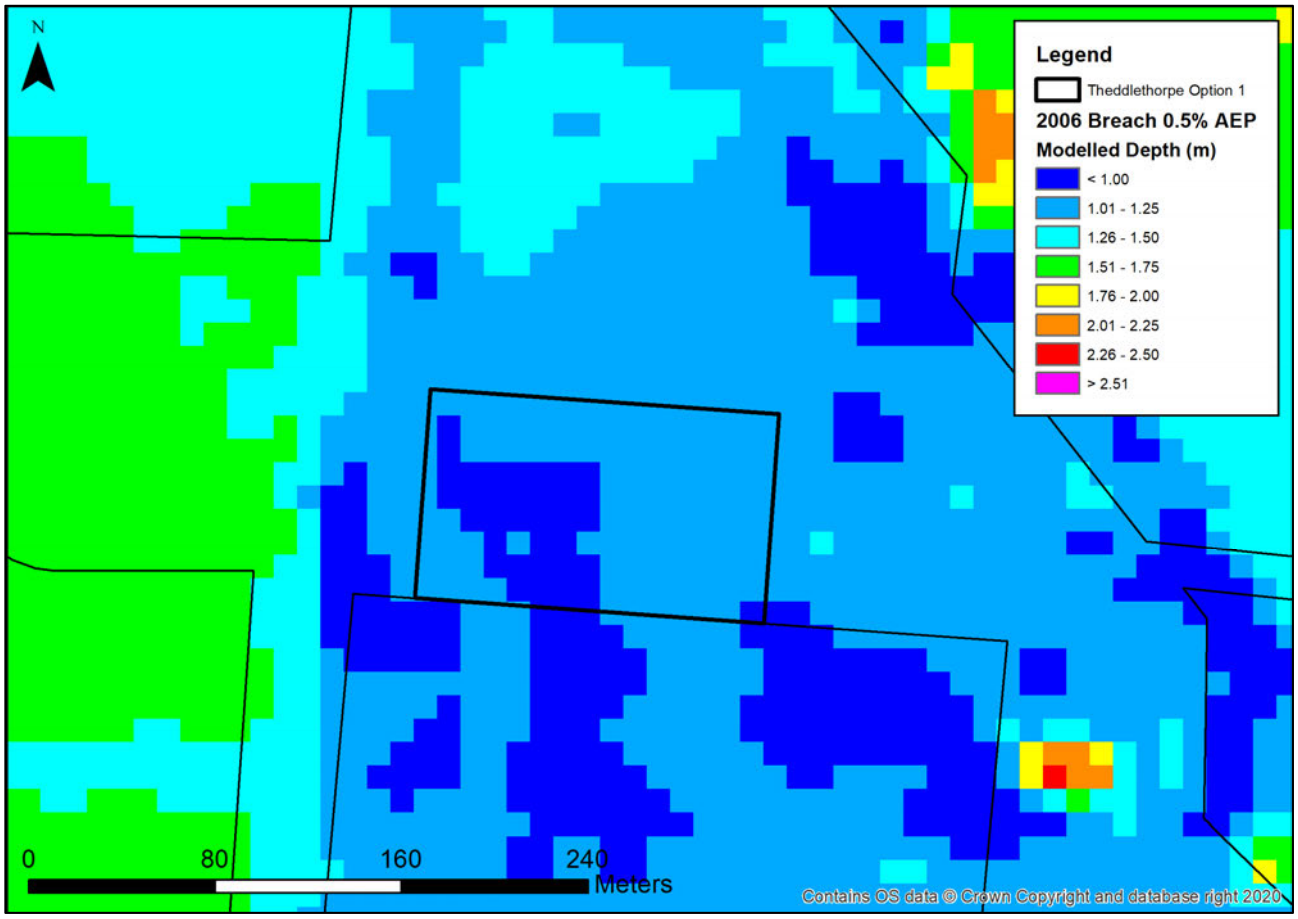


Table 3.4 Flood Depth Statistics for Theddlethorpe Option 1

Column heading	Average Ground Level (m AOD)	Minimum Depth (m)	Average Depth (m)	Maximum Depth (m)
Theddlethorpe1 Breach 200	2.052	0.880	1.051	1.174
Theddlethorpe1 Breach 1000		0.993	1.162	1.288
Theddlethorpe1 Breach 200CC		1.441	1.608	1.739
Theddlethorpe1 breach 1000CC		1.561	1.729	1.865

Figure 3-4 shows that the majority of flooding at Theddlethorpe Facility (Option 1) for a 0.5% AEP breach flood event has a depth between 1.01m – 1.25m or lower, with an average depth of flooding calculated as 1.05m, as presented in Table 3.4. The maximum modelled flood depth at the Theddlethorpe Facility (Option 1) is not significantly higher at 1.17m associated with a localised topographic low point in the southern and eastern area of the Site. This is the same for all the modelled events with a small difference (<150mm) between the average and maximum depth across the site. It is likely that this low point will be lost through development of the Site, should this option be taken forward. This demonstrates that the average flood depth value provides an appropriate estimate for the typical maximum flood depth on which to base the assessment of mitigation.

The calculated average depth was validated for the 0.1% AEP climate change event by checking against the flood depths at locations across the site highlighted in yellow in Figure 3-5 as shown in Table 3.5. Whilst there is a range of modelled depths the approximate equivalent water level is similar across the site, ranging from 3.6 to 3.9m AOD. The equivalent derived flood level using the average depth is similar and thus the average depth provides a suitable basis to inform mitigation for the scheme and the required facility levels in relation to existing ground levels. Specific design levels will be derived during later stages of design when the building positions have been fixed.

Flood depth checks were carried out using LIDAR DTM 2022 at 1 metre resolution, downloaded 28 June 2024.

Table 3.5 Flood Depth Checks - Theddlethorpe Facility Option 1

Point location	Modelled Depth (m)	Model Ground Level (m AOD)	Derived approximate water level (m AOD)
2	1.79	1.99	3.8
11	1.83	1.98	3.8
13	1.68	2.15	3.8
15	1.64	2.02	3.7
24	1.82	2.12	3.9
26	1.67	2.10	3.8
34	1.71	1.93	3.6
Average	*1.73*	*2.05*	*3.8*

Figure 3-5. Flood depth validation points based on LIDAR data

3.2.2 Theddlethorpe Facility – Option 2 (No longer included in the DCO application)

Please note that this option is only included for completeness as the work was undertaken before the ExA had accepted the change request which has subsequently removed Theddlethorpe Facility Option 2 from the Proposed Development and DCO.

The second site option for the Theddlethorpe Facility is located to the west of the former Theddlethorpe Gas Terminal site, located on arable land directly west of The Cut.

Ground levels within the Site are generally flat and range from a minimum of around 1.3m AOD towards the east to a maximum of around 2.0m AOD to the west.

Figure 3-6. Maximum Flood Depths 0.5% AEP Breach Model – Theddlethorpe Facility Option 2

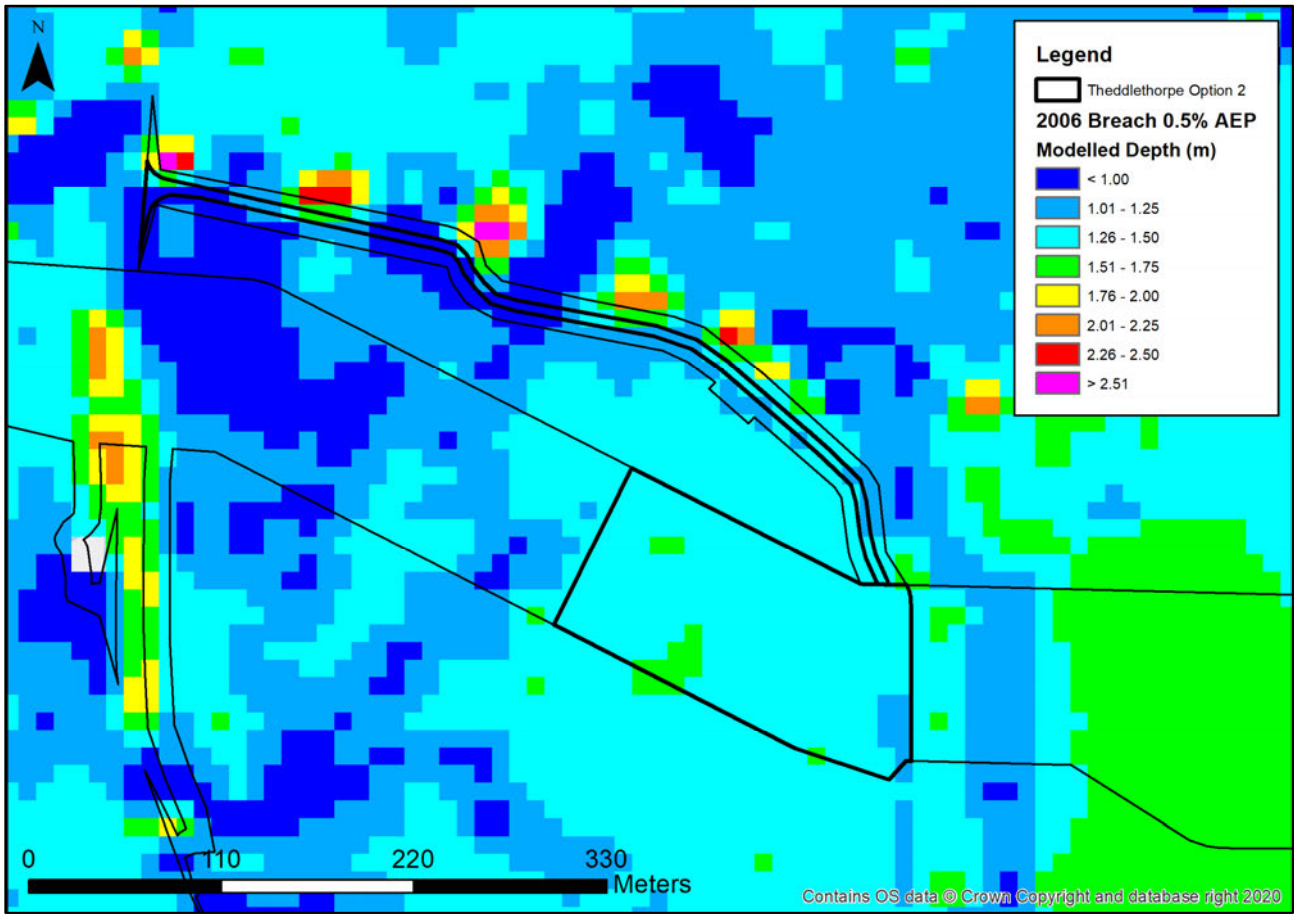


Table 3.6 Flood Depth Statistics for Theddlethorpe Option 2

Breach Event Scenario	Average Ground Level (m AOD)	Minimum Depth (m)	Average Depth (m)	Maximum Depth (m)
Theddlethorpe 2 Breach 200	1.497	1.148	1.421	1.517
Theddlethorpe2 Breach 1000		1.267	1.539	1.635
Theddlethorpe 2 Breach 200CC		1.706	1.979	2.075
Theddlethorpe 2 Breach 1000CC		1.789	2.060	2.152

Figure 3-6 shows that the majority of flooding at Theddlethorpe Facility (Option 2) for a 0.5% AEP breach flood event has a depth between 1.26m – 1.5m, with an average depth of flooding calculated as 1.42m, as presented in Table .6. The maximum modelled flood depth at the Theddlethorpe Facility (Option 2) is higher at between 1.51m and 1.75m, however this flood depth is localised to a small number of isolated topographic low points. As for Theddlethorpe (Option 1) there is only a small difference between the calculated average and maximum depth across the site (<100mm) and therefore the average depth provides a good estimate of the typical maximum flood depth on which to base the assessment of mitigation.

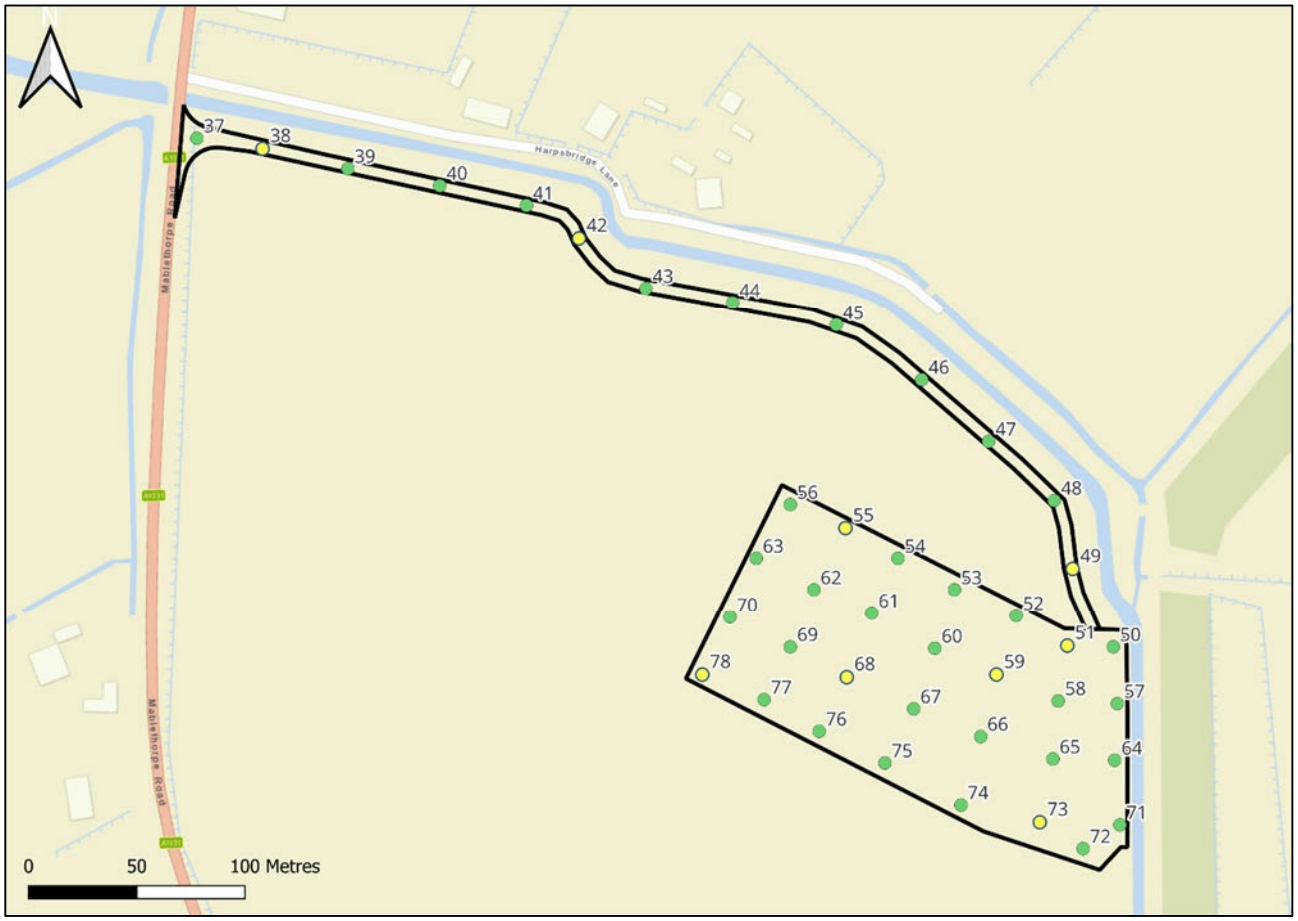
The calculated average depth was validated for the 0.1% AEP climate change event by checking against the flood depths at locations across the site highlighted in yellow in Figure 3-7 and shown in Table 3.7. Whilst there is a range of modelled depths the approximate equivalent water level is similar across the site, ranging from 3.3 to 3.6m AOD. The equivalent derived flood level using the average depth is at the upper end of this range and thus the average depth provides a suitable basis to inform mitigation for the scheme and the required facility levels in relation to existing ground levels. Specific design levels will be derived during later stages of design when the building positions have been fixed.

Flood depth checks were carried out using LIDAR DTM 2022 at 1 metre resolution, downloaded 28 June 2024.

Table 3.7 Flood Depth Checks - Theddlethorpe Facility Option 2

Point location	Modelled Depth (m)	Model Ground Level (m AOD)	Derived approximate water level (m AOD)
38	1.50	1.84	3.3
42	1.62	1.78	3.4
49	1.90	1.73	3.6
51	1.95	1.53	3.5
55	2.12	1.45	3.6
59	2.07	1.52	3.6
68	2.12	1.42	3.5
73	2.11	1.45	3.6
78	2.02	1.46	3.5
Average	*2.06*	*1.50*	*3.6*

Figure 3-7. Flood depth validation points based on LIDAR data



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