The Keadby Next Generation Power Station Project

Document Ref: 6.3

Planning Inspectorate Ref: EN0110001

The Keadby Next Generation Power Station Development Consent Order [year]

Environmental Statement (ES)

Volume II – Appendix 12A Flood Risk Assessment (Redacted)

The Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure Regulations 2009 – Regulation 5(2)(e) The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017'

Applicant: Keadby Next Generation Limited

Date: August 2025

Version: V0

Document History

Document Ref	6.3.16 / Appendix 12A
Issue	V0
Document Owner	AECOM

Glossary

Abbreviation/	Description
AEP	Annual Exceedance Probability
AGI	Above Ground Installation
AIL	Abnormal Indivisible Load
AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Survey
CCGT	Combined Cycle Gas Turbine
CEMP	Construction Environmental Management Plan
CFL	Critical Flood Level
CFMP	Catchment Flood Management Plan
CIRIA	Construction Industry Research and Information Association
CRT	Canal and River Trust
DCO	Development Consent Order
DEMP	Decommissioning Environmental Management Plan
DESNZ	Department for Energy Security and Net Zero
EA	Environment Agency
ES	Environmental Statement
FRA	Flood Risk Assessment
GPP	Guidance for Pollution Prevention
kV	Kilovolt

Abbreviation/	Description
LLFA	Lead Local Flood Authority
LWS	Local Wildlife Site
MAGIC	Multi-agency geographical information for the countryside
MW	Megawatt
NLC	North Lincolnshire Council
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
NTS	Non-Technical Summary
PINS	Planning Inspectorate
PFRA	Preliminary Flood Risk Assessment
PPG	Planning Practice Guidance
PWS	Private Water Supply
SAC	Special Area of Conservation
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
RBMP	River Basin Management Plan
WFD	Water Framework Directive

Contents

Plates

Tables

Annexes

Figures

12A. Flood Risk Assessment

12A.1. Overview

12A.1.1. This Flood Risk Assessment (FRA) has been prepared by AECOM Limited ('AECOM') on behalf of Keadby Next Generation Limited ('the Applicant') which is a subsidiary of SSE plc. It forms part of the application for a Development Consent Order (DCO) ('the Application'), that has been submitted to the Secretary of State (the 'SoS') for Energy Security and Net Zero under Section 37 of 'The Planning Act 2008' ('the 2008 Act').

12A.1.2. The Applicant is seeking development consent for the construction, operation and maintenance of a new combined cycle gas turbine ('CCGT') electricity generating station on land at, and in the vicinity of, the existing Keadby Power Station, Trent Side, Keadby, Scunthorpe DN17 3EF ('the Site').

12A.1.3. The Proposed Development is an alternative to Keadby Carbon Capture and Storage (CCS) Power Station ('Keadby CCS Power Station'), which was consented on 29th December 2022 under the 2008 Act. This is to enable the Applicant to pivot to whichever decarbonisation pathway (CCS or hydrogen) becomes technically and commercially viable at the Site first.

12A.1.4. The terms of reference used to describe the Proposed Development in this report are broadly consistent with those defined within Chapters 1-20 of the Environmental Statement (ES) (**Volume I, Application Document Ref. 6.2**) and illustrated on **ES Report Volume III Figure 3.3**: Indicative Parts of the Site Plan (**Application Document Ref. 6.4**) reproduced in **Plate 12A.1** for ease of reference. Further details of the Proposed Development are provided in Section 12A.5 of this FRA.

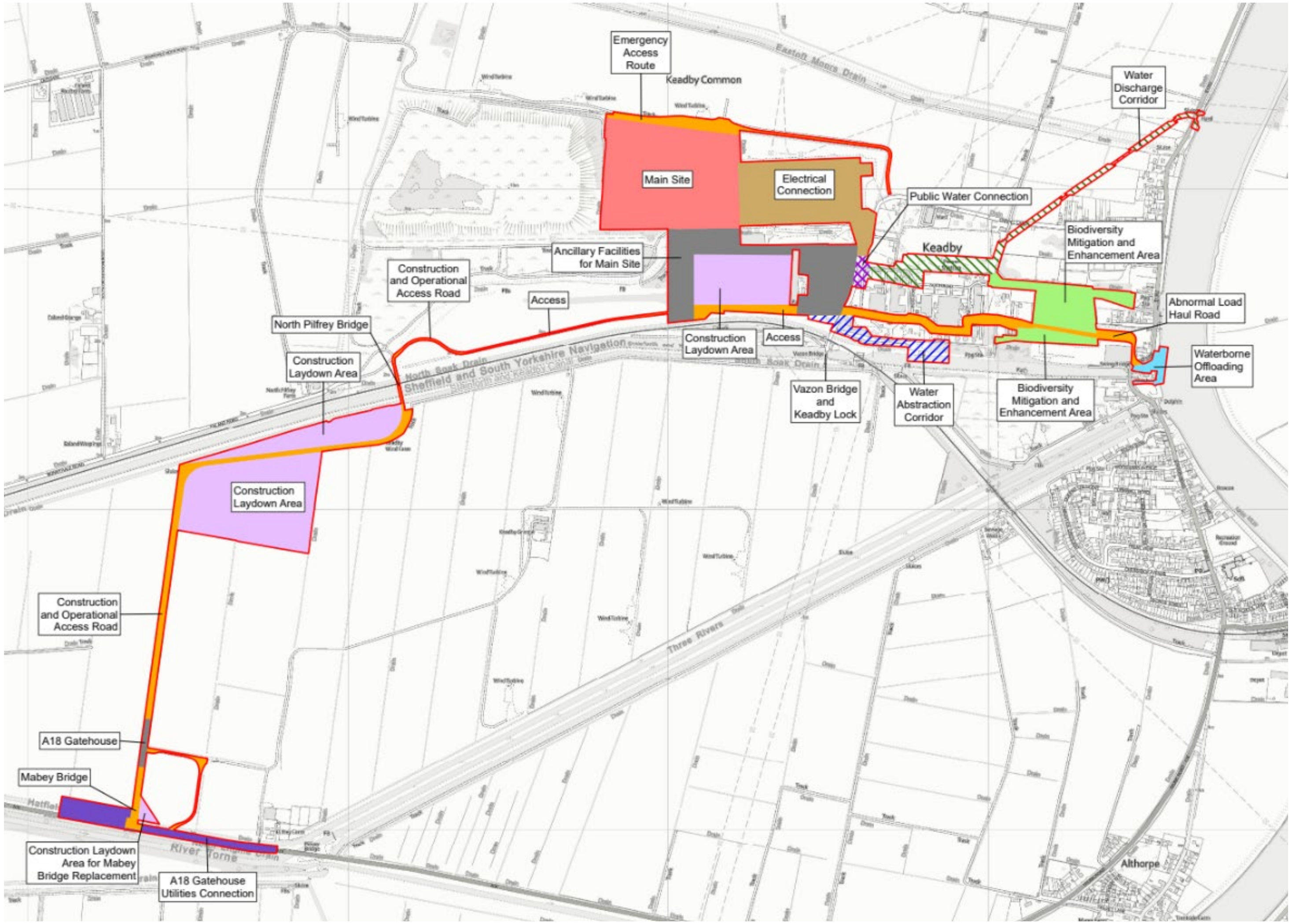


Plate 12A.1: Indicative Parts of the Site Plan (reproduced from Figure 3.3 (ES Report Volume III))

12A.2. The Purpose and Scope of this Document

12A.2.1. The 'Flood Map for Planning' (Environment Agency (EA), 2025) (**ES Volume III Figure 12.3:** Fluvial and Tidal Flood Risk (**Application Document Ref. 6.4**) shows that the Site and surrounding land is almost entirely within Flood Zone 3. Flood Zone 3 is defined by the National Planning Policy Framework (NPPF) Planning Practice Guidance (PPG): Flood risk and coastal change (Ministry of Housing, Communities and Local Government, 2022), as *'land with a high probability of flooding i.e. >1% Annual Exceedance Probability (AEP) (1 in 100 or greater annual chance) of river flooding, or a >0.5% AEP (1 in 200 or greater annual chance) of flooding from the sea'*. These definitions do not take account of flood defences.

12A.2.2. The 2022 North and North East Lincolnshire Strategic Flood Risk Assessment (SFRA) defines the Site within the Tidal Flood Zone 3a. It is not defined within Flood Zone 3b (functional floodplain), land where water has to flow or be stored in times of flood, as the Site does not act as a functional floodplain due to existing EA defences and other well established drainage infrastructure which prevent natural flooding from occurring.

12A.2.3. As the Site comprises an area in excess of one hectare (ha) and is located within Flood Zone 3, an FRA is required to accompany the DCO Application, in line with the requirements of NPS EN-1 (2024) Paragraph 5.8.13.

12A.2.4. This document comprises an FRA that is appropriate to the nature and scale of the Proposed Development and meets the necessary requirements of current planning policy (NPS EN-1 and the NPPF), to support the DCO Application for the Proposed Development. This FRA presents the current understanding of the likely impact of flooding on the Proposed Development and the potential impacts of the Proposed Development on flood risk elsewhere. The following has been undertaken:

- review of the Scoping Opinion (**ES Volume II Appendix 1A (Application Document Ref. 6.3)**) including relevant comments received from the EA, North Lincolnshire Council (NLC), the Isle of Axholme and North Nottinghamshire Water Level Management Board (the local internal drainage board (IDB)), the Canal and River Trust (CRT) and Severn Trent Water (STW) in regard to the flood risks posed to the Site; the necessary measures that would be required to protect the Proposed Development from flooding or to mitigate potential impacts of the Proposed Development on flood risk in the area; and the scope of the FRA (refer to **Table 12A.2**);

- further consultation with the EA, CRT and NLC regarding the Proposed Development and approach to the FRA (refer to **Table 12A.2**);
- review of publicly available data to determine the flood risks associated with all sources of flooding including the Humber Estuary, main rivers, ordinary watercourses (including those under the jurisdiction of the IDB), groundwater, artificial sources, surface water runoff/ overland flow and drainage and surrounding areas;
- review of relevant information prepared for the Keadby CCS Power Station FRA (AECOM, 2021) as remains relevant to the Proposed Development;
- tidal flood modelling, including breach modelling, to assess flood risks to the Proposed Development, and potential impacts of the Proposed Development on flood risk in the area;
- review of the drainage strategy for the Proposed Development; and
- review of the Proposed Development design in light of the identified flood risks and identification of measures, where necessary, that would manage any residual flood risk to the Site to acceptable levels.

12A.2.5. It is expected that further consultation will be undertaken to inform the final FRA.

12A.3. Data Sources

12A.3.1. The baseline conditions for the Site were established through a desk-based study and reference to the FRA prepared for the Keadby CCS Power Station project. This information has been used to inform the assessment made within the FRA. Data collected during the course of this assessment is detailed in **Table 12A.1**.

Table 12A.1: Data Sources to inform this FRA

Purpose	Source	Comments
Identification of hydrological features	Ordnance Survey (OS) mapping (2024)	Identifies the position of the Site and local hydrological features.
Historical Land Use and Hydrological Features	Historic OS maps dating from 1842-	Identifies historical land use change and hydrological features.

Purpose	Source	Comments
	1952 (Ordnance Survey, 2024)	
Identification of Existing Flood Risk	Flood Map for Planning (EA, 2025)	Identifies potential fluvial/ tidal inundation extents.
	Risk of Flooding from Rivers and Sea map (EA, 2025)	Identifies potential fluvial/ tidal flood risk, including climate change.
	Risk of Flooding from Surface Water map (EA, 2025)	Identification of indicative flood risk from surface water and small watercourses, including climate change.
	Flood Inundation Mapping (EA, 2024)	Provides information on the potential risk of flooding from reservoirs (artificial sources).
	North and North East Lincolnshire SFRA (North East Lincolnshire Council, 2022)	Assesses potential flood risk across the NLC boundary area. Includes potential flood risk from fluvial/tidal, sewers, overland flow and groundwater.
	North Lincolnshire Preliminary Flood Risk Assessment (PFRA) (NLC, 2017)	
	NLC Local Flood Risk Management Strategy (LFRMS) (NLCl, 2016)	

Purpose	Source	Comments
	British Geological Survey (BGS) (2024) records	Provides details of geology and hydrogeology in the vicinity of the Site.
	EA Tidal Trent model and data (Jacobs, 2023)	Provides information on fluvial and tidal flood risk from the River Trent and tributaries. Provides data to support the hydraulic modelling undertaken for this FRA.
	EA Torne model and data (Capita AECOM, 2017)	Provides information on fluvial flood risk from the River Torne and tributaries.
Identification of Historical Flooding	SFRA	Provides details of recorded historical flooding.
	PFRA	
	EA (2024) Historic Flood Map	
Details of the Proposed Development	Indicative Parts of the Site Plan referred to in **ES Volume III Figure 3.3 (Application Document Ref. 6.4)**	Provides layout of the Proposed Development.

12A.4. Consultation with Key Stakeholders

12A.4.1. Consultation responses received (via the Scoping Opinion and PEIR consultation) from the Planning Inspectorate, EA, STW, CRT, IDB and

NLC have been reviewed for this FRA. The consultation comments and associated responses are summarised in **Table 12A.2**.

Table 12A.2 Consultation for the FRA

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
Planning Inspectorate (PINS) Scoping Opinion, June 2024	Where the construction phase has been scoped in on the basis that significant effects could occur, this suggests that there is potential for significant effects to occur during the decommissioning phase. Where it is assumed that the effects of decommissioning are likely to be similar to or no worse than the effects from construction, this should be justified. The ES should provide a proportionate description of the activities and works which are likely to be required to decommission the Proposed Development or extend its operational life, and the anticipated duration. Where significant effects are likely to occur as a result of works to decommission the Proposed Development or extend its operational life, these should be described and assessed in the ES.	The final FRA considered the potential effects of decommissioning on flood risk.
	As the Flood Risk Vulnerability Classification for development and need to apply particular tests (according to the Government's Flood risk and coastal change Planning Practice Guidance) differs according to the Flood Zones in which a development is to be located, the description within the ES of the baseline flood risk for the Proposed Development should distinguish between Flood Zones 3a and 3b.	The FRA distinguishes between Flood Zones 3a and 3b.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	Para 6.5.1.4 states that historical data indicates that the Site is not at risk from groundwater flooding based on the geological setting of the wider area encompassed by Keadby 1 and Keadby 2 Power Stations, but also that groundwater flooding is currently understood to be effectively managed via a well-developed drainage system serving these power stations. The latter statement appears to suggest that there is a risk of groundwater flooding. This should be clarified in the ES.	This is clarified in the FRA.
	No reference is made in the report to the relationship between the River Don and the Stainforth and Keadby Canal, which is fed by the Don. The Applicant is referred to the comments of the EA (Appendix 2 of this Opinion) in relation to potential changes in flow levels of the canal as a result of the Proposed Development and potential impacts arising from that. Neither does the Report reference the risk of flooding from the canal due to excess flows from the River Don. The ES should consider such impacts and include an assessment of significant effects where they are likely to occur and propose suitable mitigation.	Further consultation has been undertaken with the CRT and potential impacts on flows and levels in the Keadby Canal and River Don is discussed in the FRA.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	Should use be made of cofferdams in the Stainforth and Keadby Canal during construction of the proposed abstraction infrastructure the ES should consider potential impacts on water flow and provide an assessment where significant effects are likely to occur.	The impacts of these on flood risk has been assessed in the FRA.
	Anglian Water should be consulted in addition to the bodies highlighted within this section of the Report in relation to baseline data and the scope of the assessment.	Anglian Water confirmed the Proposed Development lies outside the Anglian Water statutory sewerage area. No other comments made relating to flood risk.
Severn Trent Plc Scoping response email, June 2024	There are sewers within the Site.	Flooding from sewers is not likely to present a significant flood risk to the Proposed Development compared with tidal and fluvial flooding.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
Severn Trent Plc Scoping response email, June 2024	Request for clarification as to whether the Proposed Development will have any impact on the pumping station at Chapel Lane.	The pumping station is outside the Red Line Boundary for the Proposed Development and will not be impacted by the Proposed Development.
North Lincolnshire Council Scoping response May 2024	No comments made relating to flood risk	N/A
North Lincolnshire Council Targeted consultation on Site Boundary	The FRA should be updated to reflect this new modelling [EA national flood mapping, 2025] and associated outputs from the updated Flood Map for Planning. It is also recommended that the latest surface water flood mapping be incorporated, as this provides higher spatial resolution and a	The FRA has been updated with reference to the latest EA flood mapping. Flood risk mitigation for the proposed development is described in Section 12A.10.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
changes April 2025	more accurate understanding of surface water flow routes and the potential for surface water flooding across the site. In addition, the updated NAFRA2 datasets while not appropriate for site-specific planning indicate flood depths of up to 1.2 metres under both low and medium risk scenarios, further underlining the need for robust mitigation.	
North Lincolnshire Council Targeted consultation on Site Boundary changes April 2025	The development is located within 500 metres of the River Trent and within the Isle of Axholme, as acknowledged within the submitted FRA. The North Lincolnshire Strategic Flood Risk Assessment clearly states that all new development within the Isle of Axholme must be set above the critical flood level of 3.8 metres AOD, with an additional 300 millimetres of freeboard, to ensure resilience. The FRA notes that critical infrastructure will be raised above this threshold where practically possible, with manned workspaces designed to be located above modelled flood depths. While this approach is noted, the LLFA would expect all critical infrastructure and manned buildings to be situated above the critical flood level as standard, and for this to be justified in full where deviations are proposed. Additional mitigation measures should also be incorporated to manage residual flood risk and improve long-term	The SFRA references the critical flood level in relation to residential development. The Proposed Development is ‘essential infrastructure’. No specific guidance is provided in the SFRA in relation to other types of development. Mitigation principles appropriate to the operational needs of the Proposed Development (refer Section 12A.10) have been discussed with the EA and tidal breach modelling has been

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	resilience across the site. The LLFA is supportive of the measures proposed in Sections 12A.9.21 and 12A.9.22 of the PEIR FRA.	completed to inform the proposals.
North Lincolnshire Council Targeted consultation on Site Boundary changes April 2025	It is further noted that this proposal forms part of a wider green energy scheme, including a future carbon capture facility and a large-scale solar development. In combination, these elements are likely to have a significant impact on local hydrology, particularly through the introduction of new impermeable areas and potential changes to existing land drainage patterns. There is potential for consequential impacts affecting residents in Keadby and surrounding villages.	The Proposed Development is not related to any large scale solar development in the local area and is an alternative to the previously consented Keadby CCS Power Station (located on the same plot of land). An outline drainage strategy for the Proposed Development has been prepared (refer Section 12A.9). The Proposed Development does not lead unacceptable impacts that would require strategic interventions.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
North Lincolnshire Council Targeted consultation on Site Boundary changes April 2025	Given the strategic nature of the development and its alignment with regional green growth objectives, the LLFA considers flood resilience to be a priority issue. Investment in improved drainage and strategic flood defences as part of this scheme would benefit not only the development site but also the wider area, supporting future growth while protecting existing communities and infrastructure. The LLFA would welcome discussions with the applicant regarding opportunities for collaboration and investment in local flood management and resilience programmes.	Improvements in wider drainage and flood defence infrastructure are not included in the development proposals and are therefore not a matter for consideration in the FRA.
North Lincolnshire Council Targeted consultation on Site Boundary changes April 2025	From a drainage perspective, the LLFA is unable to provide detailed comments at this stage due to the absence of a formal drainage design. A comprehensive surface water drainage strategy will be required, clearly demonstrating how flows across and beyond the site will be managed, with appropriate hydraulic modelling in place. This strategy should account for a range of design storm events and incorporate upper-end allowances for climate change for both the 1 in 30yr and 1 in 100yr events. Furthermore, the LLFA expects the inclusion of Sustainable Drainage Systems (SuDS) as discussed in the FRA, to support flow control, enhance water quality, and deliver long-term sustainability benefits across the site.	An Outline Drainage Strategy has been prepared for the DCO Application and is provided in Annex 3 of this FRA (refer to Section 12A.9). Approval of the detailed drainage design by North Lincolnshire Council will be secured by a Requirement of the **Draft DCO** (**Application Document Ref. 3.1**).

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
Anglian Water Services Scoping response May 2024	Confirmation the Proposed Development lies outside the Anglian Water statutory sewerage area. No other comments made relating to flood risk.	N/A
Canal & River Trust Scoping response May 2024	CRT state the Stainforth & Keadby Canal is fed from the River Don and excess flows could lead to increased risk of flooding downstream. The CRT consider the FRA should include consideration of the potential flood risk from the navigation. This could include level checks and a full assessment made of existing flood protection along the canal.	Flood risk from the canal is considered in the FRA. Refer subsequent consultation below.
Canal & River Trust	CRT state that the use of coffer dams in the Stainforth & Keadby canal to facilitate construction of abstraction equipment may affect water flows and the impact may require some assessment.	The FRA considers impacts on flood risk relating to coffer dams or other construction works.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
Scoping response May 2024		
Canal & River Trust PEIR Statutory consultation February 2025	References the comments made in the Scoping Response. Confirms the CRT has no issues in principle provided these matters are considered as the scheme is developed further. Recommends further consultation.	These matters are considered in the FRA and further consultation has taken place with the CRT as noted below.
Canal & River Trust Consultation April 2025	The CRT confirmed: - The canal is isolated from the Don during periods of floods however it does receive uncontrolled discharges from the local runoff. These are typically managed through the canal system to discharge at Keadby lock and maintain water levels within a set range. Flood inundation from the canal is not expected to pose any significant risk to the Proposed Development Site. - Agreement that the cofferdam / abstraction structure is unlikely to have any significant impact on flood risk from the canal as the	The FRA includes assessment of the potential effects of the coffer dam and the works to Keadby Lock gate to support the abstraction. Any further mitigation works are outside of the scope of the DCO and therefore not a matter for this FRA.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	intrusion into the channel is reasonably small. CRT referenced recent modelling completed for another project in the area which showed a significant channel constriction is necessary to have any significant impact in increased flood risk. If increased overtopping were to occur (deemed unlikely), the North and South Soak drains would help to divert flows away, although it is noted the railway lies between the canal and the North Soak Drain. - A brief, qualitative assessment of the potential effect of the cofferdam will be sufficient for the FRA. - CRT is separately working with SSE to investigate works required to Keadby lock gate to support the abstraction and any associated mitigation works.	
Environment Agency Scoping response May 2024	The EA notes the proposed operation period of 25 years however states a design period of 75 years should be used to assess the potential impacts of climate change and to inform relevant flood mitigation measures.	The FRA has assessed the likely "extended" operation period (currently estimated at 35 years) and 75 years as requested by the EA.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
Environment Agency Scoping response May 2024	The EA state the FRA will need to consider breach; overtopping and climate change scenarios.	These have been assessed in the FRA.
Environment Agency Scoping response May 2024	The EA state that the decommissioning phase should be scoped into the assessment as the level of flood risk to the development will increase over its lifetime; therefore there will need to be consideration of this within the FRA, to ensure decommissioning works do not increase flood risk on site or elsewhere.	The FRA considers the potential effects of decommissioning on flood risk.
Environment Agency Scoping response May 2024	The FRA should include suitable flood risk mitigation measures, considering the safety of the site users. The occupation and operation of the site will need to be confirmed, in order to establish necessary on-site refuge and safe evacuation of the site in the event of a flood event.	Flood risk mitigation measures appropriate to the operation of the site are detailed in the FRA and have been discussed with the EA.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
Environment Agency Scoping response May 2024	We would encourage early discussion with the EA in terms of the scope and requirements of the FRA, as well as availability and requirements for flood modelling and climate change assessments. The EA provided summary information on the latest EA modelling of the Tidal Trent (Jacobs, 2023). Of note, the EA state the Tidal Trent modelling did not include a H++ scenario but that this was included in the Humber Extreme water Levels (HEWL) (Jacobs, 2021) and may be used to inform the assessment. The EA acknowledged it may be appropriate to use existing modelling carried out for this site if it uses the most up to date information or it can be demonstrated that it is conservative with respect to the Tidal Trent modelling.	Further consultation with the EA has been undertaken (see below). The FRA includes assessment of the H++ scenario.
Environment Agency Scoping response May 2024	The EA holds modelling of the North and South Soak Drains and Three Rivers (2017). The EA states that for the most part the proposed site is outside the defended modelled flood extents however it is important to note this modelling uses older DP09 climate change uplifts. The EA does not hold any modelling data for the Keadby Boundary Drain or Eastoft Moors Drain.	The FRA includes assessment of flood risk associated with these watercourses.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	The EA states the highest flood levels at the site are driven by the Tidal Trent, particularly in a breach scenario. Whilst any proposed development platform is likely to be well above flood levels for these watercourses it is important to demonstrate the Proposed Development will not have an adverse effect on flood risk for these watercourses.	
Environment Agency Consultation Meeting November 2024	- EA confirmed the FRA approach generally aligns with EA expectations, adopting a precautionary approach as improvements to the Trent defences, whilst expected, has not been assumed. - Confirm expectation that a 75 year design life should be assessed. - Confirmed the Torne model likely provides a better representation of fluvial flood risk from the Torne / Three Rivers system than the 2023 Trent model and provides a suitable basis for the FRA - EA requested the AECOM 2023 tidal breach model is updated to account for the latest Trent flood levels. Confirmed bespoke tidal flood modelling is not necessary across the southern part of the Site (south of the canal)	The FRA assesses the 75 year design life. The AECOM breach model has been updated to provide assessment of defended and breach tidal flood scenarios, using the latest Trent flood levels and informs the FRA. The FRA includes assessment of the H++ scenario. Mitigation principles have been taken forward as detailed in Section 12A.10.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	- EA confirmed modelling of the H++ / Credible maximum climate change scenario is not necessary however the FRA should include alternative assessment. - EA confirmed expectation the mitigation principles developed for Keadby CCS Power Station will be taken forward. - EA confirmed an expectation that off-site impacts of the Proposed Development should be no greater than previously presented for Keadby CCS Power Station.	
Environment Agency PEIR Statutory Consultation February 2025	- The FRA provides insufficient detail regarding construction and operation procedures for staff requirements in the event of a flood. Flood mitigation measures set out for the site will need to ensure that staff required on site during a flood event would remain safe. Please consult with the Lead Local Flood Authority (LLFA) in regards to flood evacuation plans. - Full details of the proposed replacement of Mabey Bridge have not been submitted. The proposed replacement structure will need to be clear span and have no adverse impact on flood flows and depths. A Flood Risk Activity Permit (FRAP) will also be required. Full detail on the design and construction methodology of the structure will be required as part of this. - Culverting, infilling and access bridges on non-main river watercourses have not been fully detailed in the FRA. Full detail	Further information is provided in the FRA regarding staffing on site. A flood risk management / evacuation plan will be developed for the Proposed Development. NLC has not responded to consultation requests regarding this matter to inform this FRA. Preliminary design information is available for Mabey Bridge, a clear-span structure, and informs the FRA.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	of these works should be included within the FRA, with reference to the relevant consenting procedures with other risk management authorities. As with structures on main river watercourses, the applicant should provide full design and construction details for any infrastructure proposed on watercourses within the site. This should confirm that there will be no adverse impact on flood flows and extents. Any proposed crossings should be designed so that the soffit level of any bridges sits above the design flood level. The design flood level for permanent crossings in this case would be the 1% (1 in 100) annual exceedance probability (AEP) plus higher central climate change scenario. - The impact of the remaining land raising in the defended 0.5% (1 in 200) annual exceedance probability higher central and upper climate change scenarios for 2121 should be quantified by presenting water level difference maps within the Flood Risk Assessment. If the plan is to leave any land raising in place, then associated compensatory flood storage should be sought to mitigate any impacts on flood risk to third parties. - The FRA will need to fully address the Sequential Test, in order to show that the development is appropriately located, as referred to in Section 2.4.3 (*of the PEIR FRA*). However, further	The FRA references in-filled drains. Details of other watercourse crossings are not available, however the FRA considers potential impacts. Subsequently confirmed with the EA that modelling and the 1% AEP design standard is not required. Residual land raising is considered in the updated modelling, including flood depth difference maps (refer to Annex 2) and the FRA (refer to Section 5). EA subsequently confirmed compensatory flood storage is not required, and alternative mitigation is only required if off-site impacts are deemed unacceptable.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	detail is required to evidence robust site selection, in relation to flood risk. This could be supported by appropriate mapping. - In line with National Planning Practice Guidance, climate change should be assessed for a 75-year period. - Flood mitigation measures for the site, and for critical elements of the development will be subject to further flood modelling work. However, the principles set out for resistance and resilience in the FRA are acceptable. We recommend that flood evacuation procedures are developed for the site. Where the site is proposed to be remain operational, confirmation should be given of number of staff on site, and how they would remain safe. Emergency access to and from the site during a flood event will also need to be considered. Please consult with the Lead Local Flood Authority on this matter. - It is recommended that areas of the site, where staff may be required to remain for operational reasons during a flood event, should be mitigated in the same manner as critical operational infrastructure. - The FRA should fully detail off site impacts to flood levels resulting from the development……. we would not accept any further increase in offsite flood levels.	Further information is provided on site selection in relation to the Sequential Test. A 75 year period has been assessed in the FRA. Mitigation measures are described in Section 12A.10. Further information is provided in the FRA regarding staffing on site. A flood risk management / evacuation plan will be developed for the Proposed Development. NLC has not responded to consultation requests regarding this matter to inform this FRA. Off-site impacts are detailed in the FRA and accompanying model report. Impacts are typically less than shown for Keadby CCS Power Station.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	- The AECOM 2023 breach model should use boundary conditions from the latest EA Tidal Trent model. - EA confirmed general agreement to climate change allowances identified in the FRA; confirmed the EA Tidal Trent model reflects the latest available model data for the Trent but provides a conservative and precautionary assessment of fluvial flood risk from the Three Rivers (Torne).	Updated tidal flood modelling has been completed. EA Torne model data has been used to assess fluvial risk for the FRA where the Trent model data is overly conservative.
Environment Agency Consultation meeting March 2025	The following matters were discussed: - Agreement that the EA Torne model provides the best representation of fluvial flood risk across the study area and that further fluvial modelling is not necessary due to limited interaction with the Proposed Development. - Agreement that modelling of watercourse crossings, and design to the 1% AEP plus climate change event, is not necessary but the FRA should demonstrate no significant impact to 3rd party property. - EA requested assessment of the tidal 2121 event (from the EA 2023 Tidal Trent model) to consider the effect of residual land raising over a 100 year time horizon. If modelling shows impacts to 3rd party properties greater than shown for Keadby CCS Power Station there may be a requirement for appropriate	The FRA references the Torne model data. The FRA includes qualitative assessment of watercourse crossings. The updated tidal modelling includes assessment of the 2121 event (refer Section 12A.8). A **Schedule of Other Consents and Licences** (**Application Document Ref. 5.4)** accompany the DCO application which will set out all other

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	mitigation but this need not be via compensation storage. Alternatively there may be a mechanism to impose a requirement to assess the position at a later stage (as defence improvements are anticipated in line with the Humber strategy). - EA confirmed storm surge modelling is not required. - EA requested a permits and consents strategy is developed. - AECOM confirmed the FRA will propose to secure preparation of a flood management / evacuation plan via a DCO requirement.	consents and licences outside the DCO.
Environment Agency Targeted consultation on Site Boundary changes April 2025	EA noted that additional Site areas as well as the wider scheme will need to avoid compromising the integrity of structural flood defences and ensure access is not precluded for future maintenance.	The area of land added into the Site boundary along the riverfront is only to enable the Applicant to use an existing access road and an existing mooring point for secure vessels using the existing wharf to the north during construction. No physical works are proposed. The area of land around Mabey Bridge has been widened slightly – the red line was previously drawn on the existing

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
		bridge edges but as the deck of the replacement bridge will be slightly wider the red line has been slightly expanded to allow for this. The EA asset dataset shows 'natural high ground' in this area. The preliminary design information indicates existing ground levels are unchanged.
Environment Agency Consultation meeting June 2025	A meeting was held to discuss the tidal flood modelling undertaken for the DCO: • EA expressed general agreement to the modelling approach as presented (EA will undertake a model review). • EA expressed general agreement to the adequacy of the mitigation measures as presented: Raised development platforms are flood free in all modelled events, with over 1m freeboard to critical infrastructure and >300mm freeboard to administration & control buildings. A18 gatehouse (lies outside the model extent) is occupied on an ad-hoc basis. Land raising is not proposed but safe refuge	Further details of the modelling are provided in the FRA and accompanying modelling report (Section 12A.8 / Annex 2). Ditches which are to be filled in are identified and included in the modelling.

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
	will be provided (e.g. upper floor) with the building designed to withstand water flows. • EA confirmed the 3rd party impacts shown by the modelling are reasonable. These are broadly comparable and slightly better than previously shown for Keadby CCS Power Station. EA requested information on the scale of change compared with existing flood depths to be included in the FRA. • Project team confirmed no modelling is being completed for Mabey Bridge, with the FRA referencing existing EA model data. • EA requested further information on culverting and in-filling for non-main rivers. As design information is not available the EA advised this could be secured via a DCO commitment and principles could be agreed. Culverting should be avoided and impact on flood risk and ecology reduced.	
Isle of Axholme and North Nottinghamshire	The response confirmed the Site is located within the Board's district and there are a number of Board maintained watercourses in	The FRA will consider flood risk implications of potential works

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
Water Level Management Board Scoping response May 2024	proximity to the Site that have the potential to be impacted by the development. The response highlights the need for the Board's consent to works affecting the watercourses, including increases in flow or volume discharging to Board maintained watercourses (specific works requiring consent are detailed in the response).	affecting Board maintained watercourses. The requirement for consents is noted.
Isle of Axholme and North Nottinghamshire Water Level Management Board PEIR Statutory Consultation February 2025	The response confirmed the Site is located within the Board's district and there are a number of Board maintained watercourses in proximity to the Site that have the potential to be impacted by the development. The response highlights the need for the Board's consent to works affecting the watercourses, including increases in flow or volume discharging to Board maintained watercourses (specific works requiring consent are detailed in the response). The Board noted consent would only be granted where proposals are not detrimental to the flow or stability of the watercourse or culvert, or the Board's machinery access. The Board noted surface run-off rates to receiving watercourses must not be increased.	The **Schedule of Other Consents and Licences** (**Application Document Ref 5.4**) acknowledges the requirement for IDB consent for works affecting IDB-maintained watercourses. IDB-maintained watercourse are shown on **ES Volume III Figure 12.5:** Internal Drainage Board Assets **(Application Document Ref. 6.4**). Works affecting IDB-maintained watercourses are anticipated to comprise construction of the Emergency

Consultee and date of consultation	Summary of consultee responses	How comments have been addressed
		Access bridge over Drain 1 (Glew Drain), construction and operation of a surface water discharge into Drain 1, works to improve an existing access track (for use as an Emergency Access) which crosses Drain C and Drain D, and potential 400kV cable laying in the vicinity of Drain B. The Outline Drainage Strategy [Section 12A.9 / Annex 3] sets out the proposed approach to surface water drainage including attenuation to ensure an acceptable runoff rate.

12A.5. The Proposed Development and Site Description

Location

12A.5.1. The Site is located within the wider Keadby Power Station site, to the west of Keadby 2 Power Station. The Site is approximately centred on national grid reference (NGR) 482351, 411796. **ES Volume III Figure 1.1:** Site Location Plan **(Application Document Ref. 6.4**) shows the site location.

12A.5.2. The Site comprises land which is entirely within the administrative area of NLC. The Keadby Power Station site currently encompasses the operational Keadby 1 Power Station and Keadby 2 Power Station, both owned and under control of SSE plc.

12A.5.3. The main area of the Site is bordered by the tidal River Trent to the east, by Stainforth and Keadby Canal to the south, by agricultural land and Keadby Wind Farm to the north, and by the former Keadby Ash Tip and scrubland to the west. The Site access road crosses the land south of the canal to join the A18. The Site is surrounded by numerous drains.

The Proposed Development

12A.5.4. The Proposed Development is an alternative to Keadby CCS Power Station, which has previously been consented under the 2008 Act, to enable the Applicant to pivot to whichever decarbonisation pathway (CCS or hydrogen) becomes technically and commercially viable at the Site first.

12A.5.5. The Proposed Development would comprise a high efficiency gas fired power station with an electrical output capacity of up to 910MWe and associated buildings, structures and plant and other associated development defined in Schedule 1 of the **Draft DCO** (**Application Document Ref. 3.1**) as Work Nos. 1-11 and shown on the **Works Plans** (**Application Document Ref. 2.3**). The Proposed Development will include the following elements:

- a new-build CCGT electricity generating station fuelled by hydrogen and/or natural gas with a power output of up to 910MW (**Work No. 1**) including:
  - a CCGT plant;
  - cooling infrastructure;
  - natural gas and hydrogen blending equipment;

  - supporting facilities including administration and control buildings, workshops, storage buildings, effluent treatment facilities, fire water storage tank(s), demineralised water treatment plant including storage tank(s), and permanent laydown areas for operation and maintenance activities;

- a hydrogen supply pipeline, including a gas compound for the hydrogen supplier's apparatus and a hydrogen gas compound for the Applicant's apparatus (**Work No. 2**);
- a natural gas supply pipeline including a compound for the natural gas supplier's apparatus and a natural gas compound for the Applicant's apparatus (**Work No. 3**);
- electrical connection works for the export and import of electricity to and from the generating station and the existing 400kV National Grid Electricity Transmission (NGET) substation located adjacent to the Keadby Power Station site, including works within the substation (which would be undertaken by NGET) (**Work No. 4**);
- water supply connection works to provide cooling and make-up water to the generating station, including intake structures and an underground and/or overground water supply pipeline running between the generating station and the Stainforth and Keadby Canal (**Work No. 5**);
- connections to and use of an existing outfall and associated pipework for the discharge of used cooling water, surface water and treated effluent to the River Trent (**Work No. 6**);
- public water connection pipeline from a new connection on Chapel Lane to provide potable water to the generating station (**Work No. 7**);
- new permanent access to the generating station (**Work No. 8**), comprising:

  - maintenance and improvement of an existing private access road from the A18, including replacement of a private bridge (Mabey Bridge) (**Work No. 8A**);
  - installation of layby and gatehouse with barriers, enclosures, drainage and lighting north of the A18 junction (**Work No. 8B**) and associated utilities connections (**Work No. 8C**); and
  - emergency access route comprising the maintenance and improvement of an existing private track running between the generating station and Chapel Lane and including new private bridge crossing over Glew Drain (**Work No. 8D**);

- temporary construction and laydown areas (**Work No. 9A**);

- maintenance and improvement of the existing access routes running between the A18 and construction laydown areas (**Work No. 9B**); and between Skew Bridge adjacent to the A18 and a temporary construction laydown area associated with Mabey Bridge replacement (**Work No. 9C**);
- retention, maintenance and improvement and subsequent removal of existing temporary haul route from the Waterborne Transport Offloading Facility (**Work No. 9D**) and the inspection and repair of the existing wharf, and temporary placement of mobile cranes including the temporary oversailing of crane arms (**Work No. 9E**); and
- landscaping and biodiversity enhancement measures (**Work No. 10**);
- an allocation of land to meet the requirements of the Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013 (**Work No. 11**).

12A.5.6. To the extent that it does not form part of any of the above works, further associated development within the meaning of the Planning Act 2008 is proposed and has been assessed within this ES comprising:

- surface water drainage systems, including works to existing drainage systems;
- electrical, gas, potable water supply, foul water drainage and telecommunications infrastructure connections and works, and works to alter the position of such services and utilities connections;
- hard standings and hard landscaping;
- soft landscaping, including bunds and embankments;
- external lighting, including lighting columns;
- closed circuit television cameras and columns and other security measures;
- site establishment and preparation works, including site clearance, demolition works, earthworks and excavations; land raising; temporary construction access; alteration of services and utilities; and works for the protection of buildings and land;
- temporary construction laydown areas and contractor facilities, including materials and plant storage and laydown areas; generators; concrete batching facilities; vehicle and cycle parking facilities; pedestrian and cycle routes and facilities; offices and staff welfare facilities; security fencing and gates; external lighting; roadways and haul routes; wheel wash facilities; and signage;
- vehicle parking, including secure cycle storage facilities;

- accesses, roads and pedestrian and cycle routes;
- security fencing and boundary treatment; and
- temporary works associated with the maintenance of the authorised development.

12A.5.7. Further details of the Proposed Development are set out within **ES Volume I Chapter 4**: The Proposed Development **(Application Document Ref. 6.2**). The areas of the Site described above are shown in **ES Volume III Figure 3.3:** Indicative Parts of the Site Plan **(Application Document Ref. 6.4**) and an indicative Layout of the CCGT is included as **ES Volume III Figure 4.1:** Indicative Layout of Main Site and Ancillary Facilities **(Application Document Ref. 6.4**).

12A.5.8. The Main Site will contain the core infrastructure components associated with the CCGT unit including a gas turbine and associated generator, heat recovery steam generator, selective catalytic reduction equipment, cooling infrastructure, hydrogen and natural gas reception facilities, natural gas and hydrogen blending equipment, stack for the discharge of flue gas, emissions monitoring systems, transformers, chemical storage facilities, and facilities required in connection with the above.

12A.5.9. Ancillary Facilities associated with the Main Site will be located to the south and south-east of the Main Site. The Ancillary Facilities will include a gatehouse, security building and staff parking, permanent plant laydown area for operation and maintenance activities, admin, control and stores buildings and a surface water drainage system.

12A.5.10. The remaining areas of the Site are designated for temporary Construction Laydown Areas; Access routes; Water Discharge and Abstraction Corridors; Biodiversity Mitigation and Enhancement; Electrical Connections (including the existing National Grid substation); and Waterborne Transport Offloading Area.

12A.5.11. Cooling water will be sourced from the Stainforth and Keadby Canal with a new intake structure constructed within the canal. Treated effluent will be discharged to the River Trent using existing assets and pipework associated with Keadby 1 and Keadby 2 Power Stations. Available information indicates the abstraction structure will intrude around 5m into the canal, with a similar design to the existing structure for Keadby 2. A temporary cofferdam and working area will be required to construct the intake structure. The total working area will extend around 20m into the canal with the cofferdam anticipated to intrude around 10m into the canal over an approximate 12m length.

12A.5.12. It is expected that the Keadby Lock Gate crest level will be raised to facilitate the abstraction. This work will be completed by CRT. Details are not yet confirmed however it is anticipated the new crest level will be set closer to the maintained water level in the canal (an increase of around 200mm), thereby reducing flow over the lock gate and increasing the water available for abstraction.

12A.5.13. The preferred option for discharge of surface water is to a drain managed by the IDB. An alternative discharge route is also proposed (following segregation, attenuation and treatment), should this be required, via the existing Water Discharge Corridor used for Keadby 1 and Keadby 2 Power Stations.

Operation and staff numbers

12A.5.14. The facility will be designed to operate up to 24 hours per day, 7 days per week with programmed offline periods for maintenance.

12A.5.15. Operation of the Proposed Development is anticipated to create approximately 50 full-time operational roles.

12A.5.16. Plant operative staff will typically work on a two 12-hour shift pattern and administrative staff will typically work an office-hour pattern.

12A.5.17. Temporary and contractor employees associated with maintenance activities would also be employed as required. The maximum number of staff on Site at any one time is anticipated to be 41, generally working from the administration and control buildings although some staff may be working within the wider plant areas. During a significant flood event, when the Site may be evacuated, it is anticipated around 10 staff would be required remain on Site to maintain safe operation.

Access

12A.5.18. The main access to the Site during construction and operation would be via the existing access road from the A18. The existing perpendicular and skewed access points off the A18, which were built for construction vehicles during construction of Keadby Wind Farm and used during the construction of the Keadby 2 Power Station, would be used to access the Site. It is proposed that the perpendicular access point (Mabey Bridge) which crosses the Hatfield Waste Drain will be replaced. The skewed access point will only be used during this replacement work. The design of the new bridge is anticipated to be a clear-span crossing with a higher soffit level than the existing structure.

12A.5.19. A secondary access (both pedestrian and vehicular) from the Main Site will be available onto Chapel Lane which will be used as an emergency access route. This route will comprise the maintenance and improvement of an existing private track running between the Main Site and Chapel Lane, and will include a new crossing over Drain 1 to the north of the Main Site. The emergency access will be gated, and under normal operation this gate will be closed and unmanned.

12A.5.20. An additional construction access route is proposed for Abnormal Indivisible Loads (AIL). This route commences at the Waterborne Transport Offloading Area, crosses a short section of the B1392 and then incorporates an existing temporary haul road that runs to the east of PD Port Services freight yard, through an agricultural field (owned by the Applicant). The additional AIL route then crosses the existing hardstanding 'Outage' car park and into the existing Keadby Power Station Site.

Design life

12A.5.21. Construction of the Proposed Development could (subject to the necessary consents being granted and an investment decision being made) start in 2027. Assuming an approximate three and a half year construction programme followed by a period of commissioning, the Proposed Development is unlikely to commence commercial operation before 2030.

12A.5.22. The design life of the Proposed Development is approximately 25 years from the completion of construction. At the end of operation, it is expected that the Proposed Development will have some residual life remaining and an investment decision would then be made based on the market conditions prevailing at that time. Such a scenario may give rise to a greater operational lifetime, currently estimated around 35 years. As a precautionary approach, as advised by the EA, this FRA also considers a potential design life of 75 years. For the purposes of this FRA and determination of appropriate climate change allowances the following dates have been assumed:

- Start of construction: 2027
- Start of operation: 2030
- Maximum expected end of design life / decommissioning: 2065 (35 years)
- Precautionary end of design life / decommissioning: 2105 (75 years)

12A.5.23. At the end of its operating life, it is anticipated that all above-ground equipment associated with the parts of the Proposed Development will be decommissioned and removed from the Site. A Decommissioning Plan (including Decommissioning Environmental Management Plan (DEMP)) will be produced. The DEMP will consider in detail all potential environmental risks and contain guidance on how risks can be removed, mitigated or managed. This will include details of how surface water drainage should be managed during decommissioning and demolition.

Current Land Use

12A.5.24. The Site compromises industrial land including parts of the existing Keadby 1 and Keadby 2 Power Stations, an existing 400kV Substation (owned and operated by National Grid), car parking, agricultural land and other industrial land. Existing roads within the Site include Trent Road and Chapel Lane.

12A.5.25. Beyond the current Keadby Power Station site land uses are predominantly arable farming. Various types of power infrastructure have been developed near to the Site in recent years, including overhead electricity transmission and distribution infrastructure and the Keadby Windfarm to the north which became operational in 2014. Additional wind turbines and electricity transmission and distribution infrastructure is present over the wider surrounding area. Residential uses and canal and river related uses are found in the nearby villages of Keadby and Gunness. The former Keadby Ash Tip is located immediately west of the main area of the Site.

12A.5.26. Between the Three Rivers and Stainforth and Keadby Canal land drains are spaced every 150m across agricultural fields orientated in a north-south direction.

Surface Waterbodies

12A.5.27. **ES Volume III Figure 12.1:** Surface Waterbodies and their Attributes (**Application Document Ref. 6.4**) shows the surface waterbodies described in this section. The Site lies to the west and in close proximity to the tidal River Trent, which flows in a northerly direction towards the Humber Estuary.

12A.5.28. Approximately 300m to the north of the Site, beyond Keadby Common, is Warping Drain (also known as Eastoft Moors Drain). Warping Drain, an ordinary watercourse, flows east and into the tidal River Trent via sluice gates. The drain is artificial in its character, being overwide, straight, and with flood embankments either side. Flows will also be influenced by tidal locking.

12A.5.29. Approximately 700m to the west of the Site is the Keadby Boundary Drain, an ordinary watercourse, which flows south to north and is a tributary of Warping Drain. There are flood gates on Warping Drain at the point where the Keadby Boundary Drain joins Warping Drain via a sluice.

12A.5.30. South of the Site there are a number of watercourses flowing west to east in parallel with each other. These include the North Soak Drain (adjacent to the Site boundary) and the South Soak Drain, which flow either side of the Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal. This waterbody is approximately 26km long and drains an area of around 56km^2. The North and South Soak Drains flow into the Three Rivers around 500m to the south, and this then connects with the River Trent via sluice gates at Keadby Pumping Station, which is a series of major pumps draining the Isle of Axholme. These three watercourses, plus the River Trent, are all main rivers.

12A.5.31. The Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal is linked to the River Trent via Keadby Lock. It is managed by the CRT.

12A.5.32. In addition, there are a number of small drains located within and on the border of the Site.

Topography

12A.5.33. With the exception of the Ash Tip, land within and surrounding the Site is generally low lying at elevations below 10m Above Ordnance Datum (AOD) and with very shallow gradients. Surrounding area topography is illustrated on **ES Volume III Figure 14.2:** Topography (**Application Document Ref. 6.4**)

12A.5.34. According to the EA's Digital Terrain Model (EA, 2021), the ground level across Keadby Common is typically 0.5 to 1m AOD. Levels on the Keadby 1 and Keadby 2 Power Station sites (proposed for Construction Laydown and Ancillary Facilities) are slightly elevated compared to the surrounding land within the Site, with levels typically between 1.0 to 2.0m AOD. Levels within the construction laydown areas (farmland) south of the Stainforth and Keadby Canal are typically circa 1.0 to 1.5m AOD.

12A.5.35. A notable steep ridge is present immediately to the west of the Site (outside the Site boundary) where land associated with the former Keadby Ash Tip is in excess of 19m AOD.

12A.5.36. The A18 carriageway is also at slightly higher levels (circa 2.5m AOD) than surrounding lower lying land.

Geology and soils

12A.5.37. According to **ES Volume II, Appendix 13A:** Phase 1 Desk Based Assessment **(Application Document Ref. 6.3),** the local geology is characterised by approximately 12m to 17m of alluvium and drift deposits of clay, silt and sand, with occasional peat layers recorded at various depths between 0.45m and 1.6m thickness. These superficial deposits overlie the Mercia Mudstone Formation which shows evidence of near surface weathering, the extent to which decreases with increasing depth. Although not mapped, made ground is assumed across the Site, given the historical phases of development that have taken place.

12A.5.38. The EA classifies the underlying superficial geology as Secondary A aquifer and the Mercia Mudstone as a Secondary B aquifer. The Site does not contain or lie within or in close proximity (<1km) to any Source Protection Zones (SPZ).

12A.5.39. Groundwater levels within the historical borehole records referenced in **ES Volume II, Appendix 13A:** Phase 1 Desk Based Assessment **(Application Document Ref. 6.3),** indicate generally shallow groundwater levels within the superficial geology of between 0.9m - 3.0m below ground level (bgl). Occasionally, deeper groundwater strikes were recorded between 5.4m - 6.9m bgl.

12A.5.40. The Soilscape for England published by the National Soil Resources Institute describes the soils at the site as "*Loamy and clayey soils of coastal flats with naturally high groundwater*" (Cranfield Soil and Agrifood Institute, 2018). These soils are naturally wet and drain predominantly to local groundwater and marginal ditches.

Proposed Development Drawings

12A.5.41. Drawings and maps provided as part of the **ES Volume III** (**Application Document Ref. 6.4**) which support this Appendix are summarised below:

- Figure 1.1: Site Location Plan;
- Figure 3.1: Proposed Development Site;
- Figure 3.2: Aerial Photo of the Proposed Development Site;
- Figure 3.3: Indicative Parts of the Site Plan;
- Figure 4.1: Indicative Layout of Main Site and Ancillary Facilities;
- Figure 12.1: Surface Water Bodies and their Attributes;

- Figure 12.2: Groundwater Bodies and their Attributes;
- Figure 12.3: Fluvial and Tidal Flood Risk;
- Figure 12.4: Ecologically Designated Sites Relevant to the Water Environment;
- Figure 12.5: Internal Drainage Board Assets;

12A.5.42. Additional figures are annexed to this FRA:

- Figure 12A.1: Risk of Flooding from Rivers and Sea
- Figure 12A.2: Risk of Flooding from Rivers and Sea – Climate Change (2036 to 2069).
- Figure 12A.3: Surface Water Flood Risk;
- Figure 12A.4: Surface Water Flood Risk – Climate Change (2040 to 2060)

12A.6. Legislation, Policy and Guidance

Introduction

12A.6.1. An overview of the legislative and policy context that is relevant to the Proposed Development is provided within **Chapter 7**: Legislative Context and Planning Policy (**Application Document Ref. 6.2**) and **Chapter 12:** Water Environment and Flood Risk (**Application Document Ref. 6.2**).

12A.6.2. The sections below consider the planning policies and guidance of relevance to the Site with regards to the flood risk from all sources and appropriate mitigation measures which should be considered.

National Policy

National Policy Statements

12A.6.3. The Overarching National Policy Statement (NPS) for Energy (EN-1), Section 5.8.13 (Flood Risk) (Department for Energy Security and Net Zero (DESNZ), 2024b) details that projects of 1 ha or greater in Flood Zone 1 in England and all proposals for energy projects located in Flood Zones 2 and 3 in England should be accompanied by an FRA.

12A.6.4. The requirements for FRAs set out in Paragraph 5.8.15 are that they should:

- be proportionate to the risk and appropriate to the scale, nature and location of the project;
- consider the risk of flooding arising from the project in addition to the risk of flooding to the project;
- take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made;
- be undertaken by competent people, as early as possible in the process of preparing the proposal;
- consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure and exceedance;
- consider the vulnerability of those using the Site, including arrangements for safe access;
- consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects)

and include information on flood likelihood, speed-of-onset, depth, velocity, hazard and duration;

- identify and secure opportunities to reduce the causes and impacts of flooding overall, making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management;
- consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment, and river and coastal processes;
- include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that these risks can be safely managed, ensuring people will not be exposed to hazardous flooding;
- consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems;
- detail those measures that will be included to ensure the development will be safe and remain operational during a flooding event throughout the development's lifetime without increasing flooding elsewhere;
- identify and secure opportunities to reduce the causes and impacts of flooding overall during the period of construction; and
- be supported by appropriate data and information, including historical information on previous events.

12A.6.5. In determining an application for development consent, the Secretary of State should be satisfied that, where relevant:

- the application is supported by an appropriate FRA;
- the Sequential Test has been applied and satisfied 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 any relevant national and local flood risk management strategy;
- Sustainable Drainage Systems (SuDS) have been used unless there is clear evidence that their use would be inappropriate (with reference to any applicable National Standards published under the Flood and Water Management Act 2010);

- the project includes safe access and escape routes where required, as part of an agreed emergency plan, and that any residual risk can be safely managed over the lifetime of the development; and
- land that is likely to be needed for present or future flood risk management infrastructure has been appropriately safeguarded from development to the extent that development would not prevent or hinder its construction, operation or maintenance.

12A.6.6. Paragraph 5.8.9 of NPS EN-1 states that if, following application of the Sequential Test, it is not possible, (taking into account wider sustainable development objectives), for the project to be located in areas of lower flood risk the Exception Test can be applied. The test provides a method of allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

12A.6.7. NPS EN-1 refers to the NPPF for further details of the Sequential and Exception Tests.

12A.6.8. Paragraph 5.8.41 of the NPS-EN1 states that energy projects should not normally be consented in Flood Zone 3b or on land expected to fall within this zone within its predicted lifetime. This may also apply where land is subject to other sources of flooding (for example surface water). However, where essential energy infrastructure has to be located in such areas, for operational reasons, they should only be consented if the development will not result in a net loss of floodplain storage and will not impede water flows.

12A.6.9. Exceptionally, where an increase in flood risk elsewhere cannot be avoided or wholly mitigated, the Secretary of State may grant consent if they are satisfied that the increase in present and future flood risk can be mitigated to an acceptable and safe level taking accounts of the benefits of the nationally significant infrastructure.

12A.6.10. The DCO, or any associated planning obligations, will need to make provision for the adoption and maintenance of any SuDS, including any necessary access rights to property. The Secretary of State should be satisfied that the most appropriate body is being given the responsibility for maintaining any SuDS, taking into account the nature and security of the infrastructure on the proposed site. The responsible body could include, for example, the applicant, the landowner, the relevant local authority, or another body, such as an IDB.

National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, 2025)

12A.6.11. The NPPF (2025) is supported by the Flood risk and coastal change PPG (2022). The NPS requirements apply to the Proposed Development however this makes reference to the NPPF as applicable.

12A.6.12. The Flood Zone definitions used in both the NPS and the NPPF are defined in Table 1 of the PPG and as reproduced in **Table 12C.3**, below. As discussed in Section 12A.2, the 'Flood Map for Planning' (EA, 2025) identifies that the majority of the Site and surrounding environs are located within Flood Zone 3. The Flood Zones are assessed without taking into account any flood defences which may be present and the do not take into account the possible impacts of climate change.

Table 12A.3 NPPF Flood Zone Definitions

Flood Zone	Definition
Flood Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding
Flood Zone 2 **Medium Probability**	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding
Flood Zone 3a High Probability	Land having a 1% or greater annual probability of river flooding (>1% AEP); or Land having a 0.5% or greater annual probability of sea (flooding)
Flood Zone 3b Functional floodplain	Land where water from rivers or the sea has to flow or be stored in times of flood (Not separately distinguished from Zone 3a on the Flood Map for Planning). Normally comprises 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, even if it would only flood in more extreme events.

Sequential and Exception Tests

12A.6.13. The Sequential Test ensures that a sequential, risk-based approach is followed to steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account. Where it is not possible to locate development in low-risk areas, the Sequential Test should go on to compare reasonably available sites with medium risk areas and then, only where there are no reasonably available sites in low and medium risk areas, within high-risk areas. All projects should apply the sequential approach to locating development within the site.

12A.6.14. In accordance with Annex 3 of the NPPF (2025) an electricity generating station (such as the Proposed Development) is classified as 'Essential Infrastructure' Table 2 of the PPG provides a matrix identifying which vulnerability classifications are appropriate within each Flood Zone (replicated in **Table 12A.4**, below).

Table 12A.4 NPPF PPG 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.

"†" 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 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.

12A.6.15. As **Table 12A.4** indicates, application of the Exception Test is required for the Proposed Development. In accordance with paragraph 5.8.11 of the NPS EN-1 to pass the Exception Test it should be demonstrated that:

- the project would provide wider sustainability benefits to the community that outweigh flood risk (these would include the benefits or need for the infrastructure); and
- the project 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.

12A.6.16. During the early stage of planning the Proposed Development, the Applicant considered potential sites in the Humber region for a new CCGT project, reviewing a number of factors: environmental impact (including those topics considered in the ES), electrical grid connection, cooling water availability, natural gas supply, proximity to future hydrogen supply, access constraints and land and space constraints. The electrical grid connection was a key differentiator favouring development on the Keadby Power Station site. The alternative sites not taken forward all had similar flood risk profiles (in Flood Zone 3).

12A.6.17. The majority of the Site occupies previously developed land including land associated with the former coal-fired Keadby Power Station (now demolished), on-site historic landfill and land recently developed for Keadby 2 Power Station. For those elements of the Site that are not previously developed and part of the Keadby Power Station site, a site selection process was undertaken comprising both brownfield land and other areas of land under intensive agricultural management for temporary use as construction laydown areas, as explained in **ES Volume I Chapter 6:** Consideration of Alternatives (**Application Document Ref. 6.2**). In respect of the first part of the Exception Test, i.e. wider sustainability benefits, the need for the development to support decarbonisation of the electricity grid is set out in **ES Volume I Chapter 4**: The Proposed Development (**Application Document Ref. 6.2**). NPS EN-1 states that in respect of the Exception Test the wider sustainability benefits can include the need for nationally significant energy infrastructure projects as set out in that document. This site-specific FRA demonstrates the second element of the Exception Test is satisfied.

12A.6.18. As detailed in later sections, the North and North East Lincolnshire SFRA has defined the functional floodplain (Flood Zone 3b) and this does not include the Site.

Environment Agency Climate Change Guidance (2022)

12A.6.19. The EA published updated climate change allowances in May 2022 to support the NPPF, which are based on the latest UKCP18 climate projections. The updates provide predictions for:

- peak river flow by River Basin District;
- peak rainfall intensity;
- sea level rise; and,
- offshore wind speed, extreme wave height and storm surge.

12A.6.20. These should be considered within an FRA in regard to future impacts from climate change on application for development consent. The EA guidance outlines how and when allowances should be applied for FRA.

12A.6.21. As the Proposed Development is classed as a nationally significant infrastructure project (NSIP) the 'credible maximum' climate change scenario should be considered to assess the resilience of the Proposed Development, particularly any safety critical elements.

Tidal Climate Change Allowances

12A.6.22. **Table 12A.5** is an extract replicated from Table 1 of the EA's guidance detailing the anticipated rise in sea levels up to 2125; (i.e. enveloping the maximum anticipated operational lifetime of the Proposed Development). Both the Higher Central and Upper End allowances should be considered in the FRA. In view of the nature of the Proposed Development the Upper End allowances have been considered in this FRA.

12A.6.23. The credible maximum scenario for sea level rise (H++) is a single allowance of 1.9m total sea level rise to 2100 (EA, 2024). No H++ estimates are provided for the period beyond 2100. The implications of the credible maximum sea level rise have been considered in this FRA.

Table 12A.5 Sea level allowance for each epoch in millimetres (mm) per year with cumulative sea level rise for each epoch in brackets (based on a 1981 to 2000 baseline)

Area 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)
Humber	Higher central	5.5 (193)	8.4 (252)	11.1 (333)	12.4 (372)	1.15
Humber	Upper end	6.7 (235)	11 (330)	15.3 (459)	17.6 (528)	1.55

Fluvial Climate Change Allowances

12A.6.24. For proposed developments in areas of fluvial flood risk, the flood risk vulnerability classification, flood zone and lifetime of development are of particular importance to determine the correct climate change allowance as detailed in Table 12A.6.

Table 12A.6 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 'Functional Floodplain'	CA	X	X	X	HCA
CA = Central Allowance; HCA = Higher Central Allowance; UEA = Upper End Allowance; X = Development not permitted					

12A.6.25. As the Proposed Development is defined as 'Essential Infrastructure', the Higher Central Allowances should be used for the assessment. The appropriate allowances to use for the assessment of off-site impacts and calculation of floodplain storage compensation depend on the land uses in affected areas. For the Proposed Development this includes other Essential Infrastructure and therefore the Higher Central Allowances should be used. The Higher Central Allowances should also be used if, by exception, development is considered appropriate despite not following the flood zone compatibility categories.

12A.6.26. The Upper End climate change allowances should be used to assess the resilience against the credible maximum scenario.

12A.6.27. The majority of the Site is located within the Lower Trent and Erewash Management catchment. The corresponding increases in peak river flow are shown in **Table 12A.7**.

Table 12A.7 Environment Agency Peak River Flow Climate Change Allowances for the Lower Trent and Erewash Management catchment (Total percentage change)

	'2020s' (2015 to 2039)	'2050s' (2040 to 2069)	'2080s' (2070 to 2125)
Upper End Allowance	29%	38%	62%
Higher Central Allowance	18%	23%	39%

Peak Rainfall Intensity Climate Change Allowances

12A.6.28. To account for the anticipated changes in rainfall intensity, the EA guidance (as shown in **Table 12A.8**) states that development with a lifetime beyond 2100 should be assessed against the Upper End allowances for the 2070s epoch (2061 to 2125). Development with a shorter lifetime should be assessed against the respective Central Allowance for the 2050s or the 2070s (or whichever is higher). Development should be designed so that for the 1% AEP there is no increase in flooding elsewhere and the development is safe from surface water flooding. A credible maximum scenario is not defined for peak rainfall intensity.

Table 12A.8 Environment Agency Peak Rainfall Intensity Climate Change Allowances for the Lower Trent and Erewash Management Catchment

	3.3% AEP		1% AEP	
	'2050s' (2040 to 2069)	'2070s' (2060 to 2079)	'2050s' (2040 to 2069)	'2070s' (2060 to 2079)
Upper End Allowance	35%	35%	40%	40%
Central Allowance	20%	25%	20%	25%

12A.6.29. The climate change effects on offshore wind speed and wave height are not relevant to the location of the Site. For the credible maximum scenario the EA's guidance states a 2mm/year allowance should be applied from 2017 to represent increased storm surge. This equates to 96mm over the expected maximum lifetime of the Proposed Development (to 2065) and 176mm over an assumed 75 year lifetime (to 2105). These are small compared with the sea level rise allowances and storm surge would not apply to the River Trent near the Site, rather to the Humber estuary, and the increase would therefore not relate directly to a change in flood risk at the Site. Climate change effects on storm surge have therefore not been explicitly considered in the FRA.

National SuDS Standards

12A.6.30. Revised 'National standards for SuDS' were published in 2025 (Department for Environment, Food and Rural Affairs (Defra), June 2025). The standards are non-statutory and intended to be used alongside the NPPF and PPG.

12A.6.31. The standards that are of relevance to the consideration of flood risk to and from the Proposed Development relate to runoff destinations and management of extreme rainfall and flooding.

12A.6.32. Additional standards relate to management of everyday rainfall, water quality, amenity, biodiversity and design for construction, operation, maintenance, decommissioning and structural integrity.

Regional Policy, Plans and Guidance

Trent Catchment Flood Management Plan

12A.6.33. The Trent Catchment Flood Management Plan (CFMP) (EA, 2010) considers the scale and extent of flooding and sets policies for managing flood risk in the catchment. The CFMP identifies the Site as being within the 'Axholme and NW Lincolnshire' region, recognising that there is an extensive risk from flooding to agricultural land on both sides of the River Trent.

12A.6.34. The CFMP also states that essential infrastructure, which includes Keadby Power Station, would only be affected in an extreme event (0.1% AEP). However, it is recognised that climate change and sea level rise will potentially lead to more frequent overtopping of tidal River Trent defences, potentially causing them to fail. If this was the case then it is estimated that in the next 50 to 100 years (from 2010), 25,000 properties would be at risk in the Axholme and NW Lincolnshire sub area during a 1% AEP flood event.

12A.6.35. Within the Axholme and NW Lincolnshire regions, the CFMP identifies that flood risk management activities are to be focused on mitigating the impacts of climate change.

North and North East Lincolnshire Strategic Flood Risk Assessment

12A.6.36. A Level 1 SFRA was published in 2011 to support the LPA assessment for development sites in relation to flood risk. The SFRA was completed in consultation with NLC, the EA and IDB to provide information on the probability of flooding. The report also takes into account the impacts of climate change.

12A.6.37. It is intended that the SFRA will be used by NLC's planning and building control department to inform the application of the Sequential Test when allocating land or determining applications, in line with the NPPF.

12A.6.38. The SFRA recognises that the western floodplain of the River Trent, originally marshland, was reclaimed in the 16th and 17th Centuries and is very fertile but relies on an extremely complex drainage system, almost entirely pumped, to maintain water levels low enough for arable agriculture to take place.

12A.6.39. The SFRA was updated in June 2022 to reflect the latest information and changes in government guidance since its original publication. It is noted that there has been significant investment in tidal and river defences since 2011 and also a significant tidal event in 2013 which changed the understanding of how flood events can affect the estuary and its tributaries. It is acknowledged in the SFRA that further modelling work was ongoing at the time of writing alongside development of the Humber Flood Risk Management Strategy which would need to be considered when available.

12A.6.40. The updated 2022 SFRA is supported by interactive mapping which reflected the latest EA Flood Zones (at the time); extensive flooding which occurred in June and July 2007; and flood risk mapping developed for the SFRA. The SFRA includes mapping of the functional floodplain (Flood Zone 3b) defined as areas designated by the EA as providing flood storage under defined return period events, therefore forming part of the flood management system, or areas being considered in the Humber Flood Risk Management Strategy as potential managed realignment sites. The Site does not lie within the mapped functional floodplain. The SFRA mapping also distinguishes between fluvial and tidal flood zones, showing the main area of the Site within the tidal risk zone and the southern access in the fluvial risk zone. The mapping of reported surface water flooding does not include the Site, although small areas are shown in the vicinity, such as near Chapel Lane to the east.

12A.6.41. The SFRA divided the study area into a number of flood compartments to allow more detailed assessment. The majority of the Site lies within compartment 3T4, with the access also crossing compartment 3F4.

12A.6.42. The updated SFRA carries forward the concept (from the original SFRA) of using Critical Flood Levels (CFL) to provide guidance on what levels of mitigation are necessary in order to make development “safe”. In this area the CFL is based on engineering judgment. The Isle of Axholme is a large basin which relies heavily on a pumped regime to manage and maintain water levels, thus protecting thousands of properties. The main sources of flood risk associated within the Isle of Axholme include overtopping and/or breach of the tidal River Trent defences, the tidal influence from the Humber estuary, overtopping and breach of the defences on the Lower River Don and pump failure in the extensive inland pumped drainage networks such as the Three Rivers.

12A.6.43. The updated SFRA included a review of more recent model data and the CFL for compartment 3F4 was revised to 3.8m AOD with finished floor levels for residential development to be set 300mm above this (i.e. 4.1m AOD). No specific guidance is provided for non-residential development. However, applications for development proposals within 500m of the River Trent defences should be accompanied by a site specific FRA appropriate to the scale and nature of the proposals, showing they will not be adversely affected by rapid flowing water from a potential breach.

12A.6.44. No guidance is specifically provided for compartment 3T4 (it is assumed this is an omission). Considering the location of the Site and the proximity to the 3F4 / 3T4 boundary it is assumed the same guidance as above would apply.

Isle of Axholme and North Nottinghamshire Water Level Management Board Byelaws

12A.6.45. The Board has a number of Byelaws in place (Isle of Axholme and North Nottinghamshire Water Level Management Board, 2018) which define additional requirements for consents for watercourses under their control.

12A.6.46. The following are relevant to this FRA and require consent from the Board prior to undertaking any related activities:

- Control of Introduction of Water and Increase in Flow or Volume of Water.

- Diversion or Stopping up of Watercourses.
- No Obstructions within Nine metres of the Edge of the Watercourse.
- Not to Dredge or Raise Gravel, Sand etc.
- Fences, Excavations Pipes etc. This requires consent for related activities or structures which cross the watercourse or affect the watercourse banks.

12A.6.47. A series of guidance notes have also been published which have been considered in the preparation of this FRA.

12A.7. Local Policy, Plans and Guidance

12A.7.1. The Site lies entirely within the administrative area of NLC. The statutory development plan for the area currently comprises the following documents:

- North Lincolnshire Core Strategy - adopted June 2011 (North Lincolnshire Council, 2011);
- Housing and Employment Land Allocations - adopted March 2016 (North Lincolnshire Council, 2016);
- Saved Policies of North Lincolnshire Local Plan (North Lincolnshire Council, 2003) – adopted May 2003, saved September 2007; and
- SuDS and Flood Risk Guidance Document (North Lincolnshire Council, 2017).

12A.7.2. It is considered that these documents may be ‘important and relevant’ as defined by EN-1 (DESNZ, 2024). The following policies are considered relevant to the Proposed Development in relation to this FRA:

Core Strategy (2011) (North Lincolnshire Council, 2011)

- CS2 – Delivering more sustainable development. This policy describes the sequential approach to be adopted with development focussed on previously developed land and land within existing urban areas and defined development limits. The policy references the sequential approach to direct development to areas with a lower probability of flooding where possible.
- CS5 - Delivering Quality Design in North Lincolnshire. Amongst others, this policy describes how development should incorporate the principles of sustainable development, including mitigating against the impacts of climate change.

- CS16 - North Lincolnshire's Landscape, Greenspace and Waterscape. This describes how the council will identify strategically and locally important areas where development should not be permitted where it would result in unacceptable conflict with the functions or characteristics of the area. The policy also requires development proposals to improve the quality and quantity and address local deficiencies in accessible waterscape (amongst others) where appropriate. Further consultation is required with the council to confirm if there are any related constraints affecting the Proposed Development.
- CS18 – Sustainable resource use and climate change. This policy describes how the council will actively promote development which utilises natural resources as efficiently and sustainably as possible. Amongst others, specific measures include meeting high water efficiency standards; requiring the use of SuDS where practicable; and supporting the necessary improvement of flood defences and surface water infrastructure required against the actions of climate change, and preventing development in high risk areas where possible.
- CS19 - Flood Risk. This policy reinforces national policy requirements through the risk based sequential approach to locate development on land that has a lower flood risk (where possible) and through application of the Exception Test as applicable where development is located in high risk areas. In addition to the national policy requirement described above, development should be on previously used land or there must be no reasonable alternative although it should be noted the Core Strategy pre-dates the current NPPF where this requirement is now omitted. The policy also requires the use of SuDS where practicable and states the council will seek to reduce increased flood risk due to climate change through measures to reduce carbon dioxide emissions.

Local Plan (2003) (North Lincolnshire Council, 2003)

12A.7.3. The following saved policies are considered relevant from the Local Plan:

- DS13 – Groundwater Protection and Land Drainage. This policy requires that all development proposals should take account of the need for effective land drainage measures and groundwater protection in order to control the level of water in the land drainage system.
- DS14 - Foul Sewage and Surface Water Drainage. This policy requires satisfactory provision for the disposal of foul and surface water from new development.

- DS16 - Flood Risk. This policy requires adequate mitigation or protection for development within floodplains.

North Lincolnshire Council's SuDS and Flood Risk Guidance Document

12A.7.4. NLC, as LLFA, has produced a SuDS and Flood Risk Guidance Document Supplementary Guidance Document (SGD) (North Lincolnshire Council, 2017) providing developers and designers with guidance on SuDS and guidance on what type of SuDS are appropriate to a particular development, depending on the size and location. It also provides advice regarding adoption and maintenance of SuDS, riparian responsibilities and specific NLC requirements, which include that:

- the LLFA drainage team should be consulted at pre-application stage;
- SuDS are required for all developments;
- no water should be stored above ground up to and including the 1% AEP event unless stored in a SuDS component;
- surface water runoff should be limited for all new developments to the greenfield runoff rate;
- storage components should not be constructed in private land;
- infiltration should only be viable for areas where the infiltration rate of soils are above 1 x 10-6m/s. Infiltration testing should be undertaken over a period of time, preferably over various seasons;
- roads should not be used as flood conduits and formal overland routes should be formed from SuDS techniques if required;
- the level of betterment will be considered on a site by site basis for all brownfield sites; and
- design calculations should be undertaken with industry accepted programmes.

Emerging Policy

12A.7.5. NLC is preparing a new Local Plan to 2038. Once agreed (formally adopted), it will replace the current North Lincolnshire Local Plan, the Core Strategy and the Housing and Employment Land Allocations Development Plan Documents (DPD). The current programme for development and adoption of the new Local Plan is unknown.

North Lincolnshire Council Local Flood Risk Management Strategy

12A.7.6. As LLFA, NLC has a responsibility to develop a Local Flood Risk Management Strategy (LFRMS) which sets out a clear plan for future flood risk management in the region, ensuring people, businesses communities and other risk management authorities have an active role in how flood risk is managed.

12A.7.7. The strategy (NLC, 2016) is for the residents and businesses of North Lincolnshire and sets out how the Council intends to manage local flood risks, as well as contribute to management from non-local sources, and to engage and inform residents on their own responsibilities and enable them to contribute to the management of flood risk.

12A.7.8. To support the LFRMS the council developed mapping of the 'Local Flood Risk Extent', based on a combination of historic flood reports, modelled surface water flood extents, modelled fluvial flood extents associated with ordinary watercourses and a 20m buffer (10m on each bank) to ordinary watercourses where no modelled extents are available. This was not available for view, however it is likely to be largely superseded by the mapping produced in the more recent SFRA update.

12A.7.9. Relevant to this FRA, the Strategy proposed a study to increase understanding of drainage / groundwater / watercourse issues at various locations, including Keadby. Further information on any relevant outcomes will be requested from the council to inform the final FRA.

12A.7.10. A more comprehensive review of prevailing policy and guidance is presented in **ES Volume I Chapter 12:** Water Resources and Flood Risk (**Application Document Ref. 6.2**) which this appendix accompanies. The local policy generally reinforces the national planning policy requirements (NPPF) in place at the time of writing. Both the NPPF and NPS EN-1 have subsequently been updated and therefore better reflect current practice.

12A.8. Flood Risk Sources

Introduction

12A.8.1. The NPS requires the effects of all forms and sources of flood risk to and from the Proposed Development to be considered within a FRA. There should be demonstration of how these risks should be managed so that the development remains safe throughout its lifetime, taking into account current climate change predictions.

12A.8.2. This section discusses these potential risks in relation to tidal, fluvial, surface water runoff, groundwater and man-made/artificial sources (e.g. canals, reservoirs, pumping station failure).

Information related to multiple sources

Recorded flooding

12A.8.3. The EA's Historic Flood Map indicates that the majority of flooding on the River Trent around the Site is confined to the eastern floodplain (the Site is located on the western floodplain). Mapped historic flooding within the vicinity of the Site is confined to the Waterborne Transport Offloading Area where there is a small functional gap in the fluvial defences. In addition, a small amount of flooding is noted on Chapel Lane at the east of the Site. The flooding occurred due to overtopping of defences in the 2013 tidal flood event on the River Trent.

12A.8.4. The online mapping supporting the NLC SFRA (NLC, viewed September 2024) also shows the location of flooding reported in 2007. Nothing is shown within the Site with the closest being a small isolated area north of Chapel Lane to the east.

SFRA Critical Flood Level (CFL)

12A.8.5. As discussed in Section 12A.6, the SFRA (NLC, 2022) includes a series of Critical Flood Levels (CFLs). The majority of the Site lies within compartment 3T4 of the SFRA, with the access also crossing compartment 3F4. The CFL for compartment 3F4 is 3.8 mAOD with finished floor levels (for residential development) to be set 300mm above this (i.e. 4.1m AOD). No specific guidance is provided for non-residential development. Applications for development proposals within 500m of the River Trent defences should be accompanied by a site specific FRA appropriate to the scale and nature of the proposals. No guidance is specifically provided for compartment 3T4 (it is assumed this is an omission). It is assumed the 3F4 guidance would apply.

Availability and Suitability of Model Data

12A.8.6. Three existing models have informed this FRA:

- EA Tidal Trent Model (Jacobs, 2023)
- EA River Torne Model (Capita AECOM, 2017)
- Keadby CCS Power Station FRA Breach Model (AECOM, 2023)

12A.8.7. Annex 1 summarises the review of the model data to determine the suitability and application to the FRA. This includes details of which model simulations have been used to represent the specific FRA assessment scenarios referred to in this section. The EA Tidal Trent Model is considered to provide the best available information regarding flood levels in the River Trent, fluvial flooding from the River Trent and tidal flooding in the wider area resulting from overtopping of the River Trent defences. The River Torne model is considered to provide the best information for fluvial flooding from other watercourses in the study area. The AECOM Keadby CCS Power Station FRA Breach model is considered to provide a better representation of tidal flood risk to the main area of the Site resulting from a breach in the River Trent defences or defence overtopping and potential impacts from the Proposed Development.

12A.8.8. The AECOM Keadby CCS Power Station FRA model has been updated for this FRA with tidal inflows taken from the latest 2023 EA Tidal Trent model and has included the Proposed Development. Full details of the AECOM tidal model are provided in Annex 2 with the outcomes summarised in the following sections. The suitability of model data to inform the FRA and the approach to modelling undertaken for this FRA have been agreed with the EA.

Tidal Sources

12A.8.9. The River Trent is considered tidal from the Humber Estuary to Cromwell Lock, with the normal tidal limit approximately 70km upstream of the Site at SK 80932 61242.

12A.8.10. Within the Site there are three separate areas proposed for permanent development: for the main infrastructure; Above Ground Installation hydrogen and natural gas supplies (AGI); and administration and control buildings, parking and other facilities as illustrated in **Plate 12A.3.** The following sections use these as reference points where applicable.

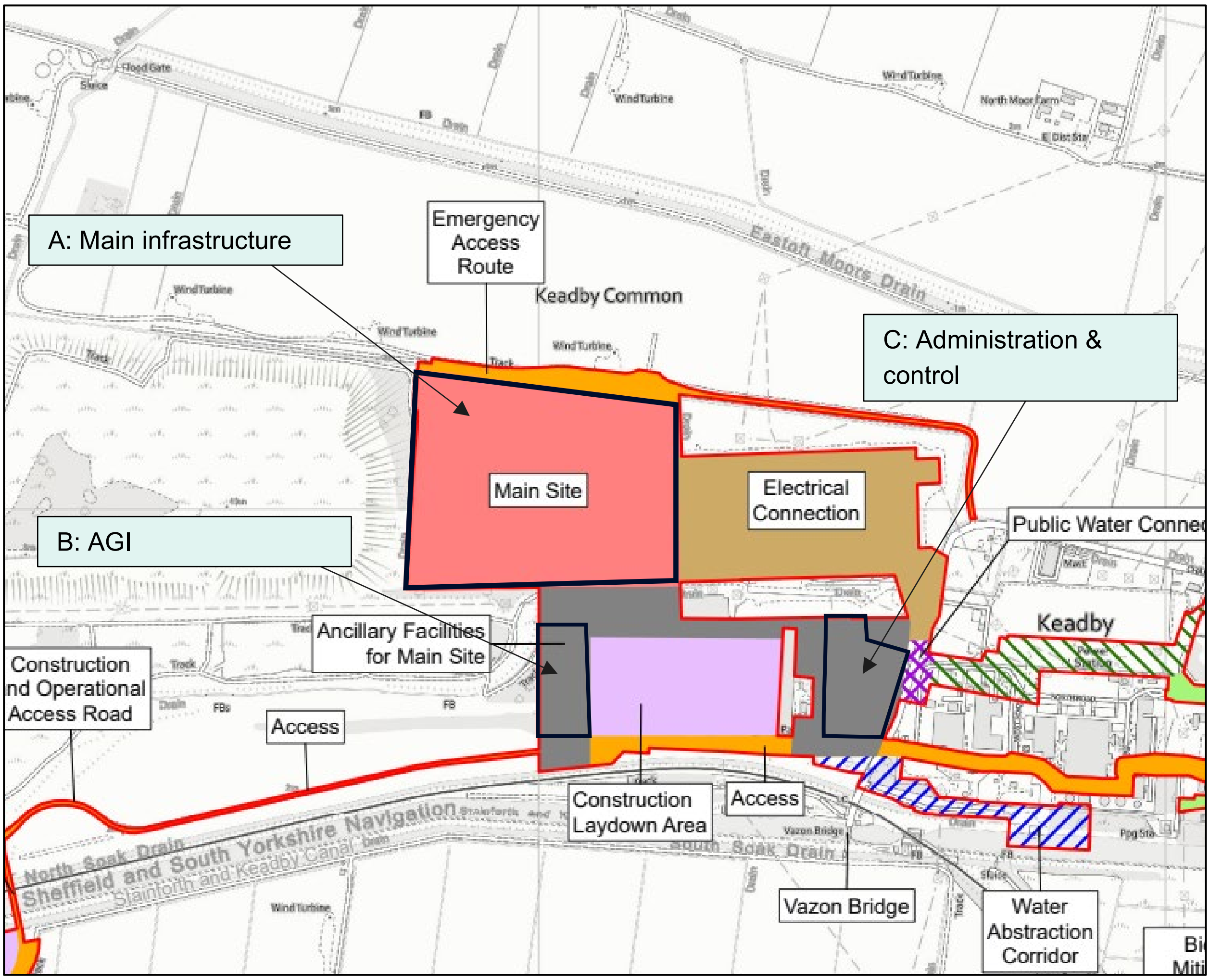


Plate 12A.2 Indicative permanent development areas (Extract from Figure 3.3 (ES Report Volume III))

EA National Flood Maps

12A.8.11. The EA Flood Zones (EA, 2025) (Figure 12.3) (ES Report Volume III) identifies areas subject to fluvial/ tidal flood risk for the present day. This mapping does not include the benefits or impacts of any existing flood defences or climate change.

12A.8.12. The ‘Flood Map for Planning’ shows that almost the entire Site and surrounding environs is within the EA’s indicative Flood Zone 3. When considering tidal sources, Flood Zone 3 is land assessed as having a 0.5% AEP or greater annual probability of flooding from the sea. The River Trent is tidal adjacent to the Site and tidal food risk (flooding from the sea) is the dominant source of flooding. The Site does however benefit from EA maintained flood defences (embankments) along the River Trent.

12A.8.13. The Risk of Flooding from Rivers and Sea map (EA, 2025) (Figure 12A.1) accounts for the effect of defences and shows the majority of the Site north of the canal is at ‘Low’ risk (between 0.1% and 1% AEP) with some areas at ‘Medium’ risk (between 1% and 3.3% AEP), mainly the area identified for landscape and planting. The proposed access south of the canal passes through an area assessed at ‘High’ risk of flooding (>3.3% AEP).

12A.8.14. The mapped climate change scenario (Figure 12A.2) represents the period 2036 to 2069, covering the expected design life of the Proposed Development, and uses the Central allowance for fluvial flooding and the Higher Central allowance for tidal flooding. With climate change, the map shows the majority of the Site at ‘High’ risk with some areas remaining at ‘Medium’ risk north of the canal.

12A.8.15. The SFRA mapping (NLC, 2022) shows the majority of the Site is located in SFRA Tidal Flood Zone 2/3a. These flood zones provide an estimate of the Flood Zone 3 extent including for the impact of climate change. The SFRA also mapped the functional floodplain (Flood Zone 3b). No part of the Site is included in land designated as functional floodplain.

Tidal Flood Defences

12A.8.16. The NPPF PPG defines the design flood event for tidal flooding as the 0.5% AEP event with an appropriate allowance for climate change.

12A.8.17. The EA Asset Management Dataset shows the River Trent defences adjacent to the Site have a 1% AEP design standard of protection with crest levels of 6.2 to 6.3m AOD. The tidal defences protecting this area consist of predominantly embankments along with floodwalls. According to EA data, these defences are typically in a ‘fair’ condition. The EA inspect these defences routinely to ensure potential defects are identified.

12A.8.18. The EA Tidal Trent modelling study included collection of new survey data for the defences in this area and an assessment of standard of protection provided by the defences. This shows the defence levels typically 6.2 to 6.3m AOD upstream and adjacent to the Site (as per the EA Asset Management Dataset) but shows sections with a minimum of around 6 mAOD.

12A.8.19. In accordance with the CFMP policy it is anticipated that improved flood defence and other measures will be undertaken to mitigate the effects of climate change in this area. The EA is currently developing the flood risk management strategy for the area. However, this FRA adopts a precautionary approach and does not account for future improvement works in the area dependent on further consultation with the EA.

Modelled Tidal Water Levels

12A.8.20. **Table 12A.9** shows the modelled water levels in the River Trent adjacent to the Site, taken from the EA Tidal Trent Model. Annex 1 includes details of which model simulations have been used to represent the specific FRA assessment scenarios referred to in this section. The assessment scenarios are representative of the Upper End sea level rise allowance for the respective assessment year.

Table 12A.9 Modelled water levels on the River Trent during tidal event (Jacobs, 2023)

Assessment Scenario	Level (mAOD)^
2030 0.5% AEP	6.19
2030 0.1% AEP	6.21
2065 0.5% AEP	6.32
2105 0.5% AEP	6.56

^Node: Trent14600DS, Three Rivers Confluence 483616, 411387)

12A.8.21. The AECOM model is considered to provide the best information on flood depths and levels for the main area of the Site (north of the canal). The EA Tidal Trent model results have been referred to for the area south of the canal and for the 2030 assessment year as this was not included in the AECOM model.

Main area of the Site (north of the Stainforth and Keadby canal)

12A.8.22. The EA Tidal Trent Model results show that the tidal scenarios are the worst case (for the River Trent) in this area. Overtopping of the defences potentially occurs during the larger events. For the 2030 epoch (0.5% AEP event) flooding is only shown north of the Stainforth and Keadby canal in the Chapel Lane area, east of the Site. This includes the proposed Water Connections Corridor and part of the biodiversity mitigation / enhancement area with maximum flood depths around 200mm. In the 0.1% AEP event the flooding extends further inland reaching the northern emergency access route where it joins Chapel Lane. Maximum flood depths are around 300mm on the Water Connections Corridor and 100mm on the emergency access route.

12A.8.23. Figure 5a (Annex 2) shows the AECOM modelled flood depths for the 0.5% AEP (2065) event around the Site. Flooding is shown to reach the main infrastructure area (**Plate 12A.3** area A), with maximum depths around 0.7m (approximately 1m AOD). Higher flood depths are shown closer to the River Trent, with flood depths reaching around 1.0m in the area designated for landscape and planting and on part of the haul route.

12A.8.24. Figure 5b (Annex 2) shows the AECOM modelled flood depths for the 0.5% AEP (2105) event around the Site. Flood depths across the main infrastructure area (**Plate 12A.3** area A) reach around 1.7m (approximately 2.1m AOD).

12A.8.25. The majority of the Site is currently (present day) at low risk of tidal flooding, with the exception of the Water Connections Corridor where shallow flooding may occur through defence overtopping (as shown by the EA Tidal Trent Model). However by the end of the lifetime of the Proposed Development, much of the Site is at significant risk, particularly under the precautionary extended lifetime assumption (to 2105) (as shown by the AECOM model). It should be noted this modelling does not account for future defence improvements.

Southern access road and A18 gatehouse (south of the Stainforth and Keadby canal)

12A.8.26. For the 2030 epoch, the EA Tidal Trent model shows flooding south of the canal from the North and South Soak Drains and the Three Rivers. This affects the main access route from the A18, with maximum depths of around 200mm. However this is likely a result of modelled fluvial flooding (discussed below) rather than tidal flooding. For 2065, the flooding shown south of the canal is similar to the 2030 assessment year. In 2105 flooding south of the canal reaches flood depths of around 300 – 400mm in the construction laydown area and access road (approximately 1.5m AOD).

Modelled Breach Water Levels Behind the Defences

12A.8.27. It is unlikely that the flood depths on the Site from overtopping would be greater than the flood depths from a breach, which represents a catastrophic failure of the defences during an extreme water level event.

Main area of the Site (north of the Stainforth and Keadby canal)

12A.8.28. Site specific breach modelling has been carried out for this FRA. The breach location is near Trent Road, 50m wide, and set to remain open for the duration of the model run (56 hours) as testing showed peak flood levels were not sensitive to the time it would take to close the breach. As discussed in the model report (Annex 2), this is a reasonably conservative breach scenario considering the extensive failure and erosion of developed land that would need to occur for the breach to open to the full modelled extent.

12A.8.29. The AECOM modelled flood depths for the 0.5% AEP breach event around the Site are shown in Annex 2 Figures 6a (2065) and 6b (2105). Flood depths across the area proposed for the main infrastructure (**Plate 12A.3** area A) reach around 2m (approximately 2.4m AOD) in 2065 and 2.3m (approximately 2.6m AOD) in 2105 affecting all the Proposed Development. As expected, flooding is worse under a breach scenario than an overtopping scenario.

Southern access road and A18 gatehouse (south of the Stainforth and Keadby canal)

12A.8.30. The EA Tidal Trent model simulated several breach scenarios. Breaches 03, 05 and 07 are located on the west bank of the River Trent in the vicinity of the Site. Breach 03 is north of the canal, and therefore the AECOM breach model results are deemed more accurate for this area. Breach 05 is downstream of the King George V Bridge (approx. NGR 4838 4108) and Breach 07 further upstream at Althorpe (approx. NGR 4834 4095) and therefore representative of a breach that may affect the southern part of the Site, south of the canal.

12A.8.31. The available results indicate that in 2105 maximum flood depths in the construction laydown area may typically reach approximately 500mm and up to around 600mm on the access road (around 1.6m AOD). The maximum modelled flood level at the A18 is approximately 1.75m AOD.

Summary

12A.8.32. Based on the available information the majority of the Site is currently (Present Day) at low risk of flooding from tidal sources with the defences in place. Over the lifetime of the development the risk is more significant (not allowing for defence improvements to mitigate the effect of climate change). Flooding is shown to reach the Site with significant flood depths, particularly for the precautionary design lifetime (to 2105).

12A.8.33. In the event that the defences were to breach, the hazard to the Site in its unmitigated state would be high as flood waters would rapidly reach the Site and reach significant flood depths of over 2m. However, the probability of this occurring is low, as to occur, it requires both a high water level in the River Trent and a structural defence failure, and this is a residual risk.

12A.8.34. The tidal flood risk presents unacceptable risks to the Proposed Development and therefore mitigation is required. The proposed mitigation and residual risk to the Proposed Development with the mitigation in place is described in Section 12A.10.

Fluvial Sources

12A.8.35. The nearest Main River is the River Trent to the immediate east of the Site. Other Main Rivers close to the Site include the Three Rivers and the North and South Soak Drains. Fluvial flooding in the area is influenced by high water levels in the River Trent. The high embankments along the River Trent allow water levels on the River Trent to rise much higher than the surrounding watercourses and much of the Isle of Axholme drainage (including the Three Rivers and North and South Soak Drains) is lifted by pumping into the River Trent.

12A.8.36. Ordinary watercourses in proximity to the Site include the Stainforth and Keadby Canal, Warping Drain (to the north) and Keadby Boundary Drain (to the west).

12A.8.37. **ES Volume III Figure 12.1:** Surface Waterbodies and their Attributes (**Application Document Ref. 6.4**) shows the watercourses in the area.

EA National Flood Maps

12A.8.38. The EA National Flood Maps do not distinguish between tidal and fluvial flooding therefore the description under tidal flooding also applies to fluvial flooding.

12A.8.39. The SFRA mapping shows the access road from the south passes through SFRA Fluvial Flood Zone 2/3a. These flood zones provide an estimate of the Flood Zone 3 extent including for the impact of climate change. The SFRA also mapped the functional floodplain (Flood Zone 3b). No part of the Site is included in land designated as functional floodplain.

Fluvial Flood Defences

12A.8.40. The NPPF PPG defines the design flood event for fluvial flooding as the 1% AEP event with an appropriate allowance for climate change.

12A.8.41. In addition to the River Trent defences the EA's Asset Management Dataset shows defences for the North and South Soak Drains and Three Rivers, comprising naturally high ground, with a 10-year design standard of protection (10% AEP event). A design crest level of 1.3m AOD is shown in the dataset.

12A.8.42. As noted, the FRA adopts a precautionary approach and does not account for future improvement works in the area.

Modelled Fluvial Water Levels and Extents

12A.8.43. The results from the EA Tidal Trent model (Jacobs, 2023) show the flood level in the River Trent remains below the defence levels in all modelled fluvial scenarios considered in the FRA which includes the 0.1% AEP event (2030) and 1% AEP event (2105) which were the most extreme events modelled. Therefore fluvial flooding from the River Trent is not deemed to pose a risk to the Site except in the event of a defence breach. A tidal breach event is the worst case for this area therefore a fluvial breach scenario has not been considered as part of this FRA.

12A.8.44. The results from the EA River Torne model (Capita AECOM, 2017) show that floodwaters remain in bank in the North Soak Drain in the vicinity of the Site for all modelled events. Flooding is shown from the South Soak Drain in all modelled events (50% AEP and larger) which affects the land between the South Soak Drain and Three Rivers. This very slightly encroaches into the Red Line Boundary at the side of the access road, south of Pilfrey Bridge crossing the canal. Modelled flood depths are not provided however the information suggests maximum flood depths in the region of 100 – 150mm which is unlikely to have a significant impact. The results show similar flooding for the design 1% AEP event in the 2065 and 2105 assessment years. The flooding does not reach the main part of the Site (north of the canal) where critical infrastructure is located.

12A.8.45. The modelled flood outlines show flooding to the A18 at the southern end of the access road; however, inspection of the model results show flood waters remain in bank for all modelled events and this is a result of the model schematisation. Modelled flood levels in the Hatfield Waste Drain, where Mabey Bridge will be replaced, are approximately 1 mAOD for the design 1% AEP event (2065 and 2105) and for the 0.1% AEP event. These compare with a soffit level for the existing bridge (in the model) of 1.41 mAOD.

Unmodelled Land Drains

12A.8.46. The land drains surrounding the Site drain predominantly into Warping Drain, North and South Soak Drains and the Three Rivers.

12A.8.47. Due to the very flat and low-lying nature of the surrounding area, the Site is surrounded to the north, south and west by a complex drainage system from agricultural fields as represented within **ES Volume I Figure 12.1**: Surface Waterbodies and their Attributes (**Application Document Ref. 6.4**). These land drains are not included in the EA's hydraulic modelling. The land drainage system relies on pumping and as a result, pumping capacity and condition have the potential to influence flood risk, alongside meteorological factors. Flooding from the surrounding land drains is considered alongside flooding from surface water below.

Summary

12A.8.48. Based on the information provided by the EA, the Site is considered at low risk of fluvial flooding. There is a residual risk associated with breach of the defences on the River Trent, however as fluvial water levels are lower than tidal water levels, the assessed tidal risk is the worst-case with regards to overtopping and breach on the River Trent and has already been discussed and assessed. There is also a residual risk associated with failure of the pumped drainage systems in the area. This is addressed through consideration of the SFRA CFL discussed earlier.

Groundwater Sources

12A.8.49. Groundwater flooding can occur when groundwater levels rise above ground surface levels. 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). The underlying soils and geology do not suggest a high susceptibility to significant groundwater flooding (such as may be expected with chalk aquifers) however the low lying ground will be more susceptible to shallow groundwater flooding, closely associated with surface water drains and river levels. The **ES Volume I Appendix 13A:** Phase 1 Desk Based Assessment (**Application Document Ref. 6.3**) showed generally shallow groundwater levels within the superficial geology of between 0.9m - 3.0m below ground level (bgl).

12A.8.50. The SFRA references groundwater flooding that occurred in the SFRA area following the major flood event in July 2007 when groundwater levels rose following heavy rain and ponded where the water could not drain effectively. However the accompanying mapping of recorded flooding does not include the Site.

12A.8.51. The areas around the Site are artificially drained by various land drains and pumping stations, which help to maintain the groundwater level. These are expected to remain operational through the lifetime of the

Proposed Development, contributing to a low risk of groundwater emergence at the Site.

12A.8.52. In addition, a significant proportion of the Site is covered in impermeable hardstanding surface, reducing natural infiltration potential as part of the Proposed Development. As a result, due to hardstanding ground intercepting groundwater and preventing it from reaching the surface, the likelihood of localised groundwater reaching the surface and causing flooding is reduced.

Summary

12A.8.53. Based on the information provided, the Site is considered to be at low risk of flooding from groundwater sources as this is effectively managed by the local drainage system.

Surface Water Runoff to the Site

12A.8.54. Surface water flooding is caused by overland flow that results from rainfall that cannot drain into the ground through infiltration, instead flowing over the ground surface. This can be exacerbated where the permeability of the ground is low due to the type of soil (such as clayey soils) and geology or land use including urban developments with impermeable surfaces.

Overland Flow of Rainfall Runoff

12A.8.55. The Risk of Flooding from Surface Water (RoFSW) map (Figure 12A.3) (EA, 2025) indicates areas at risk from surface water flooding and small watercourses when rainwater does not drain away through the normal drainage systems or soak into the ground, but instead lies on or flows over the ground.

12A.8.56. The RoFSW flood map identifies that in the present day the Site is generally not at risk from surface water flooding. The map shows that there are isolated areas at risk in and around the Site, associated with lower lying areas where water is shown to pond, principally in part of the existing Keadby 2 and the area designated for landscape and planting. The published data shows flood depths are typically shallow, unlikely to exceed 200mm in most instances.

12A.8.57. With climate change (Figure 12A.4), the map shows a similar pattern of flooding though slightly more extensive. Flood depths within the Site typically remain shallow. The mapped climate change scenario represents the period 2040 to 2060, covering the majority of the expected design life of the Proposed Development, and uses the Central climate change allowance.

12A.8.58. Extensive site drainage already exists as a result of the Keadby 1 and Keadby 2 Power Stations.

12A.8.59. The Proposed Development will increase the impermeable area and therefore increase the rate of surface water runoff from the Site, this will be considered and managed as part of the drainage strategy (refer Section 12A.9).

Summary

12A.8.60. Based on the above information, the risk to the Site from overland flow of surface water generated adjacent to or from waterbodies located within the Site is considered to be low. Localised flooding may occur but this is expected to be mitigated through implementation of an effective drainage strategy for the Proposed Development. There is a residual risk associated with failure of the pumped drainage systems in the area. This is addressed through consideration of the SFRA CFL discussed earlier.

Artificial Sources

Reservoirs

12A.8.61. The Reservoir Act 1975 as amended by the Flood and Water Management Act 2010 in England applies to reservoirs which hold over 25,000m³ of water and sets out safety and maintenance requirements. The EA has assessed the flood hazards associated with the breach or failure of large reservoirs or high risk reservoirs and the EA's Flood Risk from Reservoirs map (EA, 2024) shows that the Site is not located in an area at residual risk of flooding from reservoirs in the event of a structural failure or breach.

Canals

12A.8.62. The Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal is directly adjacent to the south of the Site but given its shallow gradient and that it drains into the River Trent by a sluice, the risk of flooding is likely to be low. During consultation the CRT advised that the canal is fed from the River Don and therefore risk of flooding may increase during periods of excess flows; however, the CRT also advised that whilst the canal receives uncontrolled discharges from local runoff it is usually isolated from the River Don during periods of floods. The CRT confirmed that flows are typically managed through the canal system to discharge at Keadby lock and maintain water levels within a set range. An assessment of flood risk from the canal and the impacts of the abstraction works was completed for the Keadby CCS Power Station project (Annex 4). This should be considered in conjunction with a further assessment of the canal abstraction completed in October 2022. The normal water level in the canal is set at 2.76m AOD in the pound adjacent to the Site, and the automated system used to manage water levels is designed to maintain a 50mm +/- tolerance. Water currently spills over Keadby lock which has a minimum crest level of 2.55m AOD. Overtopping from the canal is understood to occur above 3m AOD therefore there is some additional storage capacity in the canal before spilling would occur.

12A.8.63. West of the railway, if any overtopping of the canal were to occur, this would drain into the North and South Soak drains located at a lower elevation on either side of the canal. To the east it is possible that water may flow towards the Site although it is unlikely that flood depths would be significant compared with tidal flooding. The CRT confirmed its opinion that flooding from the canal is unlikely to pose any significant risk to the Site.

Summary

12A.8.64. The risk of flooding from artificial waterbodies is considered to be low. The Site is not at risk of flooding from reservoirs and as water levels in the canal are controlled, flooding is unlikely. Should flooding occur other watercourses may intercept flows before reaching the Site. Flood volumes reaching the Site are unlikely to lead to significant flooding compared with tidal inundation, and hence mitigation against tidal risk will address any residual risk.

12A.9. Management of Surface Water from the Site

Introduction

12A.9.1. An indicative surface water drainage strategy has been prepared for the Proposed Development (Annex 3). At this stage surface water discharge via infiltration has been discounted due to anticipated ground conditions and high groundwater table.

Construction

12A.9.2. During construction, temporary drainage measures will be established to manage surface water on Site, prevent its runoff to surrounding land drains and direct water away from the proposed working areas. The exact drainage measures that will be employed are the responsibility of the appointed Contractor(s) to design and manage. Typical construction drainage measures may include establishment of temporary drainage ditches or dikes, attenuation ponds to enable any sediment to drop out of suspension and temporary connections to existing drainage networks (should discharge of accumulated water be required).

12A.9.3. There are small areas of brownfield land within the construction laydown areas. The condition of the construction laydown areas is anticipated to remain largely unchanged throughout construction and operation of the Proposed Development and it is assumed these areas will continue to be permeable throughout construction and operation. It is anticipated that the runoff rate from the construction laydown areas may increase during the construction and operational phases due to anticipated compaction and (in some places) vegetation loss. However, due to a high-water table and flat site, it is likely to have minimal impact on the existing run off rates for the Site. This includes all haulage and access routes within these areas. Attenuation is therefore not deemed to be required.

Operation

12A.9.4. The Proposed Development will permanently increase the total impermeable area on the Site. Within the main area of the Site there will be a number of bunded areas which will collect surface water and drain it to a separate on-site treatment facility. This reduced runoff has not been accounted for at this stage of design as the area is considered negligible. For the purposes of the Outline Drainage Strategy (Annex 3) it has been assumed that the area of the Site that houses the permanent development is totally impermeable.

12A.9.5. Within the main are of the Site there are three separate areas proposed for permanent development (for the main infrastructure; AGI; and administration and control buildings, parking and other facilities) as illustrated in **Plate 12A.3**. These areas will be raised to provide flood mitigation (refer to Section 12A.10). Conventional drainage networks are proposed although the strategy references potential use of SuDS such as swales in permeable areas. The strategy also references a requirement to minimise impermeable areas and, where these cannot be reduced, to explore source control measures at detailed design stage. Toe drainage may be required surrounding the raised land areas. However, at this stage of design there is not enough information to confirm if this is required and potential flows.

12A.9.6. A permanent laydown area is proposed within the part of the Site housing the main infrastructure (**Plate 12A.3** area A) which will be surrounded by raised ground. The strategy notes a requirement for pump and sump to discharge at greenfield runoff rates, with cut-off drains at the higher level to minimise runoff into the area.

12A.9.7. Drainage within the Site will be gravity driven if suitable gradients can be achieved however the strategy notes there may be a need for pumped drainage to be determined at design stage. If required, the strategy notes that pump control systems should be housed in an elevated location if possible, above the critical flood level.

12A.9.8. Two separate attenuation storage areas are anticipated, one serving the area where the main infrastructure will be located (**Plate 12A.3** area A), and another serving the other two permanent development areas (**Plate 12A.3** area B and C) and other parts of the main area of the Site. It is anticipated that discharge from area A will be via Drain 1 (Glew Drain) on the northern Site boundary (**Plate 12A.4**). The preferred discharge point for the other attenuation areas is via Drain 2. Exceedance routes for drainage assets within the Proposed Development will be directed away from critical infrastructure and towards the system discharge points. These routes will be developed as part of the detailed design.

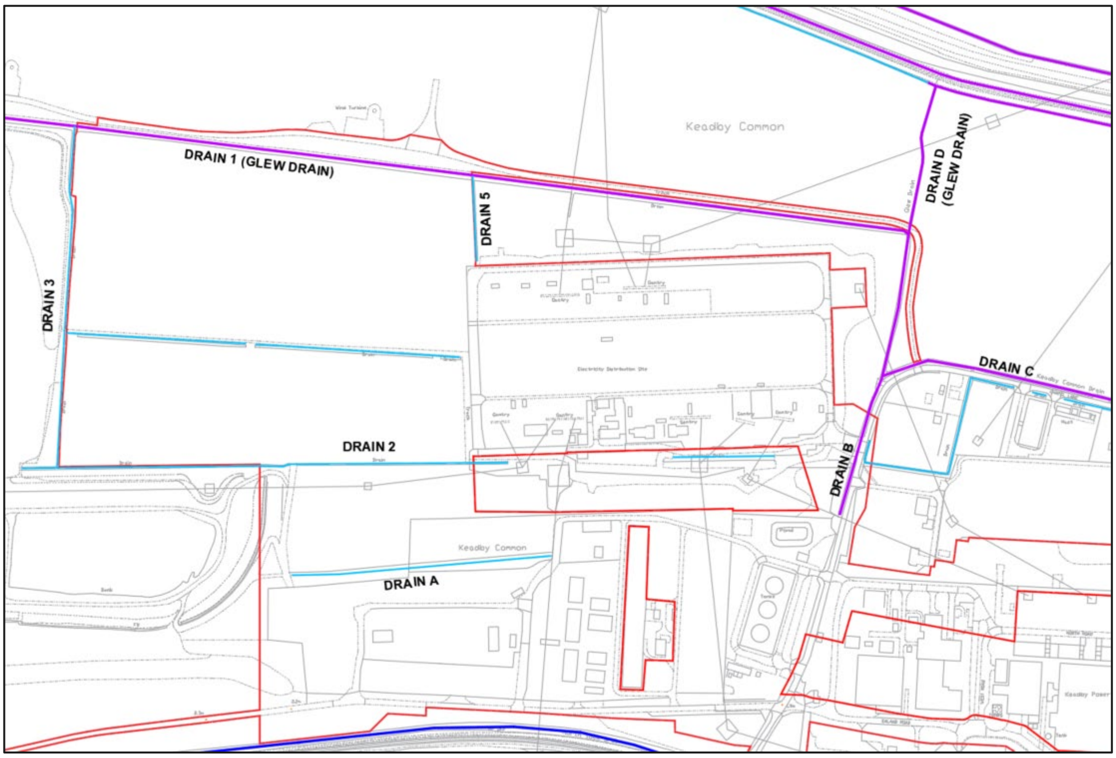


Plate 12A.3 Existing land drains in and around the Site (Extract from the Outline Drainage Strategy Plate 4-1 (Annex 3))

12A.9.9. The discharge rates are to be agreed and consented by the IDB. The drainage strategy assumes discharge at greenfield rates (50% AEP). The strategy states an anticipated 1% AEP design event, with an additional climate change allowance of 45% (Upper End). The strategy references the NLC SuDS guidance document and the requirement for the drainage to be designed to prevent flooding in this event.

12A.9.10. In scenarios where the ditch network becomes full while the land remains dry, the permanent development drainage system for development outside the main infrastructure area (e.g. **Plate 12A.3** area B and C) will be unable to discharge as it is not located within the land raising and flooding of the drainage system would occur. The drainage strategy also references the risk of tidal flooding and (if defences fail) fluvial flooding at the Site. It is noted the risk of flooding to drainage networks and attenuation in raised areas will be minimal however drainage systems in non-raised areas of the Site will be at high risk of flooding. In this instance runoff from the Site and attenuated flows would mix with floodwater and would no longer be controlled (unless stored in closed systems). This is the current Site response and it is not anticipated the additional runoff will be significant compared with existing flood volumes.

12A.9.11. The detailed design of the surface water drainage network will account for fluvial and tidal inundation risk by ensuring that inspection and maintenance of assets can be easily undertaken following flood events. Additionally, sensitive drainage assets, such as pumps, should be isolated and protected from inundation using sluice gates or similar mechanisms that can be closed prior to forecasted fluvial and tidal flood events (noting there may be little warning in the event of defence failure). It is expected that sensitive assets would be preferentially located on raised land where this risk is removed.

12A.10. Mitigation of Flood Risks, Residual Risks and Off-Site Impacts

Overview

12A.10.1. This section describes the proposed measures for the construction and operation phases of the Proposed Development to mitigate flood risk to an acceptable level and minimise any off-site impacts. Some of the mitigation measures have been incorporated into the design of the Proposed Development. Others have been included in the **Outline Construction Environmental Management Plan** (CEMP) (**Application Document Ref. 7.4)** which will be developed by the Contractor into a final CEMP as a Requirement of the **Draft DCO (Application Document Ref. 3.1)**.

12A.10.2. This section includes assessment of the risk of flooding to the Proposed Development with the mitigation measures in place and assessment of any off-site impacts resulting from the Proposed Development.

Construction

12A.10.3. Construction works undertaken adjacent to, beneath and within watercourses to comply with relevant guidance during construction, including the requirements of any Environmental Permit, Ordinary Watercourse Consent and/ or IDB Byelaws, particularly AN01, AN02, AN03, AN05 and AN06.

12A.10.4. A Flood Risk Activity Permit (FRAP) is likely to be required for certain works close to EA main rivers and flood defences, including works over Hatfield Waste Drain.

12A.10.5. The **Outline CEMP** (**Application Document Ref. 7.4**), which accompanies the ES, incorporates measures aimed at preventing an increase in flood risk during construction works, as far as reasonably practicable. This includes measures to prevent an increase in flood risk during the construction works. Examples of such measures include:

- adequate containment of storage areas, to ensure that material does not wash away and cause pollution and damage to infrastructure;
- Stockpiles and storage areas to be located away from watercourses and land drains;
- the construction laydown area site office and supervisor will be notified of any potential flood occurring by use of the ‘Floodline Warnings Direct’ service;

- the Contractor will be required to produce a Flood Risk Management Action Plan/ Method Statement which will provide details of the response to an impending flood and include:
  - a 24 hour availability and ability to mobilise staff in the event of a flood warning;
  - the removal of all plant, machinery and material capable of being mobilised in a flood for the duration of any holiday close down period;
  - details of the evacuation and site closedown procedures; and
  - arrangements for removing any potentially hazardous material and anything capable of becoming entrained in floodwaters, from the temporary works area.

12A.10.6. Due to the risk to construction personnel and equipment resulting from a breach of defences on the River Trent, construction works should not take place during times of high flow when there is a Flood Alert.

Residual risk to the Proposed Development during construction

12A.10.7. The measures incorporated in **the Outline CEMP (Application Document Ref. 7.4)** will help to reduce the likelihood of flooding affecting construction works and laydown areas however considering that some works will take place directly in or above watercourses it will not be possible to remove the risk entirely.

12A.10.8. The Site is at risk of flooding due to a breach in the River Trent defences and parts of the Site may be at risk from defence overtopping (south of the canal) and close to the River Trent (water discharge corridor and landscape / planting area). Further mitigation is reliant on the effective deployment of a flood risk management action plan, to seek to evacuate site personnel and (where possible) remove plant, machinery and material away from the areas at risk prior to a flood occurring.

Off-site impacts during construction

12A.10.9. Implementation of the measures described above is expected to reduce the likelihood of any significant increase in flood risk from the local drains and IDB watercourses resulting from construction activities in the vicinity. During significant flood events there may be some localised displacement of floodwater (for example at stockpiles). However as the flooding is extensive this is highly unlikely to have any significant impact on flood extents or depths in the wider area.

12A.10.10. The cofferdam required for the canal abstraction will slightly reduce the flow capacity and storage volume available in the canal, however this is reasonably small compared with the size of the canal and as water levels are controlled it is not expected to lead to any significant change in flood risk. In consultation the CRT agreed a significant impact is unlikely, referencing a recent modelling study for another project which showed a significant constriction is necessary to have any significant impact and the proposed extent of cofferdam does is not of a scale to be a significant constriction.

Operation

12A.10.11. The Applicant does not intend to build new flood defences for the Site. Rather, the Proposed Development will be designed taking into account the flood risk to the Site.

12A.10.12. The following mitigation measures have been considered to protect the Proposed Development in accordance with the legislative and regulatory authority requirements:

- flood resistance and resilience measures (including raising critical operational infrastructure);
- flood emergency response plans;
- flood warnings and alerts;
- emergency access and egress; and
- design capacity exceedance.

12A.10.13. It is expected that required mitigation, including protection of critical operational infrastructure, would be secured by Requirement of the final DCO.

Flood Resistance and Resilience Measures

12A.10.14. The following flood resilience and resistance mitigation measures have been considered to ensure the effective operation of the Proposed Development is maintained, and to ensure the safety of people:

- flood resistant/ resilient design;
- raising external ground levels; and
- elevating critical operational infrastructure above the peak flood inundation level.

12A.10.15. CIRIA Report C688 (2010) ‘Flood Resilience and Resistance for Critical Infrastructure’, states that:

12A.10.16. “*Flood resilience involves designing an infrastructure asset, or adapting an existing infrastructure asset so that although it comes into contact with floodwater during floods, no permanent damage is caused, structural integrity is maintained and, if operational disruption does occur, normal operation can resume rapidly after a flood has receded. Flood resistance involves designing an infrastructure asset or adapting and existing infrastructure asset so that floodwater is excluded during flood events and normal operation can continue with no disruption occurring to the essential services the asset provides*”.

12A.10.17. In order to protect against the risk from defence overtopping and residual risk of breach, it is proposed ground levels in the main parts of the Site (**Plate 12A.3** areas A, B and C) will be raised above the modelled breach flood level for the ‘design event’, the 0.5% AEP tidal event including for climate change for the lifetime of the Proposed Development (currently assumed to be 2105 as a precautionary estimate). **Table 12A.10** provides a comparison of the Proposed Development levels, modelled flood levels and freeboard. In line with the NPS, emphasis on a risk averse approach for safety critical infrastructure, land raising and raised floor levels are preferred over secondary defences. This reduces dependency on active intervention during a flood (for example to close gates) where there may be insufficient warning in a breach situation. It also reduces concerns over structural stability under rapid flow conditions and high flood depths.

12A.10.18. The main developed parts of the Site (**Plate 12A.3** areas A, B and C) will be raised to 3.0 m AOD. It is also proposed that critical operational infrastructure is raised to a level of 4.1m AOD (i.e. the CFL +300mm) where reasonably practical to do so, or a minimum of 1m above the development platform level (4.0m AOD). A minimum finished floor level of 3.3m AOD has been defined for manned buildings on the main area of the Site (e.g. Workshops/ Control/ Admin buildings). Safe refuge will be available for staff working within the other parts of the main area of the Site (**Plate 12A.3** areas A and B).

12A.10.19. The A18 gatehouse will be occupied on an ad-hoc basis, for example during maintenance periods when there is a high volume of deliveries. Ground raising is not proposed; however, safe refuge will be provided and the potential for rapid breach flows and need to provide safe refuge in this circumstance will be considered. The available model results show the maximum modelled flood level (representative of the 0.5% AEP breach event (2105)) at the A18 is approximately 1.75m AOD. Incorporating a 300mm freeboard provides a level of 2.05m AOD, which will be considered in the design of safe refuge for this facility.

12A.10.20. The modelled breach events result in higher flood levels at the Site than overtopping of defences. The risk of overtopping in the future as a result of climate change driven sea level rise assumes that in the intervening period, no raising of the River Trent tidal defences occurs. This is a highly conservative assumption and given the areas of land and property at risk across the wider area, it would be reasonable to assume that future defence raising, and upgrades may continue to protect the Site, mitigating the overtopping risk. This cannot however be relied upon. The proposed ground raising will mitigate the risk to the main development area (**Plate 12A.3** areas A, B and C).

12A.10.21. Where necessary, it is recommended that spares for critical operational infrastructure items should be kept on site (where possible) to reduce the potential recovery time in the event of a major flood event.

12A.10.22. The following measures should also be considered in the detailed design of the Proposed Development:

- boundary walls and fencing designed with high water resistance materials and/ or effective seals to minimise water penetration for low depth, short duration floods;
- tanks bunded to a level higher than the 'design event' 0.5% AEP plus climate change breach flood level for the lifetime of the Proposed Development;
- pollution control considered to prevent/ reduce the chance of any fuel/ material stored on site leaking;
- site drainage and landscape design following guidance (e.g. CIRIA C635) to minimise the risk from exceedance flows and any overland flow entering the Proposed Development buildings;
- landscaping of the Site to direct or divert floodwater away from buildings; and
- SuDS designed to manage surface water flood risk and water quality.

12A.10.23. The following measures are potentially also appropriate for consideration in the detailed design of the Proposed Development depending on risk:

- pipelines and storage tanks designed to withstand the water pressures associated with high return period event flooding;
- tanks securely tethered in such a way to ensure the infrastructure remains secure should flooding occur;
- electrical supply entering the Proposed Development from height and down to required connections;

- use of flood barriers on access points;
- protecting wiring for operational control of the Proposed Development, telephone, internet and other services by suitable insulation in the distribution ducts to prevent damage;
- materials with low permeability up to 300mm and accept water passage through building at higher water depths;
- flood proofing including the use of flood resistant building materials, use of water-resistant coatings, use of galvanised and stainless-steel fixings and raising electrical sockets and switches;
- utilising floor materials that are able to withstand exposure to floodwater without significant deterioration and that can be easily cleaned, e.g. concrete-based or stone;
- incorporating water resistant services within the buildings, i.e. avoid services using ferrous materials;
- design development to drain water away after flooding;
- provide access to all spaces to permit drying and cleaning;
- carefully considering the type of usage and layout of ground floor areas to minimise the potential impact on business operations following a flood; and
- suitable waterproofing measures to development located below ground i.e. tanking below ground storage areas etc.

Flood Emergency Response Plan

12A.10.24. With the above measures in place the majority of the developed areas of the Site, including proposed buildings and critical operational infrastructure, is deemed at a low residual risk of flooding. However the flood hazard across the remainder of the Site could potentially be very high and in the event of defence failure onset of flooding could be very fast. Therefore, a system should be put in place to safeguard the site occupants.

12A.10.25. A Flood Emergency Response Plan should be developed for the Proposed Development. This should link closely with the wider Keadby Power Station Site emergency response plans and management system procedures to ensure the residual risk is managed over the lifetime of the Proposed Development. This will include the recommendation of at least one designated Flood Warden to be appointed for the Site who is familiar with the risks and remains vigilant to news reports, EA flood warnings and water levels in the River Trent.

12A.10.26. The Flood Emergency Response Plan should be prepared in consultation with the EA, LLFA, Local Resilience Forum and local emergency planning teams and should cover emergency situations both during core (24/7) operating hours and over holiday periods / planned outages. The plan should define access and egress routes from the Site with recommendations on the most appropriate route depending on location, signage strategy in and around the area and congregation points. The Plan also needs consider situations where safe access and egress is not available, both within the Site and to the wider area. The Plan should include the Proposed Development being registered to receive flood warnings from the EA's 'Floodline Warnings Direct' service to inform if there is a risk of flooding from a tidal storm surge type event, which could result in overtopping or breach of defences, or a significant local fluvial event.

12A.10.27. As the Flood Emergency Response Plan will be set up to manage the residual risk of flooding, careful consideration should be undertaken as to what action will be taken at each level of warning. The plan will define how occupants of the Site will be evacuated to an appropriate safe place of refuge should the water level in the River Trent become high and the probability of breach subsequently increase, to provide for the safety of all occupants, recognising that due to the nature of operations as 'essential infrastructure', it is important to only evacuate when essential to do so.

Flood Warnings and Alerts

12A.10.28. The EA operates a Flood Warning Service for many areas at risk of fluvial and tidal flooding. It should be noted that the Flood Warning Service cannot be relied upon to cover a breach situation, however it may help forewarn of conditions under which a breach may be more likely to occur. The service currently consists of three stages:

- **Flood Alert** - flooding is possible and that you need to be prepared;
- **Flood Warning** - flooding is expected and that you should take immediate action. Action should be taken when a flood warning is issued and not wait for a severe flood warning; and
- **Severe Flood Warning** – flooding could be a risk to life and significant disruption to communities.

12A.10.29. All stages of warning are disseminated via the 'Floodline Warnings Direct', which is a free service that provides warnings to registered customers by telephone, mobile, email, and SMS text message. Local radio, TV, loudhailers, sirens and Floodline are also used to deliver flood warning messages. The Floodline number is 0345 988 1188, and it is always kept up to date with the EA's latest flooding information.

12A.10.30. More detailed information on the likely extent and time scale of these warnings can be obtained by request from the EA, by their 'Quickdial' recorded information service, or via their website.

12A.10.31. For any proposed commercial or industrial developments within a designated floodplain (as in the case of the Site), a system for monitoring flood warnings should be developed with designated responsible persons (site managers) able to monitor and disseminate the warnings. This will enable site personnel to be alert to the potential hazard and, should it become necessary, provide more time to enable emergency access and egress of staff occupants away from the local area which may become flooded during a flood event (including routes for egress) prior to inundation. They should also provide more time to implement protection measures for any equipment on site through sealing all external doors to prevent flood inflow into such buildings should this be necessary.

12A.10.32. The Site is located within a designated EA Flood Alert Area (short code 034WAB420, covering tidal flooding of the River Trent for riverside areas from Gainsborough to the Humber confluence, including West Stockwith, Wildsworth, East Ferry, East and West Butterwick, Derrythorpe, Gunness and Keadby).

12A.10.33. The Site is located within two designated EA Flood Warning Areas (FWA) (short code names 034FWBTRKEADBY, covering the River Trent at Scunthorpe including isolated properties from the M180 to the Humber Confluence, and 034FWBTRCROWLE, covering the River Trent at Crowle including isolated properties from the M180 to the Humber Confluence).

Emergency Access and Egress

12A.10.34. An emergency access and egress route is a route that is 'safe' for use by occupiers without the intervention of the emergency services or others. A route can only be completely 'safe' in flood risk terms if it is dry at all times.

12A.10.35. Safe access and egress from new developments are as follows in order of preference:

- safe, dry route for people and vehicles;
- safe, dry route for people;

- if a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people; and
- if a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles.

12A.10.36. For 'essential infrastructure' development, dry access and egress from the Site is desirable during times of extreme floods. However, areas behind defences are at particular risk from rapid onset of fast-flowing and deep flooding, with little or no warning if defences are overtopped or breached. The Site and immediate surrounding area is located in an area of high hazard during the event of a breach. Safe access therefore cannot be guaranteed and it is recommended the Site is evacuated immediately upon a decision by the Applicant that this is necessary unless it is unsafe to do so, in which case a place of safe refuge will be provided and sought on-site. Staff required to remain on Site should be aware that movement between the various areas of the Site will be restricted for the duration of the event as the flood hazard is high outside of the three raised areas. This includes the access routes to and within the Site.

Places of Safe Refuge

12A.10.37. Places of safe refuge are generally considered an acceptable approach to flood risk management in areas adjacent to tidal river defences as in the event of a defence breach inundation is likely to be rapid and therefore evacuation from the site and local area can sometimes be an unsafe option.

12A.10.38. Rooms should be allocated and adapted to provide adequate facilities to provide a place of safe refuge including welfare facilities for employees; where possible it is recommended these are provided above ground floor level. It is proposed that safe refuge areas within the main infrastructure area and the administration and control buildings (**Plate 12A.2** areas A and C) will have a minimum floor level of 3.3m AOD. For the A18 Gatehouse, a 300mm freeboard to the maximum modelled flood level at the A18 (i.e. 2.05m AOD) which will be considered in the design of safe refuge. **Plate 12A.2** Area B (AGI) will not be regularly occupied, with staff only accessing for planned maintenance activities. The Flood Emergency Response Plan will include measures to avoid work in this area when there is a higher risk of flooding.

Drainage System Failure, Capacity Exceedance and Maintenance

12A.10.39. Following the completion of the Proposed Development, an additional residual risk relates to maintenance of the on-site drainage infrastructure. Failure, blockage and capacity exceedance above that of the design events for the drainage system are a potential risk to the Site and the surrounding area.

12A.10.40. In order to reduce the risks, an inspection and maintenance programme should be put in place for the drainage infrastructure to prevent/ minimise the residual risk of flooding from this source, should it occur.

12A.10.41. CIRIA C635 (CIRIA, 2006) provides guidance on measures that can be incorporated into the detailed design of developments to steer surface water that has exceeded the capacity of the drainage system away from buildings and route it towards the intended point of attenuation and discharge (for example along swales and roads using raised kerbing and through parking areas). The proposed drainage infrastructure design should be agreed with the LLFA and IDB before construction to ensure that the risks of flooding from drainage infrastructure are not increased due to the Proposed Development.

Residual risk to the Proposed Development during operation

Main area of the Site

12A.10.42. With the recommended mitigation in place the residual risk to the main facilities and infrastructure in the Proposed Development is low. Figures 7a, 7b, 8a and 8b (Annex 2) show the modelled tidal flood depths for the 2065 and 2105 scenarios with the Proposed Development. **Table 12A.10** summarises the Proposed Development levels and modelled flood levels with the proposed ground raising (extracted from the AECOM model used for this FRA).

Table 12A.10 Modelled flood levels (adjacent to the raised areas) and freeboard

	A: Main Infrastructure	B: AGI	C: Administration & Control
0.5% AEP Defended flood level (2065)	0.98m AOD	n/a (flooding does not reach the plot)	n/a (flooding does not reach the plot)
0.5% AEP Breach flood level (2065)	2.69m AOD	2.69m AOD	2.77m AOD

	A: Main Infrastructure	B: AGI	C: Administration & Control
0.5% AEP Defended flood level (2105)	2.08m AOD	2.08m AOD	2.08m AOD
0.5% AEP Breach flood level (2105)	2.89m AOD	2.89m AOD	2.97m AOD
SFRA Critical flood level (CFL)	3.8m AOD		
Proposed ground Level	3.0m AOD 2065: Min 0.3m freeboard 2105: Min 0.1m freeboard	3.0m AOD 2065: Min 0.3m freeboard 2105: Min 0.1m freeboard	3.0m AOD 2065: Min 0.2m freeboard 2105: Minimal freeboard
Minimum floor level (safe refuge)	3.3m AOD 2065: Min 0.6m freeboard 2105: Min 0.4m freeboard	n/a	3.3m AOD 2065: Min 0.5m freeboard 2105: Min 0.3m freeboard
Minimum critical infrastructure level	4.0m AOD 2065: Min 1.3m freeboard 2105: Min 1.1m freeboard Min 0.2m freeboard to SFRA CFL	4.0m AOD 2065: Min 1.3m freeboard 2105: Min 1.1m freeboard Min 0.2m freeboard to SFRA CFL	n/a

12A.10.43. The raised development plots are shown to remain flood free in all the modelled tidal events (including breach). For the expected maximum lifetime (2065) a minimum 300mm freeboard is achieved to the plots where critical infrastructure will be located and 200mm to the administration and control plot. The freeboard is reduced for the precautionary lifetime (2105) but the plots remain flood free.

12A.10.44. Additional mitigation, to further raise critical infrastructure and incorporate resistance measures, will minimise the likelihood of flooding even in the event of multiple failures (such as defence breach and failure of the pumped drainage systems) such that the energy infrastructure can remain operational and minimise any long-term damage to the Proposed Development that would prevent it resuming full operation after a flood. The minimum proposed level for critical infrastructure (4m AOD) provides over 1m freeboard to all modelled tidal flood levels and 200mm freeboard to the SFRA CFL. This will also mitigate the risk of flooding in the event of failure or exceedance of the on-site drainage system.

12A.10.45. Safe refuge areas are provided with a minimum freeboard of 500mm for the expected maximum development lifetime (2065) and 300mm for the precautionary development lifetime (2105).

12A.10.46. In the defended scenario, including the Proposed Development, the majority of the Site remains flood free for the expected lifetime to 2065 (Figure 7a, Annex 2). The model results show flooding to the water connections corridor and landscape / planting areas. Where possible, equipment in these areas should be sealed to prevent water ingress however equipment in these areas is not deemed critical to the effective operation and rapid recovery of the Proposed Development. The available model results from the EA Tidal Trent and AECOM FRA models indicate safe access and egress is likely to be feasible within the Site and via the southern access road to the A18, although flooding in the wider area may impact on wider transport networks.

12A.10.47. Localised flooding may occur through exceedance of the Site drainage system or local drainage network. This is unlikely in the raised development areas, where the main infrastructure and buildings are located. The available information suggests potential flood volumes are insufficient to lead to flooding of any significant depth or hazard across the majority of the Site but there may be some impact to the remainder of the Site and access routes if water pools to any depth. It is recommended this is considered in detailed design, with site levels designed to direct exceedance flows away from infrastructure and access routes.

12A.10.48. For the precautionary lifetime (to 2105) and in the event of breach (Figures 7b, 8a and 8b, Annex 2) parts of the main area of the Site remain at high risk of flooding, including the access routes and water connections corridors. The model results show flood depths reaching around 2m in the breach scenario.

12A.10.49. In these residual risk scenarios the flood risks are such that safe access and egress cannot be guaranteed for the Proposed Development. A Flood

Emergency Response Plan, including signing up to the EA Flood Warning Service, will help to mitigate this risk allowing for personnel to be evacuated from Site in advance of a flood where possible. Where staff are required to remain on site, or the speed of flooding does not allow for safe evacuation, places of safe refuge will be available.

12A.10.50. Flooding is likely to compromise the drainage infrastructure in the lower lying parts of the Site leading to uncontrolled discharges however runoff volumes on the Site are negligible compared to the tidal flood volumes.

Southern access road and A18 gatehouse

12A.10.51. There remains some residual fluvial and tidal flood risk to the southern part of the Site (south of the canal). As described in Section 12A.8, fluvial flooding may slightly encroach into the Site boundary however it is not anticipated to lead to any significant impact to the Proposed Development.

12A.10.52. In the defended scenario the EA Tidal Trent model shows limited flooding affecting this part of the Site for the expected lifetime to 2065. A short section of the access road is shown at risk, but with reasonably shallow flood depths not exceeding 200mm. For the precautionary lifetime (2105) and in the event of breach the majority of the Site is shown at risk of flooding and flood depths are such that the access road may be compromised. However, safe refuge will be available in the A18 gatehouse should it be in use at the time. No infrastructure is located in this part of the Site.

Credible Maximum climate change

12A.10.53. As an NSIP the resilience to the “Credible Maximum” climate change has been considered. Model data is not available for this scenario however the assumed sea level rise is 1.9m, approximately 600mm greater than the 1.3m used in the EA Tidal Trent model and considered for the 2105 assessment year in this FRA.

12A.10.54. **Plate 12A.5** compares the modelled water levels in the River Trent at the confluence with the Humber and the vicinity of the Site. As can be seen, once water levels in the River Trent exceed around 6.2m AOD at Keadby Bridge (where wide scale overtopping of defences occurs) the water level in the River Trent is less sensitive to changes in the downstream level. The modelled scenarios apply the sea level rise directly to the downstream boundary of the River Trent, where it joins the Humber Estuary. However the EA Tidal Trent model also included a scenario where the sea level rise was applied to the Humber Estuary model and the water level at the River

Trent was extracted from that model. This produced a water level at the downstream boundary of the River Trent approximately 860mm lower for the same event.

12A.10.55. Estimates of the 0.5% AEP flood level at Keadby Bridge have been derived for the Credible Maximum sea level rise (**Table 12A.11**) assuming linear extrapolation of the available modelled levels. This assumes the additional 600mm sea level rise would translate directly to the same increase at the downstream boundary of the River Trent. However, as noted, the results using the Humber Estuary model suggest the increase would be smaller in reality.

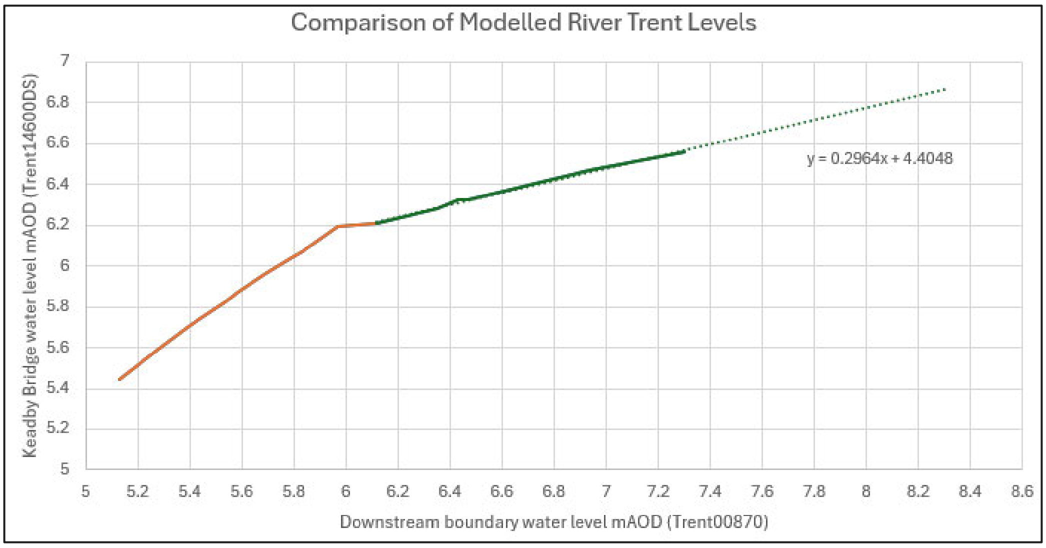


Plate 12A.4 Comparison of modelled River Trent Levels (EA Tidal Trent model, Jacobs 2023)

Table 12A.11 Estimated River Trent Levels for the Credible Maximum sea level rise

	Water Level (mAOD)	
	Downstream boundary (Trent00870)	**Keadby Bridge (Trent14600DS)**
Modelled		
2121 Upper End	7.30	6.56
2121 Humber Estuary extract	6.43	6.33
Derived Credible Maximum		
Based on 2121 Upper End	7.86	6.73

Based on 2121 Humber Estuary extract	6.99	6.48

12A.10.56. The derived water level at Keadby Bridge based on the Humber Estuary extract is lower than the modelled 2121 Upper End level. Therefore it is likely that the flooding already assessed for the FRA 2105 assessment year is representative of the Credible Maximum scenario. The higher derived level in the Trent (6.73m AOD) is approximately 180mm above that previously assessed and used in the AECOM modelling. Once flood flows spread onto the floodplain (either via overtopping or breach) maximum flood levels are controlled by the local topography and will tend to increase by a smaller amount than the increase in water level in the River Trent itself.

12A.10.57. On this basis it is considered possible that flood levels will exceed the Proposed Development platform levels but they are unlikely to reach the critical infrastructure or safe refuge level.

Off-site impacts during operation

Ground raising within the main area of the Site

12A.10.58. The raised development platforms will locally deflect floodwater. This has been tested in the AECOM model. Figures 9 to 11 (Annex 2) show the differences in modelled flood depths.

12A.10.59. In the defended scenarios the results show very little change between baseline and Proposed Development. In these scenarios the bulk of inflow to the model is via the overland flows on the north and north east boundaries of the model, rather than over the defences immediately alongside the Site. The model results show that floodwaters fill the area tending towards a maximum flood level where an equilibrium is achieved between flows entering and leaving the model area. The volume of flood storage removed due to the Proposed Development is minor in comparison with the total flood volume in the area. Minor pockets of increased flood depth are shown for 2065 in the surrounding agricultural land. The reasons for this are unclear and likely due to model anomalies or minor changes in flow patterns which result in larger depths where waters pool. The increases are reasonably small, typically less than 50mm, in rural areas with no properties in the vicinity.

12A.10.60. In the breach scenarios, the majority of flow enters the model via the breach and therefore the Proposed Development has more of an effect as flows are diverted around the raised plots. An increase of between 10 and 100mm is shown across the existing Keadby power station and part of Keadby village (including undeveloped land) north of the canal. The existing flood depths are highly variable but exceed 1m across most of this area and are well above 2m in places. Existing flood depths are lower at the main Keadby power station site, generally in the region of 200 – 500mm (2065) and 400 – 700mm (2105).

12A.10.61. Larger increases in flood depth (100 to 300mm) are shown in the Keadby power station site immediately east of where the main infrastructure and AGI will be located (areas A and C) as the raised ground largely closes the flow path across Keadby Common. An associated reduction in flood depth is seen north of Keadby Common. The increase in flood depth is typically in the region of 300mm. The main area impacted is a temporary car park area used for the construction of Keadby 2 power station where modelled flood depths already exceed 1m in places. The majority of this area lies within the Site boundary but is not proposed for development at this time.

12A.10.62. In these breach scenarios higher flood depths are shown along part of the rail line which runs between the North Soak Drain and the canal. The maximum increase is up to around 200mm (2065) and 260mm (2105) compared with existing maximum flood depths along the line of around 250mm (2065) and 350mm (2105). Therefore whilst the increase in flood depth is reasonably large it is likely the operation of the railway would be compromised in this type of event in any case. Additional repairs may be needed following a flood however it should be noted this represents a low probability breach scenario.

12A.10.63. The model results show an increase in flood depth in the North Soak Drain in the vicinity of the Site however there is no significant change in flows leaving the model via the North Soak Drain so increased flood risk in the wider drainage network is not expected.

12A.10.64. The change in flood depth at identified properties across the study area has also been assessed (refer to Annex 2). In the defended scenarios minimal change in flood depth (<1mm) is shown. In the breach scenarios some properties are shown to have an increase in flood depth of up to 90mm. The largest increase shown to a residential property is 60mm. In most instances where these larger increases are seen the existing modelled flood depths are significant, several hundred millimetres or over a metre in places.

12A.10.65. The proposed ground raising will require some infilling of existing drains however as outlined in the drainage strategy connectivity will be maintained. The Proposed Development may result in localised changes in flooding from surface water or these smaller watercourses where floodwaters are diverted away from the raised areas. However, as flood volumes are small this will be largely constrained to the Site itself and land in the immediate vicinity. There are no identified third party properties which may be affected.

12A.10.66. The increases in maximum flood depths due to the Proposed Development are typically minor in comparison with the existing flooding shown and are not considered to make any material change to the flood risk for the affected land, properties and infrastructure. The findings have been shared with the EA who confirmed they are acceptable. These breach scenarios are unlikely to occur in practice as they require a major defence failure to occur in combination with the tidal flood event. In addition they take no account of defence improvements which are expected to take place in line with the flood risk management strategy for the Humber area.

Southern access road and A18 gatehouse

12A.10.67. There are no significant changes in ground levels proposed in the southern part of the Site. There may be some localised changes in flood flows around the gatehouse or due to minor topographic changes around the access road but this is only likely to affect the immediate area which consists of undeveloped land. There are no identified third party properties which may be affected.

Proposed watercourse crossings and canal abstraction

12A.10.68. The Proposed Development includes two watercourse crossings: a replacement of the existing Mabey Bridge and a new crossing of the IDB watercourse at the northern boundary of the Site

12A.10.69. The design of Mabey Bridge Replacement has taken into account feedback from the EA received for Keadby CCS Power Station regarding the need to maintain clearance equivalent to the existing soffit level, where it is not practical to design to the CFL. The current design achieves a higher soffit level than the existing bridge and incorporates a precamber curve so that the soffit level is increased towards midspan. The final soffit levels will be determined at detailed design, but the current design has a minimum soffit level of 1.45m AOD, higher than the maximum modelled fluvial flood level of approximately 1m AOD. The bridge is therefore not expected to lead to any significant change in flood risk from the Hatfield Waste Drain.

12A.10.70. Design information is not available for the northern emergency access. It is anticipated this will be a clear span structure but soffit levels and any clearance provided to flood levels in the IDB drain are unknown at this time. There is no available model data for the IDB drain. The crossing, potentially including approach embankments, may restrict flows in this watercourse during periods of high flow however if this were to occur any impacts will be localised with floodwaters able to re-enter the channel downstream of the crossing. There are no properties in the vicinity. It is recommended this is considered further in detailed design. If possible the crossing should be designed to provide clearance to the 1% AEP (climate change) flood level and proposed levels should be designed to direct exceedance flows back to the channel.

12A.10.71. Cooling water will be sourced from the Stainforth and Keadby Canal with a new intake structure constructed within the canal. It is anticipated the structure will be of a similar design to the existing Keadby 2 abstraction structure, and will have an intrusion into the canal of around 5m. The structure will slightly reduce flow width at this location, but it is a small change compared with the size of the canal. As water levels are controlled, it is not expected to lead to any significant change in flood risk. As noted in Section 12A.10, the CRT agreed any significant impact is unlikely.

12A.10.72. Annex 4 includes an assessment of the potential impact of raising Keadby lock gate on flood risk from the canal. The assessment was completed for the Keadby CCS Power Station project, however the proposed works are anticipated to be the same for the Proposed Development. The assessment concluded the changes to the lock gate would not have any significant impact to flood risk to the canal as the changes would not alter the normal water level in the canal and the lock gate would still be below the overtopping level, allowing excess flows to continue to spill over the gate into the River Trent.

Surface water runoff

12A.10.73. The Proposed Development will lead to an increase in impermeable surfaces on the Site and a subsequent increase in runoff. The outline drainage strategy proposes that runoff will be attenuated to greenfield runoff rates discharging to the IDB drainage system. Significant changes in flows and flood risk from the receiving watercourses is therefore unlikely.

12A.10.74. There is potential for exceedance of the drainage system which may lead to uncontrolled runoff leaving the Site. This may occur when high water levels in the receiving watercourses prevent discharge, due to blockage or failure, or during periods of flood when the Site and drainage system is inundated. Considering the current flow volumes in the drainage network the additional runoff from the Site is unlikely to lead to any significant increase in flood risk from the wider network. The volume is negligible compared with the tidal flood volumes in the area. It is recommended that exceedance is considered further during detailed design. If feasible the drainage should be designed to accommodate runoff during periods of high water levels in the receiving watercourses. Levels should be designed to direct exceedance flows away from properties towards less vulnerable areas.

Decommissioning

12A.10.75. At the end of its operating life, which is predicted to be around 2065, it is anticipated most of the above-ground equipment associated with the Proposed Development will be decommissioned and removed from the Site. Prior to removing the plant and equipment, all residues and operating chemicals would be cleaned out from the plant and disposed of in an appropriate manner to manage any potential for pollution risk.

12A.10.76. Once the plant and equipment have been removed to ground level, it is expected that the hardstanding and sealed concrete areas will be left in place. Any areas of the Proposed Development that are below ground level will be backfilled to ground level to leave a levelled area. It is unknown at this stage whether the raised development platforms will be removed but for the purposes of this assessment it is assumed they will remain.

12A.10.77. It is expected that a Decommissioning Plan (including DEMP) will be produced and agreed with the EA as part of the Environmental Permitting and site surrender process. The DEMP will consider in detail all potential environmental risks and contain guidance on how risks can be removed, mitigated or managed. This will include details of how surface water drainage should be managed during decommissioning and demolition.

12A.10.78. It is anticipated the DEMP will include similar measures to the **Outline CEMP** (**Application Document Ref. 7.**4) regarding mitigation of flood risks and adoption of a flood risk mitigation plan.

Residual risk to the Proposed Development during decommissioning

12A.10.79. Decommissioning works taking place on the raised development areas are at a low risk of flooding. The measures to be incorporated in a DEMP will help to reduce the likelihood of flooding affecting the decommissioning works and workers in other areas however considering that some works will take place directly in or above watercourses it will not be possible to remove the risk entirely.

12A.10.80. Outside of the raised development platforms areas the Site may be at significant risk of flooding due to overtopping or a breach in the River Trent defences. Climate change effects are expected to lead to more frequent and more severe flood risk than experienced during the construction phase although this may be mitigated by defence improvements in line with the flood risk management strategy for the area. As the flood risk is already significant in places this does not fundamentally change the recommended approach to manage those risks. The raised development areas may provide a safe place of refuge during the decommissioning phase.

12A.10.81. Further mitigation is reliant on the effective deployment of a flood risk management action plan, to seek to evacuate site personnel and (where possible) remove plant, machinery and material away from the areas at risk prior to a flood occurring.

Off-site impacts during decommissioning

12A.10.82. Implementation of the measures described above is expected to reduce the likelihood of any significant increase in flood risk from the local drains and IDB watercourses resulting from decommissioning activities in the vicinity. During significant flood events there may be some localised displacement of floodwater. However, as the flooding is extensive this is highly unlikely to have any significant impact on flood extents or depths in the wider area.

12A.10.83. In consultation, the EA requested assessment of the impact of the ground raising against the modelled EA Tidal Trent 2121 scenario, to consider the longer term effects beyond the expected lifetime of the Proposed Development. As this scenario has been used to provide model inflows for the 2105 assessment year used in this FRA this has therefore been assessed.

12A.11. Summary and Conclusions

Flood Risk Summary

12A.11.1. This FRA serves to demonstrate that the Proposed Development can remain safe during its lifetime and is unlikely to materially increase flood risk elsewhere. The following conclusions can be made regarding flood risk to the Proposed Development.

Tidal Sources

12A.11.2. The majority of the Site is currently (Present Day) at a low risk of flooding from tidal sources with the defences in place. Over the lifetime of the development the risk is potentially more significant. Flooding is shown to reach the main area of the Site with significant flood depths, particularly for the precautionary design lifetime (to 2105), not allowing for defence improvements to mitigate the effect of climate change. This is a highly conservative assumption and given the areas of land and property at risk across the wider area, it is reasonable to assume that future defence raising and upgrades may continue to protect the Site, mitigating the overtopping risk.

12A.11.3. In the event that the defences were to breach, the hazard to the Site in its unmitigated state would be high as flood waters would rapidly reach the Site and areas would flood to depths well over 1m in places. However, the probability of this occurring is low, as to occur it requires both a high water level in the River Trent and a structural defence failure, and this is a residual risk.

12A.11.4. Appropriate mitigation measures will be incorporated to mitigate this residual risk and ensure the occupiers of the Site are safe and critical operational infrastructure can continue to function in the event of such inundation. The areas of the Site where the main infrastructure and administration and control buildings are located will be raised to 3m AOD with critical operational infrastructure raised a further circa 1m above this. Consideration would be given at the detailed design stage to raising critical operational infrastructure further, taking into account the SFRA CFL + 300mm freeboard (up to 4.1m AOD) where it is reasonably practicable to do so.

12A.11.5. A safe place of refuge will be provided for employees with a minimum internal finished floor level of 3.3m AOD in the administration and control buildings and main infrastructure plots. This achieves a minimum 300mm freeboard including for the precautionary design lifetime to 2105. The AGI plot is only expected during periods of planned maintenance which will be avoided at times of higher flood risk, to be detailed in the Flood Emergency Response Plan.

12A.11.6. The southern gatehouse will only be occupied on an ad-hoc basis however the building will be designed to provide a safe refuge against the breach flood levels over the lifetime of the Proposed Development.

12A.11.7. Additional flood resilience measures are also proposed for consideration at the detailed design stage.

Fluvial Sources

12A.11.8. Based on the information provided by the EA, it has been determined that the majority of the Site is at low risk of flooding. There is a residual risk associated with breach of the defences on the River Trent however as fluvial water levels are lower than tidal water levels the assessed tidal risk is the worst-case with regards to overtopping and breach on the River Trent and has already been discussed above.

12A.11.9. Available information shows the risk of flooding from the smaller watercourses and IDB network is generally low. There may be areas of localised flooding however this is unlikely to significantly impact on the Proposed Development. There is also a residual risk associated with failure of the pumped drainage systems in the area. This is addressed through consideration of the SFRA CFL.

Groundwater

12A.11.10. Based on the information provided, the Site is considered to be at low risk of flooding from groundwater sources as this is effectively managed by the local drainage system.

Surface Water Runoff to the Proposed Development

12A.11.11. The risk to the Site from overland flow of surface water generated adjacent to, or from waterbodies located within the Site, is considered to generally be low. Localised flooding may occur but this is expected to be mitigated through implementation of an effective drainage strategy for the Proposed Development. There is a residual risk associated with failure of the pumped drainage systems in the area. This is addressed through consideration of the SFRA CFL.

Artificial Sources

12A.11.12. The risk of flooding from artificial waterbodies is considered to be low. The Site is not at risk from reservoirs and water levels in the canal are controlled.

Management of Surface Water Runoff from the Site

12A.11.13. The outline drainage strategy for the Proposed Development proposes attenuation of surface water runoff to maintain greenfield runoff rates up to the 1% AEP event with an allowance for climate change, with flows contained in SuDS features and drainage systems up to this event. Conventional drainage systems are considered likely, with further consideration of wider SuDS measures during detailed design.

Residual Risk Mitigation Measures

12A.11.14. A number of additional mitigation strategies will be considered during the design process for the Proposed Development to mitigate residual risks to the Proposed Development and seek to ensure the operation of the Site is maintained in the event of a severe tidal flood event or in the event of heavy rainfall that could result in surface water flooding at the Site, should the design capacity of the drainage network be exceeded.

12A.11.15. These strategies include:

- providing flood resistance and resilience measures including raising of critical operational infrastructure;
- flood emergency response plans;
- flood warnings and alerts;
- emergency access and egress;
- place of safe refuge; and
- design capacity exceedance.

12A.11.16. A final CEMP and a DEMP will also be developed and are expected to include measures to help to reduce the likelihood of flooding affecting the works and workers. Considering that some works will take place directly in or above watercourses it will not be possible to remove the risk entirely. Further mitigation will be reliant on the effective deployment of a flood risk management action plan, to seek to evacuate site personnel and (where possible) remove plant, machinery and material away from the areas at risk prior to a flood occurring.

Residual risk of flooding

12A.11.17. With the recommended mitigation in place the residual risk to the majority of the Proposed Development is low. Raised ground levels will significantly reduce the likelihood of flooding to the main developed areas of the Site during both tidal and fluvial flood events, including in the event of a defence breach. Additional mitigation, to further raise critical infrastructure and incorporate resistance measures, will minimise the likelihood of flooding even in the event of multiple failures such that the energy infrastructure can remain operational and minimise any long term damage to the Proposed Development that would prevent it resuming full operation after a flood.

12A.11.18. The flood risks are such that safe access and egress cannot be guaranteed for the Proposed Development. A Flood Emergency Response Plan, including signing up to the EA Flood Warning Service, will help to mitigate this risk allowing for personnel to be evacuated from Site where possible. Where staff are required to remain on site, or the speed of flooding does not allow for safe evacuation, places of safe refuge will be available.

12A.11.19. As a NSIP the resilience to the “Credible Maximum” climate change has been considered. In this scenario it is considered possible that flood levels will exceed the proposed development platform levels but they are unlikely to reach the critical infrastructure level which will be raised a minimum of 1m above the platform level. Safe refuge areas are also anticipated to remain flood free.

12A.11.20. The raised development platforms will locally deflect floodwater however the model results show this has only a minor effect in defended scenarios. In the event of defence breach larger increases in flood depth are seen in the vicinity of the Site. However, the increases are generally modest compared with the existing level of risk. The outcomes of the modelling have been discussed with the EA and are considered acceptable. Changes in levels at the southern gatehouse and access road and the new IDB watercourse crossing may have some localised impacts but are not expected to impact on properties in the area.

12A.11.21. There is a residual risk of increased surface water runoff from the Site if the capacity of the drainage system is exceeded. However, additional runoff from the Site is unlikely to lead to any significant increase in flood risk from the wider network. The volume is negligible compared with the tidal flood volumes in the area.

12A.11.22. Following implementation of the mitigation measures, the conclusion of this FRA is that residual flood risk to the Proposed Development can be managed and there are no unacceptable off-site impacts.

12A.11.23. The FRA demonstrates the second part of the Exception Test is satisfied.

12A.12. References

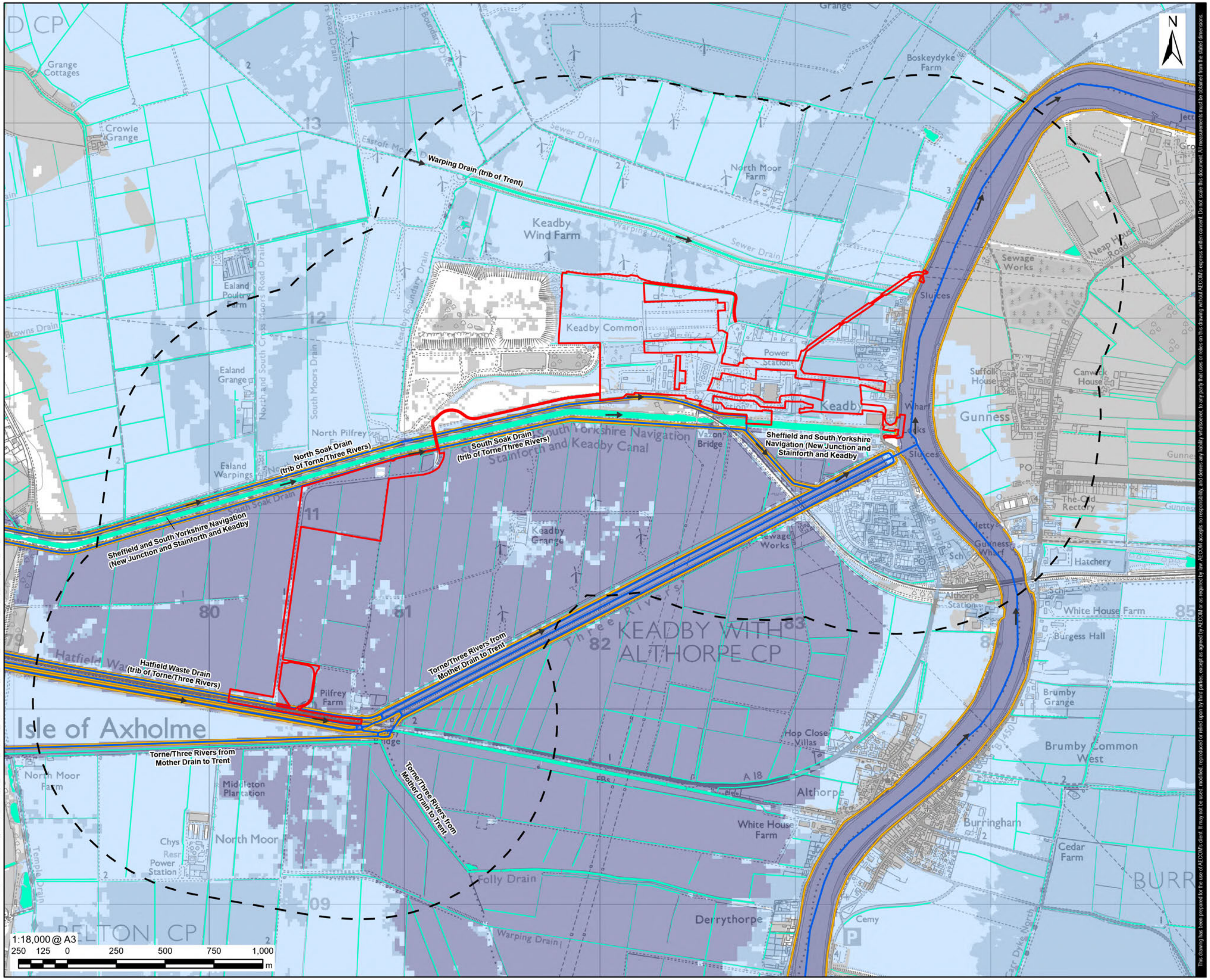
- British Geological Survey (2024). *Geology of Britain Viewer– 1:50,000 scale Bedrock and Superficial Deposits Mapping.* Available online: https://www.bgs.ac.uk/map-viewers/bgs-geology-viewer/. Last accessed September 2024.
- CIRIA (2006). *Report C635. Designing for exceedance in urban drainage - good practice.* Available online: Designing for exceedance in urban drainage - good practice (ciria.org)
- CIRIA (2010). *Report C688 'Flood Resilience and Resistance for Critical Infrastructure*. Available online: https://www.ciria.org/Resources/Free_publications/Flood_resilience.aspx
- CIRIA (2015). *The SuDS Manual (C753).* Available online: https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx
- Cranfield Soil and Agrifood Institute (2018). *Soilscapes Map*. Available online: http://www.landis.org.uk/soilscapes/. Last accessed September 2024.
- Defra (2025). *National standards for sustainable drainage systems (SuDS)*. Available online: National standards for sustainable drainage systems (SuDS) - GOV.UK.
- Environment Agency (2021). National LIDAR Programme 1m DTM. Available at: Defra Survey Data Download
- Environment Agency (2025). Risk of Flooding from Rivers and Sea. Available at: https://environment.data.gov.uk. Last accessed June 2025.
- Department for Energy Security & Net Zero (2023). *Overarching National Policy Statement for Energy (EN-1)*. Available online: EN-1 Overarching National Policy Statement for Energy (publishing.service.gov.uk)
- Environment Agency (2010). *Trent Catchment Flood Management Plan.* Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/289105/River_Trent_Catchment_Management_Plan.pdf
- Environment Agency (2025). *Flood Map for Planning (Rivers and Sea).* Available online: https://flood-map-for-planning.service.gov.uk/ Last accessed June 2025.
- Environment Agency (2025). *Risk of Flooding from Surface Water.* Available at: https://environment.data.gov.uk. Last accessed June 2025.
- Environment Agency (2024) *Flood Risk from Reservoirs.* Available online: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map. Last accessed September 2024.
- Environment Agency (2024) *Flood Warning Service- Flood warnings for England.* Available online: https://flood-warning-information.service.gov.uk/warnings Last accessed September 2024.

Environment Agency (2024). Groundwater. Available online: http://magic.defra.gov.uk/MagicMap.aspx Last accessed September 2024.

- Environment Agency. (2022) *Flood risk assessments: climate change allowances.* Available online: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances Last accessed September 2024.
- Environment Agency (2024) *Historic Flood Map Download*. Available online: https://data.gov.uk/dataset/76292bec-7d8b-43e8-9c98-02734fd89c81/historic-flood-map Last accessed September 2024.
- Environment Agency (2021) Asset Management. Available online: https://environment.data.gov.uk/asset-management/index.html Last accessed 2021.
- Ministry of Housing, Communities and Local Government (2025). *National Planning Policy Framework.* Available online: https://www.gov.uk/guidance/national-planning-policy-framework Last accessed June 2025.
- Ministry of Housing, Communities and Local Government (2022). *Planning Practice Guidance: Flood risk and coastal change.* Available online: https://www.gov.uk/guidance/flood-risk-and-coastal-change Last accessed June 2025.
- North and North East Lincolnshire Council (2022). *North and North East Lincolnshire SFRA.* Available online: https://www.nelincs.gov.uk/assets/uploads/2022/09/202206-SFRA.pdf
- Accompanying mapping: MAP.NORTHLINCS.GOV.UK. Last accessed September 2024
- North Lincolnshire Council (2003) *Planning policy – The North Lincolnshire Local Plan*. Available online: https://www.northlincs.gov.uk/planning-and-environment/planning-policy-the-north-lincolnshire-local-plan/#1593095254001-ec189f5a-67c8
- North Lincolnshire Council (2011). *Core Strategy*. Available online: http://www.planning.northlincs.gov.uk/planningreports/corestratergy/adopteddpd/FullCoreStrategy.pdf
- North Lincolnshire Council (2011). *North Lincolnshire PFRA.* Available online: https://www.nelincs.gov.uk/wp-content/uploads/2016/03/Preliminary-Flood-Risk-Assessment-2011.pdf
- North Lincolnshire Council (2016). *NLC Local Flood Risk Management Strategy*. Available online: https://www.northlincs.gov.uk/wp-content/uploads/2018/07/Local-Flood-Risk-Management-Strategy.pdf
- North Lincolnshire Council (2016) Housing and Employment Land Allocations Development Plan. Available at: https://m.northlincs.gov.uk/public/planningreports/HEDPD_Adoption_2016/Housing%20Employment%20Land%20Allocations%20DPD.pdf

- North Lincolnshire Council (2017) *SuDS and Flood Risk Guidance Document.* Available online: https://www.northlincs.gov.uk/wp-content/uploads/2020/11/NLC-SuDS-Guidance-Published-document-aa.pdf
- North Lincolnshire Council (2017) *Preliminary flood risk assessment: North Lincolnshire Council Addendum.* Available online: *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/698269/PFRA_North_Lincolnshire__2017.pdf*
- Ordnance Survey (2024). Online Maps. ttps://explore.osmaps.com/ Last accessed September 2024.
- Ordnance Survey (2024). Historical Land Use Maps England and Wales 1842-1952. Available at: https://maps.nls.uk/os/6inch-england-and-wales/ Last accessed September 2024.

Revision: 0 Drawn: MAB Checked: SM Approved: CS Date: 2025-08-19



AECOM

PROJECT

KEADBY NEXT GENERATION POWER STATION
Hydrogen-enabled flexible power

A collaboration between SSE Thermal and Equinor

CONSULTANT

AECOM Limited
Midpoint,
Alencon Link,
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

- Proposed Development Site
- 1km Study Area
- Flow Direction
- Statutory Main River
- Ordinary Watercourse
- Spatial Flood Defence

Risk of Flooding from Rivers and Sea

Flood Likelihood Category

- High
- Medium
- Low
- Very Low
- Unavailable

NOTES

The Risk of Flooding from Rivers and Sea information presented on this map, are presented at the default depth.

ISSUE PURPOSE

ENVIRONMENTAL STATEMENT

PROJECT NUMBER

60721867

FIGURE TITLE

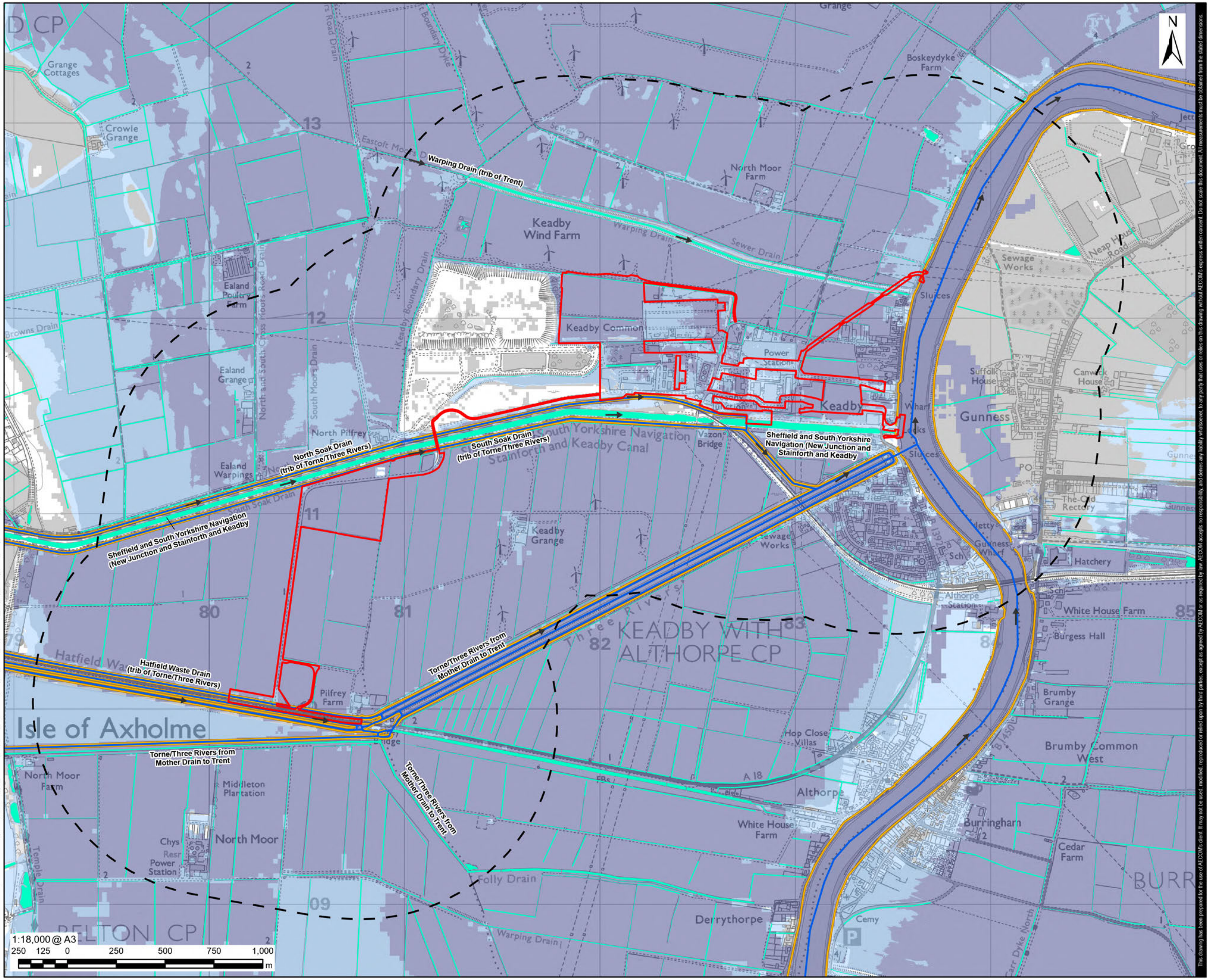
Risk of Flooding from Rivers and Sea

FIGURE NUMBER

Figure 12A.1

Filename: \\5004 - Information Systems\60721867_Keadby_Hydrogen_DCO\02_Maps\ES_Report\Chapter_12_Water_Figures\KHy_ES_Fig_12-7_River_Sea_FloodRisk_A3_R00.aprx

Revision: 0 Drawn: MAB Checked: SM Approved: CS Date: 2025-08-19



This drawing has been prepared for the use of AECOM's client. It may not be used, modified, reproduced or relied upon by third parties, except as agreed by AECOM or as required by law. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that uses or relies on this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from the stated dimensions.

Filename: \\5004 - Information Systems\60721867_Keadby_Hydrogen_DCO\02_Maps\ES_Report\Chapter_12_Water_Figures\KHy_ES_Fig_12-7_River_Sea_FloodRisk_A3_R00.aprx

AECOM

PROJECT

KEADBY
NEXT GENERATION POWER STATION
Hydrogen-enabled flexible power

A collaboration between SSE Thermal and Equinor

CONSULTANT

AECOM Limited
Midpoint,
Alencon Link,
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

- Proposed Development Site
- 1km Study Area
- Flow Direction
- Statutory Main River
- Ordinary Watercourse
- Spatial Flood Defence

Risk of Flooding from Rivers and Sea - Climate Change (2036 to 2069)

Flood Likelihood Category

- High
- Medium
- Low
- Very Low
- Unavailable

NOTES

The Risk of Flooding from Rivers and Sea information presented on this map, are presented at the default depth.

ISSUE PURPOSE

ENVIRONMENTAL STATEMENT

PROJECT NUMBER

60721867

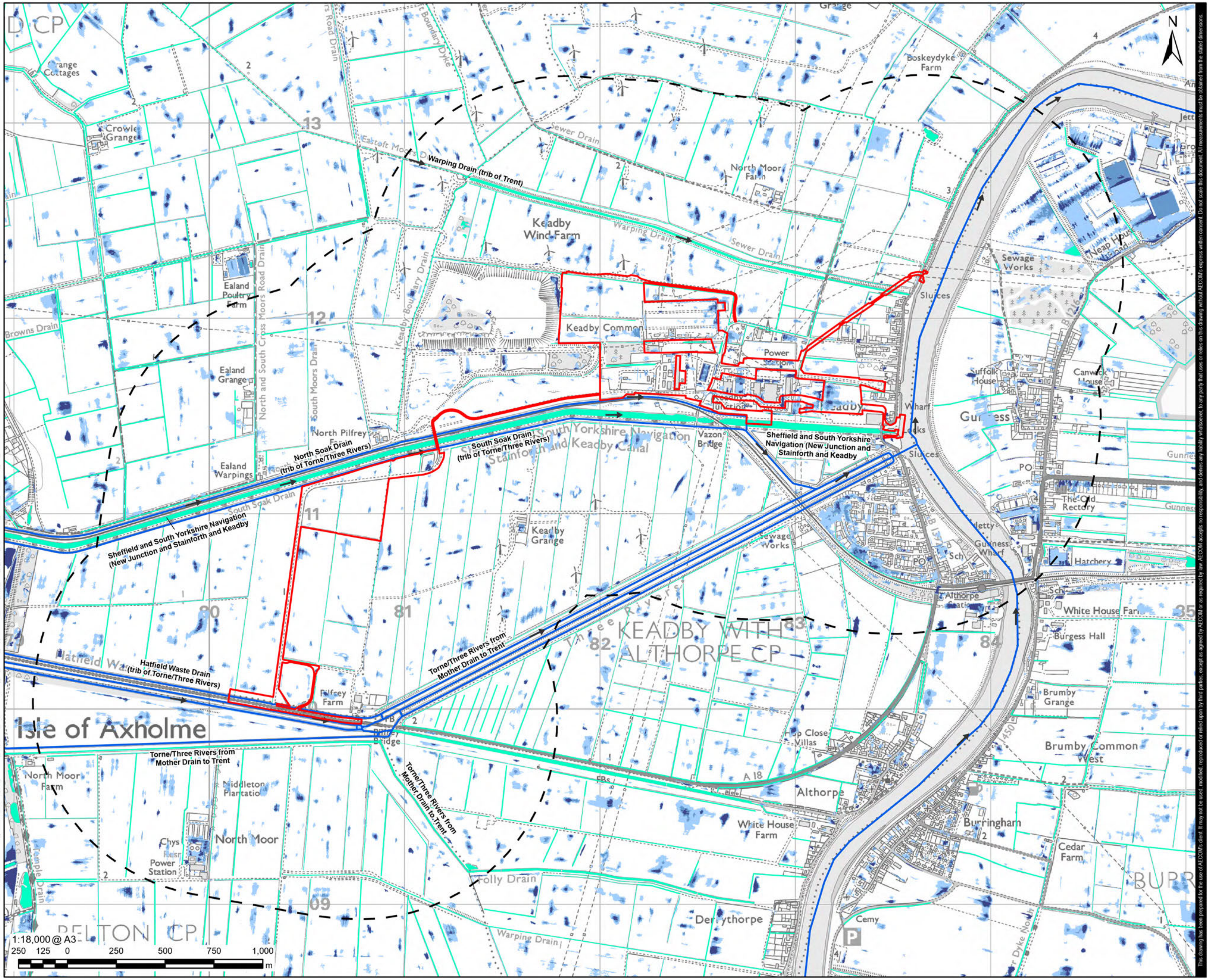
FIGURE TITLE

Risk of Flooding from Rivers and Sea - Climate Change (2036 to 2069)

FIGURE NUMBER

Figure 12A.2

Revision: 0 Drawn: MAB Checked: SM Approved: CS Date: 2025-08-21



AECOM

PROJECT

KEADBY
NEXT GENERATION
POWER STATION
Hydrogen-enabled flexible power

A collaboration between SSE Thermal and Equinor

CONSULTANT

AECOM Limited
Midpoint,
Alencon Link,
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

- Proposed Development Site
- 1km Study Area
- Flow Direction
- Statutory Main River
- Ordinary Watercourse

Risk of Flooding from Surface Water

Flood Likelihood Category

- High
- Medium
- Low

NOTES

Reproduced from Ordnance Survey digital map data © Crown copyright 2025. All rights reserved. License number AC0000808122.
Contains Ordnance Survey Data © Crown Copyright and database right 2025.
© Environment Agency copyright and/or database right 2025. All rights reserved.
© Environment Agency copyright and/or database right. Contains OS data © Crown copyright and database right 2023.

The Risk of Flooding from Surface Water information presented on this map, are presented at the default depth.

ISSUE PURPOSE

ENVIRONMENTAL STATEMENT

PROJECT NUMBER

60721867

FIGURE TITLE

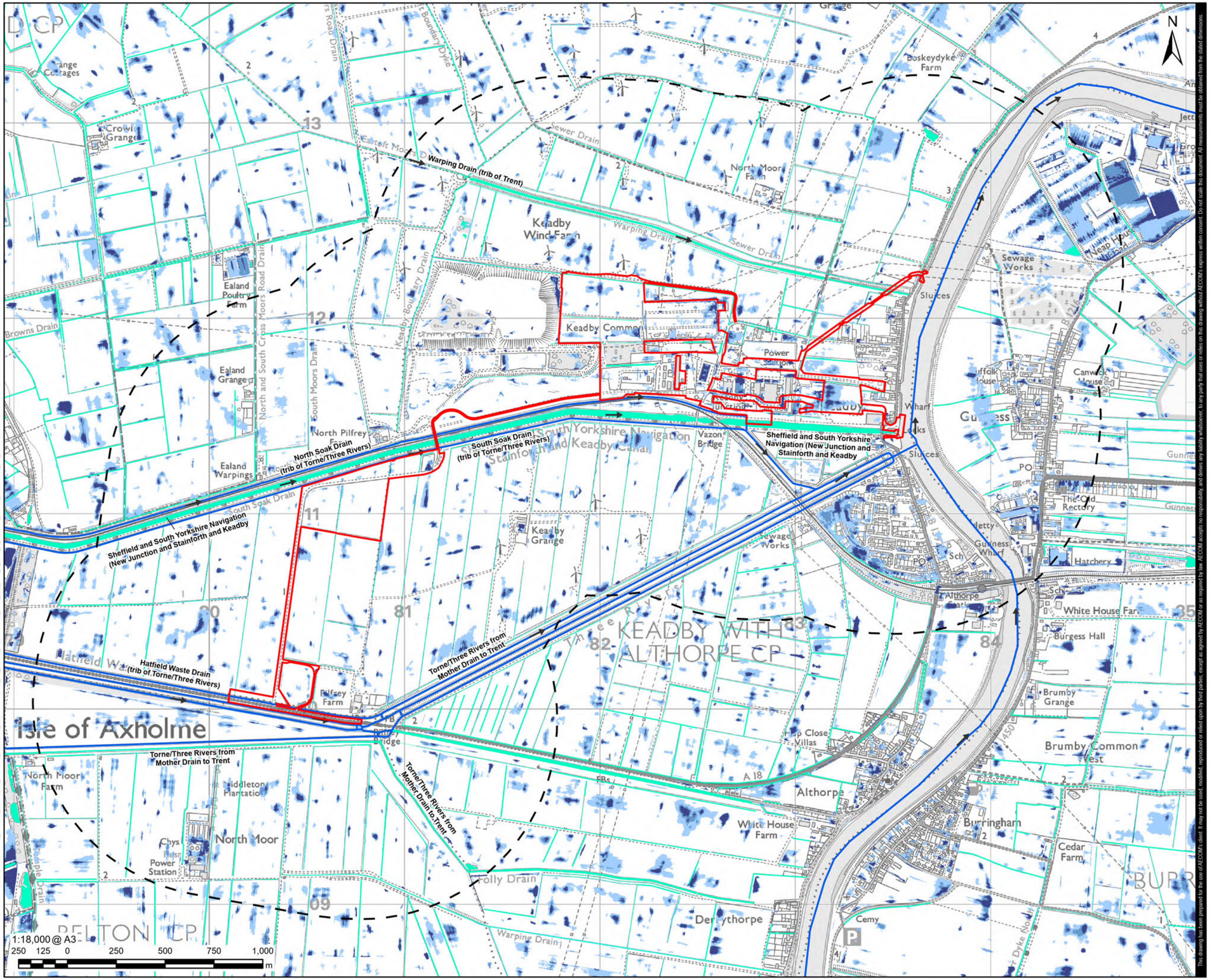
Surface Water Flood Risk

FIGURE NUMBER

Figure 12A.3

Filename: \\5004 - Information Systems\60721867_Keadby_Hydrogen_DCO\02_Maps\ES_Report\Chapter_12_Water_Figures\KHy_FRA_Fig_12A_3_12A_4_Surface_Water_FloodRisk_A3_R00.aprx

Revision: 0 Drawn: MAB Checked: SM Approved: CS Date: 2025-08-21



AECOM

PROJECT

KEADBY NEXT GENERATION POWER STATION

Hydrogen-enabled flexible power

A collaboration between SSE Thermal and Equinor

CONSULTANT

AECOM Limited
Midpoint,
Alencon Link,
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

- Proposed Development Site
- 1km Study Area
- Flow Direction
- Statutory Main River
- Ordinary Watercourse

Risk of Flooding from Surface Water - Climate Change (2040 to 2060)

Flood Likelihood Category

- High
- Medium
- Low

NOTES

The Risk of Flooding from Surface Water information presented on this map, are presented at the default depth.

ISSUE PURPOSE

ENVIRONMENTAL STATEMENT

PROJECT NUMBER

60721867

FIGURE TITLE

Surface Water Flood Risk - Climate Change (2040 to 2060)

FIGURE NUMBER

Figure 12A.4

Filename: \\5004 - Information Systems\60721867_Keadby_Hydrogen_DCO\02_Maps\ES_Report\Chapter_12_Water_Figures\KHy_FRA_Fig_12A_3_12A_4_Surface_Water_FloodRisk_A3_R00.aprx

ANNEX 1 - EXISTING MODEL REVIEWS

Contents

Plates

Tables

12A1. Aquatic Ecology baseline

12A1.1. Introduction

12A1.1.1. This Annex summarises the review of existing model data to determine its suitability and application to the Keadby Next Generation Power Station (the ‘Proposed Development’) Flood Risk Assessment (FRA). Three models have been referenced in the FRA:

- Environment Agency (EA) Tidal Trent Model (Jacobs, 2023)
- EA River Torne Model (Capita AECOM, 2017)
- Keadby 3 FRA Breach Model (AECOM, 2023)

12A1.2. EA Tidal Trent Model (2023)

12A1.2.1. The EA 2023 Tidal Trent model is the latest available model for the Trent and includes simulation of a number of tidal and fluvial dominated scenarios. The Flood Modeller-Tuflow model extends from Newark on Trent to the Humber Estuary. As well as the River Trent in the vicinity of the Site it includes the Three Rivers and North and South Soak Drains watercourses.

12A1.2.2. The latest model incorporates new defence survey data (2016) and 2020 LIDAR data. The River Trent channel between Winthorpe and Trent Falls is represented with a series of cross sections with gully lines used for tributaries. A 25m grid size is used for the floodplain.

12A1.2.3. Fluvial inflows, originally developed in 2013, were reviewed and deemed representative of the ‘present day’ (2021) estimates and therefore retained in the model. Water levels at the downstream model extent were extracted from the model of the Humber Estuary (2021) developed for the Humber 2100+ project, which used the 2018 extreme coastal flood boundaries dataset and included joint probability analysis of fluvial and tidal events.

12A1.2.4. The model was calibrated against six events. The calibration was deemed to provide confidence in the model with modelled levels within or close to the threshold of 0.15m. For tidal events the calibration showed an underprediction of water level at the Keadby gauge of 0.34m and 0.37m in the two largest tidal events, a trend that was seen in previous studies.

12A1.2.5. Breach analysis of 42 locations was included in the Tidal Trent Modelling. Breach 03 is closest to the Site, at Keadby, slightly north of Trent Road.

12A1.2.6. As confirmed by the EA, the Tidal Trent is deemed to present a conservative representation of fluvial flood risk from the Trent tributaries (including the Three Rivers and North and South Soak Drains), because:

- Keadby pumping station is not operational in the model.
- The channels are represented in 2d.
- The modelled channel bed levels are higher when compared to the surveyed channel sections used in the River Torne model (Capita AECOM, 2017).

12A1.2.7. Overall, the EA Trent model is considered suitable to support this FRA and provides the most up to date information on expected in channel flood levels in the **River Trent** for a range of scenarios. Whilst the fluvial flows were derived some years ago, with subsequent changes in available data and flood estimation methods, the EA study included a hydrology review and the model has been calibrated to observed events. However the modelled scenarios do not specifically align with the assessment scenarios for this FRA. **Table 12A1.1** compares the FRA and available model scenarios detailing how these have been used in this FRA.

12A1.2.8. The EA Trent model also includes a scenario where the downstream boundary levels under the climate change scenario were extracted from the Humber estuary model, rather than simply adjusted for predicted sea level rise. The results indicate that applying sea level rise directly to the River Trent is a precautionary approach, with an approximate 860mm difference in levels at the downstream boundary. This has been considered when interpreting the results for the assessment.

12A1.2.9. Whilst the EA Trent model provides the most up to date information on in-channel water levels, the AECOM breach model (see below) originally developed for the Keadby 3 FRA is deemed to provide a more accurate assessment of flood impacts at the Site following a breach in the defences. The AECOM model uses a smaller grid size (5m compared with 25m) and includes topographic survey and design information to improve representation of the drains and ground levels in and around the Site. The modelled breach location has also been selected to be specifically relevant to the Site.

Table 12A1.1: Comparison of FRA and Trent Model Scenarios

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
Fluvial: 2030 (construction, start of operation)				
1% AEP Defended	18% (2020s)	1% AEP Defended	0%	Fluvial design event Model results show very similar flood extent for both scenarios, not affecting the main development site. The 29% scenario has been assessed as a precautionary approach.
		1% AEP Defended	29%	
0.1% AEP	18% (2020s)	0.1% AEP	0%	Extreme event check Modelled flows slightly low which has been considered in the assessment.
Fluvial: 2065 (Expected maximum design life)				
1% AEP Defended	23% (2050s)	1% AEP Defended	29%	Modelled climate change is close to the assessment scenario
1% AEP	38% (2050s)	1% AEP Defended	39%	

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
Defended (Credible Maximum)				
Fluvial: 2105 (Precautionary maximum design life)				
1% AEP Defended	39% (2080s)	1% AEP Defended	39%	Modelled climate change matches the assessment scenario
1% AEP Defended (Credible Maximum)	62% (2080s)	1% AEP Defended	62%	
Tidal: 2030 (construction, start of operation)				
0.5% AEP Defended	80.4mm (sea level rise)	0.5% AEP Defended	0mm	Tidal design event Modelled tide level possibly slightly low but does not impact on the assessment

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
0.1% AEP Defended	80.4mm (sea level rise)	0.1% AEP Defended	0mm	Extreme event check Modelled tide level possibly slightly low but does not impact on the assessment
Tidal: 2065 (Expected maximum design life)				
0.5% AEP Defended	444mm (sea level rise)	0.5% AEP Defended	516mm (2071 UE)	Tidal design event Modelled tide level slightly high therefore presents a precautionary estimate
0.5% AEP Breach	444mm (sea level rise)	0.5% AEP Breach 03	0mm (2021)	Residual risk event Similar modelled scenario not available however EA Trent model results show the River Trent levels at Keadby are much less sensitive to changes in downstream tide level (an approximate 1.3m difference downstream results in only an approximate 370mm difference at Keadby). The range is considered in the FRA.
		0.5% AEP Breach 03	1340mm (2121 UE)	

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
				Breach results not available for this assessment however Keadby 3 Breach model is available.
0.5% AEP Defended (Credible Maximum)	1.9m (sea level rise)	N/A	N/A	Residual risk event Similar scenario has not been modelled. Qualitative assessment undertaken for the FRA. The 1.9m sea level rise estimate is to 2100 therefore this is a precautionary estimate for sea level rise to 2065.
Tidal: 2105 (Precautionary maximum design life)				
0.5% AEP Defended	1079mm (sea level rise)	0.5% AEP Defended	1340mm (2121 UE)	Tidal design event Modelled tide level too high however EA Trent model results show the River Trent levels at Keadby are much less sensitive to changes in downstream tide level (an approximate 350mm difference downstream results in only an approximate 80mm difference at Keadby). The higher level provides a precautionary estimate.

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
0.5% AEP Breach	1079mm (sea level rise)	0.5% AEP Breach 03	1340mm (2121 UE)	Residual risk event Modelled tide level is too high however levels in the River Trent at Keadby are less sensitive to this change. The higher level provides a precautionary estimate. Breach results not available for this assessment however Keadby 3 Breach model is available.
0.5% AEP Defended (Credible Maximum)	1.9m (sea level rise)	N/A	N/A	Residual risk event Similar scenario has not been modelled. Qualitative assessment undertaken for the FRA.

EA River Torne Model (2017)

12A1.2.10. The River Torne model was developed to assess fluvial flood risk across the Isle of Axholme. It includes the Rivers Torne and Idle with their associated tributaries. The model uses available topographic survey of the majority of the drains and river channels of interest, which appears to include the Three Rivers and North and South Soak Drains in the vicinity of the Site. The floodplain is represented using 1m and 2m LiDAR data, flown in 2011 and 2008 respectively.

12A1.2.11. The model is a 1d/2d FMP-TUFLOW model covering the Proposed Development study area. Model inflows were derived for 26-subcatchments, informed by Internal Drainage Board (IDB) boundaries, topography, and locations of pumping stations. The inflows via pumping stations were refined according to modelled operational data. Water levels in the River Trent were extracted from the EA 2014 Trent model to provide downstream boundary conditions for the model, assuming fluvial baseflow combined with a Mean High Water Spring tidal boundary.

12A1.2.12. The model and hydrology were calibrated using three events (November 2000, January 2000 and December 2012). Spot gauging was also undertaken to verify pump capacity at Keadby pumping station. Data limitations reduce the overall confidence in the calibration however good calibration was achieved at key locations for the November 2000 and December 2012 events. The model appeared to under predict runoff for the January 2008 event, considered likely due to the catchment state (antecedent rainfall and baseflow).

12A1.2.13. Results are available for a range of fluvial flood events, including climate change scenarios, from the 50% AEP to the 0.1% AEP.

12A1.2.14. Overall, the EA Torne model is considered suitable to support this FRA. Whilst it is several years old, the model has been calibrated to observed data and changes in standard hydrological methods are less relevant to this type of catchment dominated by artificial drainage and pumping. In consultation the EA agreed with this conclusion, subject to confirmation regarding updates to climate change allowances and availability of more recent LiDAR data since the model was completed. These were checked as detailed below.

Climate change allowances

12A1.2.15. As detailed in the FRA, and confirmed by the EA in their statutory consultation response, the appropriate fluvial climate change allowances for the FRA are as follows:

- Higher Central (used for assessment of the impact of fluvial flood risk to the development, and the assessment of off-site impacts from the development).
- 2050s (covers the 2065 assessment year): 23%
- 2080s (covers the 2105 assessment year): 39%
- Upper End (used for assessment of the credible maximum climate change scenario).
- 2050s: 38%
- 2080s: 62%

12A1.2.16. It should be noted the Higher Central allowance has been selected for assessment of off-site impacts due to the presence of Essential Infrastructure close to the Main Site. However fluvial flooding is more dominant in the area south of the Stainforth and Keadby Canal where surrounding land uses would typically be classed as ‘less vulnerable’ to flooding. In which case the Central climate change allowance is applicable.

12A1.2.17. The River Torne model includes results for the 1% AEP event with climate change uplifts of 20%, 30% and 50%. As a precautionary approach the modelled 1% AEP +30% is used for the 2065 assessment year and 1% AEP +50% for the 2105 assessment year.

12A1.2.18. The Torne model report includes tabulated flows for the four FEH inflows. Comparison of the 0.1% AEP peak flows to 1% AEP peak flows shows these vary from around +40% to +100%. However the 0.1% AEP flood extent is typically larger than the 1% AEP +50% extent (**Plate 12A1.1**), indicating the modelled flows are generally higher in the 1000 year event. It is therefore proposed to use the model outputs for the

1000 year event for consideration of the credible maximum climate change scenario.

Plate 12A1.1: Torne modelled flood extents: 1% +50% (orange) and 0.1% (grey)

Lidar updates

12A1.2.19. The current available 1m composite DTM incorporates LiDAR data flown in 2018 in this area. There is also 1m 2021 LiDAR available through the National LiDAR programme. The LiDAR used in the model is of 1m and 2m resolution dating from 2011 and 2008. **Plate 12A1.2** overleaf shows a comparison of the LiDAR in the area south of the canal where fluvial flooding occurs.

12A1.2.20. The comparison shows the model DTM follows the same pattern as more recent LiDAR and is typically around 100mm lower than the NLP DTM and 150mm lower than the composite DTM. Larger differences are shown at drain crossings etc, where it is expected the higher resolution data would be more accurate. These are in line with typical quoted accuracies for LiDAR.

12A1.2.21. As the differences are reasonably consistent across the area it is expected the flooding locations and extents shown by the model would remain similar were it to use more recent LiDAR data. The modelled flood levels (m AOD) may be 100 – 150mm higher (to give the same flood depth) but there is nothing to indicate the modelled overland flow routes and extents would see any significant change.

12A1.2.22. On this basis it is considered the Torne model provides suitable information for the Proposed Development FRA. The majority of the Site boundary lies outside the Torne modelled 0.1% AEP flood extent. Significant ground raising is not proposed in the area of fluvial flood risk. Fluvial flooding is not expected to present any significant constraint to the Proposed Development, nor is the development anticipated to have any significant effect on fluvial flooding, as any displacement of floodwaters will be minor and localised and can be considered with a qualitative assessment. The Mabey Bridge crossing (which is located within the Torne model extent) is a clear span structure outside of the modelled flood extent. Modelled in-channel water levels will be influenced by the survey channel sections and therefore changes in the DTM have less effect.

Levels across the area south of the canal

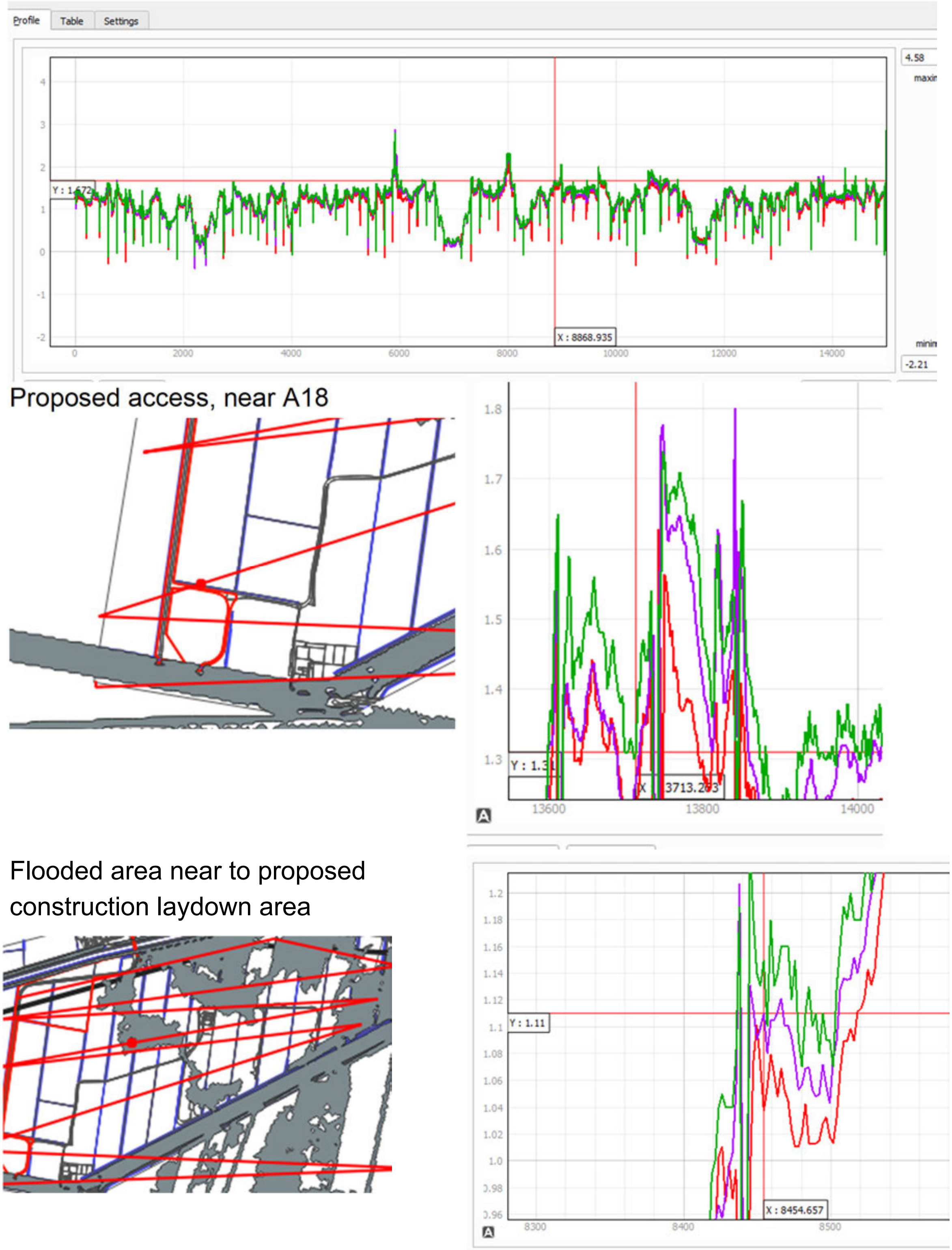


Plate 12A1.2 LiDAR comparison (Red – Torne model DTM, Purple = 2021 NLP Lidar, Green = composite DTM; 0.1% flood extent shown in grey)

12A1.3. Keadby 3 FRA Breach Model (2023)

12A1.3.1. AECOM developed a Tuflow model to assess the impact of a breach in the River Trent defences during a tidal flood event at the Site. The model was developed specifically for the Keadby 3 assessment, and therefore a breach location was selected that was judged to provide critical conditions for the Site. The model was subsequently updated in 2023 to support further design development and reflect changes at the Site.

12A1.3.2. The AECOM model has more detailed topographic resolution than the EA Trent model. The model uses a 5m grid resolution for ground levels and incorporates available survey to represent local drains and recent and ongoing developments at the Keadby Power Station site. The model also includes representation of the recently constructed flood defence at the National Grid site adjacent to the Site. This defence is estimated to be 2.4m high (above adjacent ground).

12A1.3.3. The modelled breach location is near Trent Road. The breach width is set to 50m with a base level of 2.8m AOD, representing ground level at the toe of the defence. In accordance with EA guidance the breach would typically be assumed to be closed after a period of 30 hours however the breach has been left open for the duration of the model simulation as a precautionary approach considering the potential difficulty in closing a breach at this location. Sensitivity testing showed the breach duration had no noticeable impact on peak flood levels at the Site.

12A1.3.4. The AECOM model used flood level data from the previous EA Trent model to provide the inflow to the breach model. The inflow boundary has a peak level of 6.23m AOD which compares with (precautionary) estimates of 6.32m AOD (2065) and 6.56m AOD (2105) for the equivalent scenario using the latest EA Trent model. The EA Trent model results for the alternative 2105 climate change scenario (where downstream levels are extracted from the Humber Estuary model) has a peak level of 6.33m AOD. A comparison shows the shape of the inflow hydrographs are similar and therefore the volume of inflow is likely to be similar.

12A1.3.5. The latest Tidal Trent model shows flood risk in the study area due to overtopping of defences in addition to risk were a breach to occur. The Keadby 3 model has therefore been updated to use the latest tidal inflows from the EA Tidal Trent model (2023), and to simulate both defended (overtopping) and breach scenarios. Full details are provided in the Model Report (Annex 2 of **ES Volume II Appendix 12A:** Flood Risk Assessment (**Application Document Ref. 6.3**).

ANNEX 2 - AECOM MODEL REPORT

Contents

Plates

Tables

Attachments

12A2. Flood Modelling Report

12A2.1 Introduction

12A2.1.1 This Flood Modelling Assessment has been prepared by AECOM Limited ('AECOM') on behalf of Keadby Next Generation Limited ('the Applicant') which is a subsidiary of SSE plc. It forms part of the application for a Development Consent Order (DCO) ('the Application') for the construction, operation and maintenance of a new combined cycle gas turbine ('CCGT') electricity generating station ('the Proposed Development') on land at, and in the vicinity of, the existing Keadby Power Station, Trentside, Keadby Scunthorpe DN17 3EF ('the Site'). Figure 1 (Attachment A) shows the location of the Site. An indicative layout of the Proposed Development is provided in Attachment B.

12A2.1.2 This Flood Modelling Report is an Annex to **ES Volume II Appendix 12A:** Flood Risk Assessment (FRA) (**Application Document Ref. 6.3**). This Report describes the tidal modelling (overtopping and breach) undertaken to assess the flood risk to the Site from the tidal River Trent and the potential impacts of the Proposed Development on flood risk elsewhere.

Background

12A2.1.3 The Proposed Development is an alternative to the Keadby Carbon Capture and Storage (CCS) Power Station ('Keadby CCS Power Station'), which was consented on 29th December 2022. This is to enable the Applicant to pivot to whichever decarbonisation pathway (CCS or hydrogen) becomes technically and commercially viable at the Site first.

12A2.1.4 AECOM developed a hydraulic model for the Keadby CCS Power Station project to assess the impact of a tidal breach at the Site. The model was subsequently updated in 2023. Further flood modelling is required to support the FRA for the Proposed Development. This is due to new Environment Agency (EA) hydraulic models, new data, and changes to the Proposed Development.

Model history

12A2.1.5 The hydraulic modelling presented in this report draws upon and integrates data from three key existing hydraulic models:

- The EA Tidal Trent model (Jacobs, 2023[1]);
- Keadby CCS Power Station FRA Breach model (AECOM, 2023[2]); and
- The EA River Torne model (Capita AECOM, 2017[3]).

12A2.1.6 The EA Tidal Trent model is the latest available hydraulic model for the River Trent provided by the EA and is a strategic catchment model. The model extends from Newark on Trent to the Humber Estuary and includes the River Trent in the vicinity of the Site, as well as the Three Rivers and North and South Soak Drains. This model incorporates defence survey data (2016) and LiDAR data obtained in 2020. The model incorporates both fluvial and tidal processes. As a strategic scale model it uses a 25m grid size for the floodplain. The modelled flood levels in the River Trent at the Site are higher than the preceding tidal Trent model (2014) which was used to generate inflows in the Keadby 3 FRA Breach model.

12A2.1.7 The AECOM Keadby CCS Power Station FRA Breach model was originally developed in 2021 specifically to support the Keadby CCS Power Station FRA. It was subsequently updated in 2023 and it is the 2023 model which has been referred to for this model update. The model has a 5m grid size, allowing for a more detailed representation of topography and local features. It incorporates local drainage channels, recent development (including the Keadby 2 Power Station), and the new flood defence at the adjacent National Grid site, allowing for a more refined assessment of flood impacts in and around the Site.

12A2.1.8 The EA River Torne model was a strategic scale fluvial flood model created to gain a thorough understanding of fluvial flood risk in the region. The River Torne model has simply been used to extract information for the culvert connecting the South and North Soak Drains.

12A2.1.9 Further details of the model reviews are provided in Attachment C.

Keadby NGPS Model

12A2.1.10 The Proposed Development model has been developed to support the FRA and is based on the Keadby CCS Power Station FRA Breach model (2023).

[1] Hydraulic Modelling Report Tidal Trent Re-runs, Jacobs, 2023

[2] Keadby 3 Power Station Breach Modelling Report, AECOM, 2021 (no report accompanies the 2023 update)

[3] River Torne Hazard Mapping Modelling Report, Capita AECOM, 2017

The need for new modelling is required due to several key changes since the Keadby CCS FRA Breach model was developed:

- EA requirement to assess a longer timeframe in the FRA, to 2105, with resultant increased climate change allowances.
- The new EA Tidal Trent model (2023) produces higher flood levels in the River Trent at Keadby than used in the Keadby CCS Power Station FRA Breach model and shows the Site is at risk from overtopping of defences as well as a breach in the defences.
- Revised layout and proposed ground raising for the Proposed Development.

12A2.1.11 The model extent (Figure 2a Attachment A) does not cover the entire Site as this assessment focuses on tidal flood risk to the main area of the Site (north of the Stainforth and Keadby canal) where the majority of development and the critical infrastructure is to be located. The Stainforth & Keadby Canal is a barrier which means the tidal flood mechanisms to the north and south are not linked. Significant development and land raising is not proposed south of the canal and existing EA models have been used to assess flood risk in this area as documented in the FRA (EA Tidal Trent for tidal flooding and EA River Torne for fluvial flooding).

12A2.1.12 This report documents the flood modelling work that has been undertaken to support the FRA and the Application for the Proposed Development.

12A2.2 Summary of Baseline Model Approach and Setup

12A2.2.1 Table 1 summarises the baseline modelling approach that has been applied for the assessment. The AECOM Keadby CCS Power Station FRA Breach model (2023) has been updated using the latest available data and all key model updates have been documented in **Table 12A2.1** with further details provided in Section 12A2.3.

12A2.2.2 The Proposed Development hydraulic modelling set up is documented in Paragraphs 12A2.5.5 to 12A2.5.9.

Table 12A2.1 Summary of model approach and set-up

Model Element	Approach	Change from AECOM Keadby CCS Power Station FRA Breach Model
Model type	2D-only TUFLOW model with two 1D ESTRY elements to represent culverts	No change
Model software and run parameters	TUFLOW software version (2025.0.1 iSP_w64). HPC-GPU model with sub grid sampling	The most recent version of TUFLOW has been used (previous version: TUFLOW 2020-10-AA-iSP-w64). Default run parameters are retained.
Model extent	See Figure 2a Attachment A for full model extent	Model extent to the North, East and West remain unchanged. Model Extent to the South of the model has been adjusted to sit between the North Soak Drain and the canal. Flows crossing this boundary would enter the canal and be dispersed via the wider network.
Model scenarios (refer to further information in Paragraphs 12A2.3.1 to 12A2.3.3)	Defended and breach scenarios for 2065 and 2105 assessment years for the 0.5% tidal AEP	With an operation commencement date of 2030, an expected design life of 35 years (2065) and a precautionary design life of 75 years (2105), the assessment dates differ to that of the Keadby CCS Power Station FRA. Defended scenarios are also included.
Model Topography (refer to further information in Paragraphs 12A2.3.8-12A2.3.11:)		
DTM	2021 National LiDAR Programme (LiDAR) data (1m resolution)	Original AECOM 2021 model used the 2019 composite LiDAR dataset (flown in 2018). The Keadby CCS Power Station FRA Breach Model 2023 update tested both the composite LiDAR and more recent 2021 National LiDAR Programme (NLP) data. The 2021 NLP data has been retained from the 2023 model as it includes ground level changes at the Site and showed a closer match to more recent data.
Keadby 2 assumptions	Refer to further information in Paragraphs 12A2.3.8-12A2.3.11.	No changes were made to the Baseline model
Representation of drains and watercourses	Drains 1, 2, 3, 4 and 5 are enforced in the DTM based on the April 2023 topographical survey provided for the Keadby CCS Power Station project where available. The North and South Soak drains and part of the site drains modelled based on the LiDAR DTM. See Figure 2b Attachment for the location of the drains. The wider drainage network has been represented throughout the model using the LiDAR DTM only. Where culverts are present, Zlines and Zshps were used to create a gap in the topography and provide continuity of the drainage channels. Levels were interpolated from upstream to downstream using elevations extracted from LiDAR DTM.	The LiDAR levels used to reinforce the wider drainage network were redefined through interrogation of the NLP LiDAR data but the same approach was applied.

Model Element	Approach	Change from AECOM Keadby CCS Power Station FRA Breach Model
Defences (Trent defences and other defences)	River Trent Defences: Defence crest levels amended based on survey data (extracted from EA Tidal Trent model). Applied as a Tuflow Zline with a width of 1 cell size and Option set to MAX. Other defences based on DTM as they are defined as naturally high ground in the EA asset management dataset.	Updated levels using the survey River Trent defence levels as included in the EA Tidal Trent model. The Keadby CCS Power Station Breach model used asset data provided by the EA.
National Grid sheet pile wall	Model grid elevations were raised by 2.4m to represent the flood defence wall surrounding the National Grid site based on planning documentation provided by the National Grid.	No change
Model roughness	Materials and surface types are manually taken from OS OpenMap local data and typical roughness feature codes have been set based on published values and previous examples: 1. 10210, 0.035, water 2. 10021, 0.3, building 3. 10172, 0.02, roads and tarmac 4. 10111, 0.1, natural environment	No change
Model structures	Where culverts are present within the local drainage network but not modelled as 1D elements, ground levels are lowered in the 2D domain in order to maintain conveyance along these channels (using Tuflow Zshp or Zline feature). Width has been determined based off the width of the channel from LiDAR review. The culvert that connects the North and South Soak Drains is represented as a 1d network with an SX connection. Culvert details have been derived from the EA River Torne Model.	The LiDAR levels used to reinforce the wider drainage network were redefined through interrogation of the NLP LiDAR data but the same approach was applied. Previously the culvert at the downstream end of the North Soak Drain was not modelled. It is now included within the model is a 1d connection.
Pumps	The model extent does not include any pumped watercourses so there are no pumps within the model.	No change
Model boundaries (refer to further information in Paragraphs 12A2.3.4 to 12A2.3.7) (see Figure 2a and Figure 2b, Attachment A, for schematic of model boundaries).		
River Trent boundary	2d Head-Time (HT) boundary applied along the River Trent boundary using flood level-time series extracted from the EA Tidal Trent model. See Paragraphs 12A2.3.4 to 12A2.3.5 for further detail.	This is the same approach that was used for the previous modelling. However has been updated using data extracted from the EA Tidal Trent model.
Fluvial inflows	None applied	No change
Inland boundaries	2d HT boundaries are applied at the north and eastern boundary of the model extent based on the EA Tidal Trent model results to represent flood levels in the floodplain (discussed in Paragraphs 12A2.3.6 and 12A2.3.7). 2d Head- Flow (HQ) boundaries have been applied across the model where water reaches the model extent. It is assumed flows can continue across the floodplain with no specific constriction or hydraulic control. Across the western and northern extents these are minor and distant from the Site therefore any inaccuracies will not have any significant impact on the results.	The previous model did not require inland boundaries as flow only entered the model domain via the breach. The previous model had a HQ to represent one outflow location in a drainage channel. This is now superseded by the inland HT boundaries applied. Flows did not reach any of the other model boundaries.

Model Element	Approach	Change from AECOM Keadby CCS Power Station FRA Breach Model
	A 2d HQ boundary is applied on the southern boundary of the model. Flows crossing this boundary are assumed to disperse to the wider drainage network via the canal.	
North Soak Drain	A 2d HQ boundary is applied at the western end of the North Soak Drain to represent the dispersal of flows to the wider drainage network. A 1d HT boundary is applied at the downstream end of the culvert which connects the North Soak Drain to the South Soak Drain with the HT boundary extracted from the EA Tidal Trent model results for the respective event.	The previous model did not require boundary conditions to be applied as flows did not spill into the North Soak Drain.

12A2.3 Detailed Baseline Model Setup

Simulation Details

12A2.3.1 The model has been simulated for defended and breach scenarios, both of which account for overtopping of the River Trent defences. All model runs have been carried out for the 2065 and 2105 assessment periods, using a tidal 0.5% AEP event. 2065 represents the expected maximum design life of the Proposed Development, however a precautionary extended design life up to 2105 (75 years) has also been assessed as requested by the EA. **Table 12A2.2** summarises the model runs.

Table 12A2.2 Model simulation summary

Defence scenario		Assessment Year		Tidal Event
Defended	**Breach**	**2065**	**2105**	
x		x		0.5% AEP
x			x	0.5% AEP
	x	x		0.5% AEP
	x		x	0.5% AEP

12A2.3.2 Model results have been extracted from the EA Tidal Trent model to provide the Head-Time (HT) boundary conditions used in this model. As detailed in Annex C, the available modelled scenarios in the EA Tidal Trent model were reviewed to determine which provided suitable boundary conditions for the required model scenarios detailed in **Table 12A2.2**. **Table 12A2.3** summarises the applicable sea level rise for the FRA assessment scenarios (2065 and 2105 Upper End allowance for the Humber) and the applied sea level rise for the respective EA Tidal Trent model scenarios which have been used to derive the boundary conditions. As can be seen the applied sea level rise in the EA Tidal Trent model scenarios is higher which provides a precautionary approach to this assessment.

Table 12A2.3 Sea level rise allowances

Keadby NGPS modelled event	Applicable sea level rise	EA Tidal Trent modelled event*	EA Trent model sea level rise applied	Peak water level (mAOD)^
2065 0.5% AEP	444 mm	0.5% AEP 2071 UE	516 mm	6.32
2105 0.5% AEP	1079 mm	0.5% AEP 2121 UE	1340 mm	6.56

*Used to derive boundary conditions for the Keadby NGPS model
^ Node: Trent14600DS, Three Rivers Confluence 483616, 411387)

12A2.3.3 The model simulations begin at 49 hours, prior to the time at which the River Trent defences at the Site are first overtopped and continue to 120 hours, covering approximately five tidal cycles around the peak of the event.

River Trent Boundary

12A2.3.4 The EA Tidal Trent modelled water levels from three available nodes along the River Trent boundary were reviewed. The analysis showed little variation in water levels along the model boundary and therefore the upstream node (Trent14600DS) (NGR: SE835113) was selected for the River Trent boundary as it is closest to the breach location and provides a precautionary estimate of water levels.

12A2.3.5 Further review of the EA Tidal Trent modelled River Trent water levels for the 2071 and 2121, Higher Central (HC) and Upper End (UE) events at Trent14600DS was undertaken. These events represent smaller (HC) and larger (UE) sea level rise relative to the assessment events. The results showed limited variation between the two events and confirmed that overtopping of the defences would occur in both cases. To ensure a conservative approach, the larger (UE) event levels were extracted for the River Trent boundary.

Inland boundaries

12A2.3.6 The EA Tidal Trent model shows defence overtopping throughout the study area and therefore model boundary conditions have been defined to allow transfer of flows across the inland model boundaries. Figure 2a (Attachment A) shows the HT boundaries applied.

12A2.3.7 Time-varying water level results from the respective events in the EA Tidal Trent model (refer Table 3) were extracted to provide boundary conditions. A static maximum water level plot was generated to identify areas along the boundary with similar peak water levels. Based on this, the boundary was divided into sections according to their maximum water level ranges. For each section, a representative time series was extracted from the time-varying results. These time series were then applied as boundary conditions to the corresponding inland boundary sections.

Model topography

12A2.3.8 The original Keadby CCS Power Station FRA Breach model (2021) used the 2019 EA LiDAR 1m composite DTM. Across the majority of the model extent the composite data comprises of LiDAR flown in 2018. A 1m DTM is also available which covers the study area from the National LiDAR Programme, flown in 2021, and used within the 2023 Keadby CCS Power Station FRA Breach model updates. There is also a 0.5m LiDAR DTM available, flown in 2022, however this has only partial coverage across the area.

12A2.3.9 The 1m 2021 NLP LiDAR has been retained for this model. Comparison shows this provides a closer match to the more detailed 0.5m LiDAR, whilst it is also more representative of current levels west of the Keadby 2 cooling towers where land has been cleared to form a car park.

Keadby 2

12A2.3.10 The Keadby CCS Power Station FRA Breach model (2023) incorporated various amendments to the model topography to represent the Keadby 2 Power Station (refer Figure 2b, Attachment A), which was in construction at the time the model was built. These are summarised as follows:

- **Keadby 2 power station**: modelled as platforms raised to 2.5m AOD and 2.4m AOD, based on various design drawings with spot levels on roads and information provided by the Applicant. The Applicant has confirmed this reflects as-built levels.
- **Tank storage area**: the tanks are solid and have therefore been modelled at a nominal level of5 m AOD. Surrounding roads have been modelled based on surveyed levels (April 2023).
- **Cooling towers**: the tanks are assumed to be solid and SSE has confirmed water is unable to flow under the tanks, therefore they have

been modelled at a nominal level of 5m AOD. Surrounding ground levels are based on various design drawings. SSE has confirmed this reflects as-built levels.

- **Area west of cooling towers**: this area was cleared to provide a car park and temporary buildings for Keadby 2 Power Station construction. Most of the temporary buildings have been removed however the car park area remains. The NLP 2021 LiDAR data appears representative of this area in its current state

12A2.3.11 Therefore in all instances, given that the changes represent Keadby 2 Power Station topography correctly, they have been retained as part of this modelling in the baseline.

Breach Parameters

12A2.3.12 A breach scenario has been included in the model to assess the potential consequences of a failure of the tidal defence adjacent to the development site. The breach location is shown in Figure 2b (Attachment A). The breach was represented in TUFLOW using a variable Zshp which lowers the elevation of the model grid at the breach location to allow water to enter the floodplain during the simulation.

12A2.3.13 The breach was timed such that the standard breach duration (30 hours) would occur over the largest tidal cycles. The start of the breach occurs on the rising limb when the water level in the River Trent reaches the trigger height (75% of the defence height). Once the breach occurs, it remains open for the remainder of the simulation (56 hours). This is a precautionary approach however sensitivity testing showed it does not have a significant impact on the model results. **Plate 12A2.1** illustrates the simulation and breach timing compared with the model boundaries (i.e. the water levels in the River Trent) along with the minimum defence level in the vicinity of the Site for context.

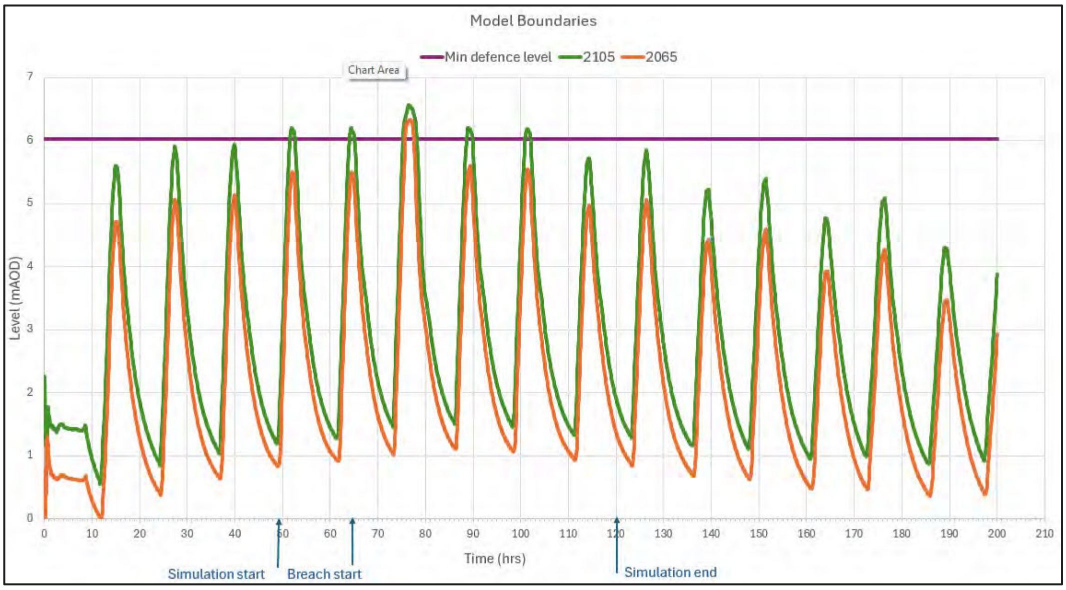


Plate 12A2.1 River Trent boundary Head Time Series

12A2.3.14 The parameters used to define the breach are summarised in Table 4. These are the same basis as used in the Keadby CCS Power Station FRA Breach model (previously reviewed by the EA) and have been selected in accordance with the EA breach assessment guidance[4]. Aside from the start time, which changes with the revised water levels in the River Trent, these are unchanged from the Keadby CCS Power Station FRA Breach model.

12A2.3.15 The adopted breach parameters are considered precautionary. The specific location of the breach has a section of defence wall however there are flood defence embankments in proximity which could also fail, hence the parameters for an earth embankment were adopted. The toe level has been defined in accordance with EA guidance as the minimum level within a 50m radius of the breach. Plate 12A.2 illustrates this region. As can be seen, for the breach to develop to this full extent would require erosion of a large area of relatively flat land, along with a number of properties and highway infrastructure.

[4] Breach of defences guidance (LIT 56413), Environment Agency, 2021

Shading is LiDAR DTM contours (0.67m intervals) – intended for illustrative purposes only

Plate 12A2.2 Breach extent

Table 12A2.4 Breach parameters

Parameter	
Location	NGR 48352 41158 Determined via LiDAR and defence height analysis
Breach Width	50m
Time to Close	Not applicable
Toe Level	2.8 m AOD

Parameter	
Crest Level	6.19 m AOD
Breach Start Time	64 hrs

12A2.4 Model Checks

12A2.4.1 There is no available data to calibrate or verify the model however checks were completed to confirm the model provides a reasonable comparison to the EA Tidal Trent model. Differences are to be expected as the EA Tidal Trent model is a strategic catchment model with much less detail in and around the Site than included in this model.

12A2.4.2 The checks focussed on the tidal inflows to the model and comparison of modelled flood levels. Differences are to be expected in how water flows through the model extent, due to the higher level of detail in the Proposed Development model, however the inflows have been derived from data extracted from the EA Tidal Trent model and should be broadly comparable.

12A2.4.3 As detailed in Section 12A2.3, a comparable EA Tidal Trent model scenario was extracted and used to provide boundary conditions for the Keadby NGPS model simulations. The EA 2071 UE simulation was used for the 2065 assessment year and the EA 2121 UE for the 2105 assessment year. Therefore, whilst these have different nominal years they are in fact directly comparable.

12A2.4.4 Table 12A2.5 compares the modelled peak flows and flow volumes across the model boundaries (as shown on Figure 2a, Attachment A). These have been obtained using plot output (PO) lines for the Proposed Development model however the Tuflow Plugin flux tool in QGIS was used to extract data from the EA Tidal Trent model, as PO data was not available. The flux tool is not deemed as accurate as PO data because it is reliant on map output data rather than time series data produced by the PO data. It should also be noted that whilst flows have been compared, the model boundaries have been applied as HT (water level). Differences will occur between the two models in how Tuflow translates the defined water level to flow in the calculations.

12A2.4.5 The data shows a good match between the models in the peak flow across the River Trent boundary (within 10%). There is a larger difference in total flow volume (up to around 30% for 2065). Larger differences are seen for the inland boundaries; the total peak flow in 2065 remains reasonably close (within 15%) with a near 40% difference in total volume. For 2105 there is an approximate 50% difference in peak flow however only a 10% difference in total volume. The data suggests more flow is entering the area in the EA Tidal Trent model for the 2065 scenario and less in total for 2105 (although the volume entering via the River Trent boundary is higher). Some of these differences may be due to the way the flow data has been extracted rather than true differences between the models.

12A2.4.6 Also apparent from the data is that in the defended scenarios the flows across the inland boundaries are, by far, the most dominant contributor of volume into the model. The opposite is true for the breach scenarios.

12A2.4.7 Inspection of the model results shows that in the defended scenarios the whole area fills with floodwater with flood levels gradually rising towards an equilibrium where the flow entering the model equates to that leaving (principally by flowing into the North Soak Drain). Therefore, in terms of the assessment the main factor is the total volume of water within the model domain. As shown, the data indicates the Proposed Development model may have a smaller volume of water for the 2065 defended scenario (~40% in total) but for 2105 the Proposed Development model has a slightly larger volume (~6%). A secondary check compared the modelled flood levels to determine if these differences were significant.

Table 12A2.5 Comparison of model inflows

	Assessment Year			
	2065		2105	
	Keadby NGPS	EA Tidal Trent	Keadby NGPS	EA Tidal Trent
Defended				
Peak flow across River Trent boundary	57 m^3/s	63 m^3/s	406 m^3/s	401 m^3/s
Total volume across River Trent boundary	222,150 m^3	331,300 m^3	2,143,700 m^3	2,521,800 m^3
Peak total flow across inland boundaries (north & east model boundaries)	252 m^3/s	219 m^3/s	2,554 m^3/s	1,700 m^3/s
Total volume across inland boundaries (north & east model boundaries)	1,573,450 m^3	2,511,000 m^3	17,373,200 m^3	15,889,600 m^3
Total volume	1,795,600 m^3	2,842,250 m^3	19,516,900 m^3	18,411,350 m^3
Breach				
Peak flow across River Trent boundary	608 m^3/s	n/a	1,036 m^3/s	n/a
Total volume across River Trent boundary	13,659,150 m^3	n/a	25,792,850 m^3	n/a
Peak total flow across inland boundaries (north & east model boundaries)	252 m^3/s	n/a	2,556 m^3/s	n/a
Total volume across inland boundaries (north & east model boundaries)	1,452,500 m^3	n/a	-2,682,550 m^3	n/a
Total volume	15,111,650 m^3	n/a	23,110,300 m^3	n/a

12A2.4.8 Figures 3a and 3b (Attachment A) compare the modelled peak flood levels. As can be seen there is less than a 0.05m difference across the majority of the model extent.

12A2.4.9 For 2065 larger differences are seen at the inland boundaries as may be expected, but these resolve across the wider floodplain with only isolated areas of difference generally distant from the Site. Two areas show larger differences however these are explained by topographic differences in the models. To the north of the Site there is a drainage channel with a high bank on the northern bank. In the Keadby NGPS model this causes water to pool on the north side, with an associated reduction in flood levels on the south side. This bank does not appear to be included in the EA Tidal Trent model due to its coarser resolution (25m). Near and within the Site, the Proposed Development model produces higher water levels to the east and north. This is explained as the Keadby NGPS model represents the raised ground levels at Keadby 2 Power Station and the NG defence wall which affects flood levels in this area.

12A2.4.10 For 2105 similar differences are shown at the model boundaries but minimal difference across the majority of the model extent. The same differences are shown at the drainage channel north of the Site. The 2105 model does not show the same difference at the Site. In this scenario flood levels are such that the whole area is inundated and therefore the higher ground levels at Keadby 2 Power Station have less influence on the maximum flood level.

12A2.4.11 Whilst the analysis shows there are some differences in the rate and volume of flow at the model boundaries, the analysis shows this typically has only limited effect on modelled flood levels, with larger differences explained by topographic differences in the two models. It should be noted that whilst the defended scenarios have been modelled, it is the breach scenarios that are most important for assessing flood risk to the Proposed Development and determining mitigation requirements as these will lead to the highest flood depths in and around the Site. They are also considered the critical scenarios when assessing the potential impacts of the Proposed Development on flood risk elsewhere, as the Proposed Development (refer Section 12A2.5) constricts and diverts the large flows coming from the breach with the flows entering via the other boundaries (where differences are seen) much less important. In the defended scenarios the diversion of flows due to the Proposed Development is much less significant as the majority of flows come from the north and the effect of the Proposed Development is more a loss of flood storage, but this is minor compared to the total flood volume in the area. On this basis the model was considered suitable for the assessment.

12A2.5 Proposed Development

Overview

12A2.5.1 The Proposed Development (Attachment B) comprises a high-efficiency CCGT electricity generating station. Of specific relevance to this Report the Proposed Development comprises the following elements:

- CCGT plant, cooling infrastructure and other facilities (to be located on Area A (the Main Site), Plate 12A.3)
- Hydrogen and natural gas supply pipelines and apparatus with above ground installations (AGI) (to be located on Area B, Plate 12A.3)
- Administration and control buildings, with parking (to be located on Area C, Plate 12A.3).

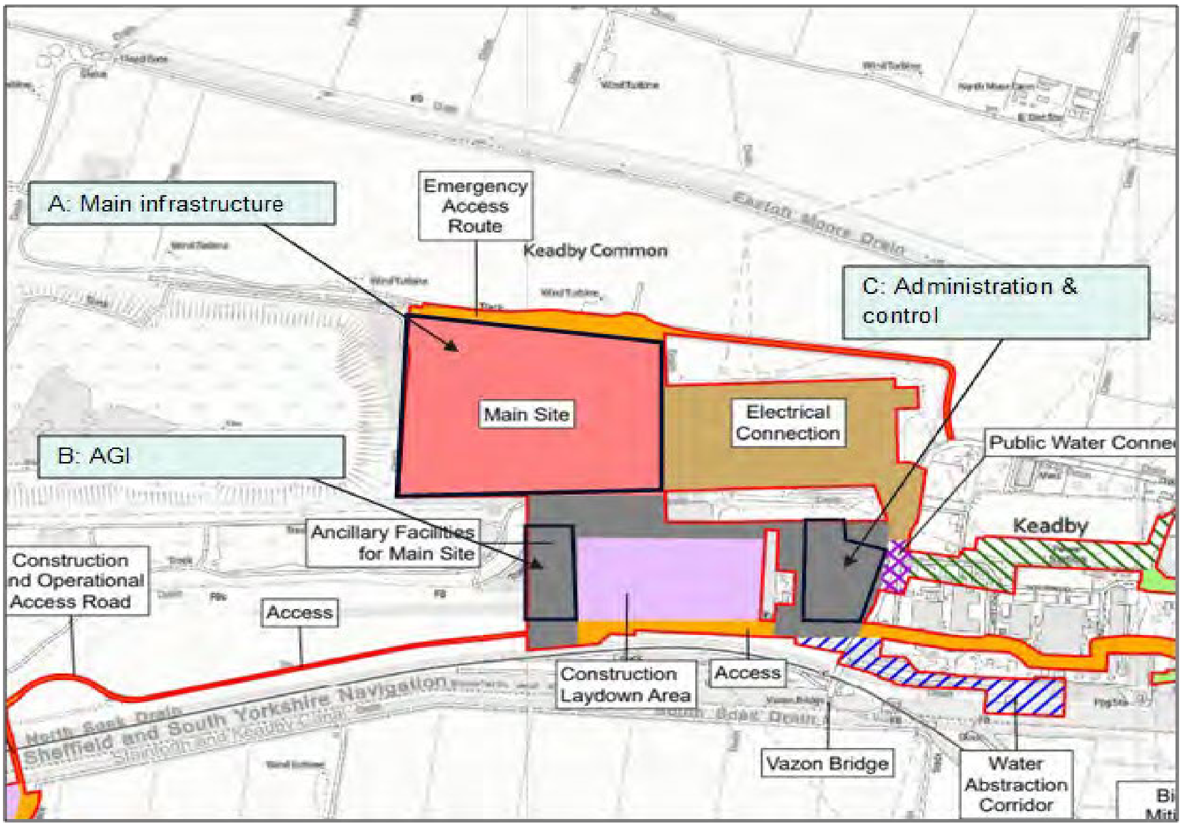


Plate 12A2.3 Main development areas (extract of indicative site layout, Attachment B)
Contains Ordnance Survey data © Crown copyright 2025 Licence number AC0000808122)

12A2.5.2 The areas described above are where critical infrastructure and manned buildings will be located within the main part of the Site covered by the Proposed Development model. Other elements of the Proposed

Development in the main part of the Site include water supply and discharge connections, access roads (permanent and construction), temporary construction and laydown areas, and land set aside for landscape and planting and to meet the requirements of the Carbon Capture Readiness (Electricity Generating Stations) Regulations 2013.

12A2.5.3 The main access to the Site is via an access road which enters the Site from the south (outside the area covered by the Proposed Development model). An emergency access is also to be provided from the north of the Main Site with a new crossing of Drain 1 (Glew Drain) which is located on the northern boundary of the Main Site. Details of this structure are not available but it is expected to be clear-span.

12A2.5.4 As described in the FRA report the flood mitigation strategy for the Proposed Development comprises locating critical infrastructure and buildings providing safe refuge (located on areas A, B and C, Plate 12A2.3) on land raised above the design flood level with floor levels and critical infrastructure raised further to provide additional resilience. It is proposed land will be raised to 3m AOD in these areas. Table 6 (Section 12A2.6) provides further details of the proposed levels and freeboard provided.

Development Representation in the Model

12A2.5.5 Figure 4 (Attachment A) illustrates the modifications made to the model. The model grid elevations have been modified at the three areas of raised land using the Ztin function based on 3d model data provided by the design team. The top elevation of each platform is set to 3m AOD with interpolation to the existing model DTM for the supporting side slopes.

12A2.5.6 Drain 4 and the eastern section of Drain 2 will be infilled and the existing access culvert removed. These drains have been removed from the model.

12A2.5.7 The proposed crossing of Drain 1 (Glew Drain) is not included in the model. The crossing is expected to be clear span and is unlikely to have any significant impact on the passage of tidal flows through the area which are being assessed. This is consistent with the model approach for existing watercourse crossings in the model extent.

12A2.5.8 There are no significant development or ground level changes proposed across other areas of the Site, within the model extent, that would impact on flood flows (e.g. buildings) therefore no other changes have been made to the model.

12A2.5.9 Model simulations have been completed for the same defended and breach scenarios detailed in Table 2, applying the same boundary conditions.

12A2.6 Model Results

Overview

12A2.6.1 In this section the results from the baseline and proposed development models are described and the mechanism of flooding modelled within the study area is discussed. The results have been assessed for the expected maximum design life of the Proposed Development (2065) and the precautionary extended design life (2105) as requested by the EA.

Baseline

12A2.6.2 Figures 5a and 5b (Attachment A) show the modelled maximum flood depths in the baseline, defended scenarios. Water initially enters the model domain through Pauper's Drain in the north-east where the initial water levels applied at the boundary are higher than the drain inverts. This inflow distributes through the drainage network.

12A2.6.3 In 2065 defence overtopping only occurs on the largest tide, starting approximately 27 hours into the model simulation. This occurs at the main River Trent boundary east of the Site with flows spreading west and north. Shortly after, flows enter the model from the inland boundaries to the north, due to defence overtopping further downstream on the River Trent. For the remainder of the model simulation flows spread away from the River Trent across the floodplain.

12A2.6.4 The mechanisms are similar for 2105, with the exception that defence overtopping occurs much sooner and occurs several times during the simulation. Floodwaters spread much further to fill the majority of the model extent and reach a level where they can spill into the North Soak Drain and would thus disperse via the wider drainage network. Across the majority of the model the maximum flood level is reached towards the end of the simulation where an equilibrium is reached between flows entering and leaving the model and flood levels are controlled by the spill into the North Soak Drain.

12A2.6.5 In 2065 flooding is shown to reach the main infrastructure area (Plate 12A.3 area A), with maximum depths around 0.7m (approximately 1m AOD). Higher flood depths are shown closer to the River Trent, with flood depths reaching around 1.0m in the area designated for landscape and planting and on part of the haul route. In 2105 flooding occurs across the majority of the main area of the Site (north of the canal) and depths across the main infrastructure area reach around 1.7m (approximately 2.1 mAOD).

12A2.6.6 Much of the Site is at significant risk, particularly under the precautionary extended lifetime assumption (to 2105). It should be noted this modelling does not account for future defence improvements.

12A2.6.7 Figures 6a and 6b (Attachment A) show the modelled maximum flood depths in the baseline, breach scenarios.

12A2.6.8 The breach scenarios introduce a significant inflow of water into the model near to the Site, substantially increasing flood depths across the Site compared to the defended scenario. While overtopping of the defences continues to occur, its contribution to flood extent and depth is secondary. The breach is the dominant mechanism, controlling the timing, extent, and severity of flooding across the model domain. In contrast to the defended scenarios, peak water levels occur earlier in the model simulation, close to the time of peak flows through the breach near to the Site and across the southern part of the model extent and later to the north, as the breach flows propagate across the floodplain.

12A2.6.9 Flooding affects all the Proposed Development north of the canal and depths across the main infrastructure area (Area A Plate 12A.3) reach around 2m (approximately 2.4m AOD) in 2065 and 2.3m (approximately 2.6m AOD) in 2105 affecting all the Proposed Development. As expected, flooding is worse under a breach scenario than an overtopping scenario.

12A2.6.10 In the event that the defences were to breach, the hazard to the Site in its unmitigated state would be high as flood waters would rapidly reach the Site and reach significant flood depths of over 2m. However, the probability of this occurring is low, as to occur it requires both a high water level in the River Trent and a structural defence failure.

12A2.6.11 The flood risk presents unacceptable risks to the Proposed Development and therefore the Proposed Development incorporates flood mitigation measures as described in Section 12A2.5.

Proposed Development

Flood risk to the Proposed Development

12A2.6.12 Figures 7a and 7b (Attachment A) show the maximum flood depths with the Proposed Development (i.e. with the land raising and drain infilling described in Section 12A2.5) and Figures 8a and 8b (Attachment A) show the maximum flood depths for the breach scenarios. Table 6 shows the modelled flood levels at the three main development areas (adjacent to the raised areas) and the associated freeboard provided.

12A2.6.13 In the defended scenarios the Proposed Development does not lead to any significant change in flow paths or flood mechanisms, aside from floodwater no longer being able to enter the main infrastructure area (Plate 12A.3, area A). For 2105, the raised land areas have a slightly greater impact as the flow path across the main infrastructure area is largely cut off and flows are diverted to the south and north. As for the baseline scenarios the maximum flood level is reached towards the end of the simulation where an equilibrium is reached between flows entering and leaving the model.

12A2.6.14 The Proposed Development has a greater impact on flood flows and flood mechanisms in the breach scenarios as the dominant flow path is from the breach and flows are therefore constricted and diverted to the south and north.

Table 12A2.6 Modelled flood levels (adjacent to the raised areas) and freeboard

	A: Main Infrastructure	B: AGI	C: Administration & Control
0.5% AEP Defended flood level (2065)	0.98 m AOD	n/a (flooding does not reach the plot)	n/a (flooding does not reach the plot)
0.5% AEP Breach flood level (2065)	2.69 m AOD	2.69 m AOD	2.77 m AOD
0.5% AEP Defended flood level (2105)	2.08 m AOD	2.08 m AOD	2.08 m AOD
0.5% AEP Breach flood level (2105)	2.89 m AOD	2.89 m AOD	2.97 m AOD
Proposed ground Level	3.0 m AOD 2065: Min 0.3m freeboard 2105: Min 0.1m freeboard	3.0 m AOD 2065: Min 0.3m freeboard 2105: Min 0.1m freeboard	3.0 m AOD 2065: Min 0.2m freeboard 2105: Minimal freeboard
Minimum floor level (safe refuge)	4.0 m AOD	4.0 m AOD	3.3 m AOD

	A: Main Infrastructure	B: AGI	C: Administration & Control
	2065: Min 1.3m freeboard 2105: Min 1.1m freeboard	2065: Min 1.3m freeboard 2105: Min 1.1m freeboard	2065: Min 0.5m freeboard 2105: Min 0.3m freeboard
Minimum critical infrastructure level	4.0 m AOD 2065: Min 1.3m freeboard 2105: Min 1.1m freeboard	4.0 m AOD 2065: Min 1.3m freeboard 2105: Min 1.1m freeboard	n/a

12A2.6.15 In the defended scenario, including the Proposed Development, the majority of the Site remains flood free for the expected lifetime to 2065 (Figure 7a, Attachment A) although the model results show flooding to the water connections corridor and landscape / planting areas.

12A2.6.16 The raised development plots are shown to remain flood free in all the modelled tidal events (including breach). For the expected maximum lifetime (2065) a minimum 0.3m freeboard is achieved to the plots where critical infrastructure will be located and 0.2m to the administration and control plot. The freeboard is reduced for the precautionary lifetime (2105) but the plots remain flood free. The minimum proposed level for critical infrastructure (4m AOD) provides over 1m freeboard to all modelled tidal flood levels.

12A2.6.17 Safe refuge areas are provided with a minimum freeboard of 0.5m for the expected maximum development lifetime (2065) and 0.3m for the precautionary development lifetime (2105).

Impacts of the Proposed Development on flooding in the area

12A2.6.18 Figures 9a and 9b (Attachment A) show the change in maximum flood depth associated with the Proposed Development for the defended scenarios.

12A2.6.19 In the defended scenarios the results show very little change between baseline and Proposed Development. In these scenarios the bulk of inflow to the model is via the overland flows on the north and north east boundaries of the model, rather than over the defences immediately alongside the Site. As described, maximum flood levels and depths occur towards the end of the simulations, as floodwaters fill the area. The volume of flood storage removed due to the Proposed Development is minor in comparison with the total flood volume in the area. Minor pockets of increased flood depth are shown for 2065 in the surrounding agricultural land. The reasons for this are unclear and likely due to model anomalies or minor changes in flow patterns which result in larger depths where waters pool. The increases are reasonably small, typically less than 0.05m, in rural areas with no properties in the vicinity.

12A2.6.20 Figures 10a and 10b (Attachment A) show the change in maximum flood depth associated with the Proposed Development for the breach scenarios. Figures 11a and 11b (Attachment A) show the same with more detail in the vicinity of the Site.

12A2.6.21 In the breach scenarios an increase of between 0.01m and 0.1m is shown across the existing Keadby power station and part of Keadby village (including undeveloped land) north of the Canal. The existing flood depths are highly variable but exceed 1m across most of this area and are well above 2m in places. Existing flood depths are lower at the main Keadby power station site, generally in the region of 0.2m – 0.5m (2065) and 0.4m – 0.7m (2105).

12A2.6.22 Larger increases in flood depth (0.1m to 0.3m) are shown in the Keadby power station site immediately east of where the main infrastructure and AGI will be located (areas A and C) as the raised ground largely closes the flow path across Keadby Common. An associated reduction in flood depth is seen north of Keadby Common. The increase in flood depth is typically in the region of 0.3m. The main area impacted is a temporary car park area used for the construction of Keadby 2 Power Station where modelled flood depths already exceed 1m in places. The majority of this area is included in the Site boundary but is not proposed for development at this time.

12A2.6.23 In these breach scenarios higher flood depths are shown along part of the rail line which runs between the North Soak Drain and the Canal. The maximum increase is up to around 0.20m (2065) and 0.26m (2105) compared with existing maximum flood depths along the line of around 0.25m (2065) and 0.35m (2105). Therefore whilst the increase in flood depth is reasonably large it is likely the operation of the railway would be compromised in this type of event in any case. Additional repairs may be needed following a flood however it should be noted this represents a low probability breach scenario.

12A2.6.24 The model results show an increase in flood depth in the North Soak Drain in the vicinity of the Site however there is no significant change in flows leaving the model via the North Soak Drain so increased flood risk in the wider drainage network is not expected.

Modelled flood depths at properties

12A2.6.25 The change in flood depth at identified properties across the study area has also been assessed (refer Attachment D). Figure 12 (Attachment A) shows the location of the properties. In the defended scenarios minimal change in flood depth (<0.001m) is shown. In the breach scenarios some properties are shown to have an increase in flood depth of up to 0.09m. The largest increase shown to a residential property is 0.06m. In most instances where these larger increases are seen the existing modelled flood depths are significant, several hundred millimetres or over a metre in places. All properties with an increase in modelled flood depth are already shown to flood in the respective baseline scenarios.

12A2.7 Model Limitations

12A2.7.1 When considering the results and discussion throughout this Report, it is important to understand the assumptions and limitations of the models and their outputs. The key assumptions and limitations include:

- **Representation of Internal Drainage Board (IDB) Drains**: IDB drains play a critical role in conveying water through the modelled area under lower flow conditions before overtopping of banks occurs. In this model, culverts that are not explicitly represented have been reinforced using land lowering based on LiDAR data, particularly those near the Site. This approach enables water to flow through these areas without obstruction, although it does not account for the physical structure of the culverts. Given the extensive inundation of the floodplain these localised impacts of structures are highly unlikely to significantly impact the results.
- **Hydraulic Gradient at Model Boundaries**: Head-Flow (HQ) boundaries at the model extent have been derived by calculating a gradient from LiDAR elevation data or a nominal 1:1000 gradient. This method assumes a uniform gradient across each sub-section of the model boundary, which may not accurately reflect localised variations. The model boundaries to the north and west where this has been used are over 3km away from the Site and so unlikely to impact results at the

site. To the south, the HQ boundary has been placed at the north bank of the Stainforth and Keadby Canal. Water entering the canal would travel out of the model domain and so the flow at this area is unlikely to impact the Site. The canal is able to overflow over the Keadby lock gates to the River Trent.

- **Inland Model Boundaries Based on EA Tidal Trent Model Outputs**: Inland boundaries have been derived by extracting time-varying water level data from the EA Tidal Trent Model (Paragraphs 12A2.3.6 and 12A2.3.7). This results in some simplification at the boundaries and differences in calculated flows due to the conversion of modelled levels to flow (with a more detailed floodplain representation than the original EA Tidal Trent model) and the omission of flow momentum. However, model verification has been undertaken to assess and validate the approach (Section 12A2.4) and found to be suitable for this assessment.
- **Breach Modelling Assumptions**: As detailed in Section 12A2.3 the assumed breach parameters are deemed precautionary and not specifically representative of the characteristics of a breach that may occur at that location. However it is deemed a suitable approach to consider the potential impacts of a catastrophic failure in the vicinity of the Site.

12A2.8 Summary and conclusions

12A2.8.1 AECOM has been commissioned to undertake flood modelling to support the Application for a new CCGT electricity generating station on land at and in the vicinity of Keadby Power Station. The model compares baseline and Proposed Development conditions to assess the impact of the proposals on flood behaviour.

12A2.8.2 The Proposed Development model simulates tidal flooding at the Site both from overtopping of the River Trent defences and a defence breach. The model is based on a previous model developed for the Keadby CCS Power Station project and has been updated to use more recent LiDAR data and boundary conditions extracted from the latest EA model of the River Trent (EA Tidal Trent model).

12A2.8.3 There is limited data to calibrate or verify the model results however comparisons against the catchment scale EA Tidal Trent model (from which boundary conditions have been extracted) have concluded the model provides a suitable basis for the assessment. The assessment shows there are some differences in the flow volumes in the two models but due to the flood mechanisms this does not have a significant impact on the resultant maximum flood levels. Where differences are shown these are explained by the additional topographic detail in the Proposed Development model. In the breach scenarios the flow through the breach is dominant at the Site and across the majority of the model and it is these scenarios which are the more critical for assessing flood risk to the Proposed Development and the impact of the Proposed Development on flood risk elsewhere.

12A2.8.4 Two assessment years have been assessed (2065 and 2105), both for the 0.5% AEP tidal flooding with Upper End climate change allowances (the design event for the FRA). The results show that flooding affects the Site in all modelled scenarios. In the defended scenarios flooding is shown to reach the proposed main infrastructure area with maximum depths around 0.7m (2065) and 1.7m (2105) with higher flood depths in parts of the Site closer to the River Trent.

12A2.8.5 The entire Site is shown to be inundated in breach scenarios with flood depths in the proposed main infrastructure area reaching around 2m (2065) and 2.3m (2105). The flood risk as shown is unacceptable and therefore the Proposed Development incorporates mitigation (in the form of land raising) to reduce the flood risk to areas proposed for critical infrastructure and buildings which provide safe refuge for site personnel.

12A2.8.6 Three areas within the Site will be raised to a level of 3m AOD. The model results show these remain flood free in all the modelled events (including breach). For the 2065 assessment year a minimum 0.3m freeboard is achieved to the plots where critical infrastructure will be located and 0.2m to the administration and control plot. The freeboard is reduced for the precautionary lifetime (2105) but the plots remain flood free.

12A2.8.7 This land raising is shown to have very little effect on maximum flood depths in the defended scenarios. The volume of flood storage removed due to the Proposed Development is minor in comparison with the total flood volume in the wider floodplain. Minor pockets of increased flood depth are shown in the surrounding agricultural land. The reasons for this are unclear but the increases are reasonably small, typically less than 0.05m, in rural areas with no properties in the vicinity.

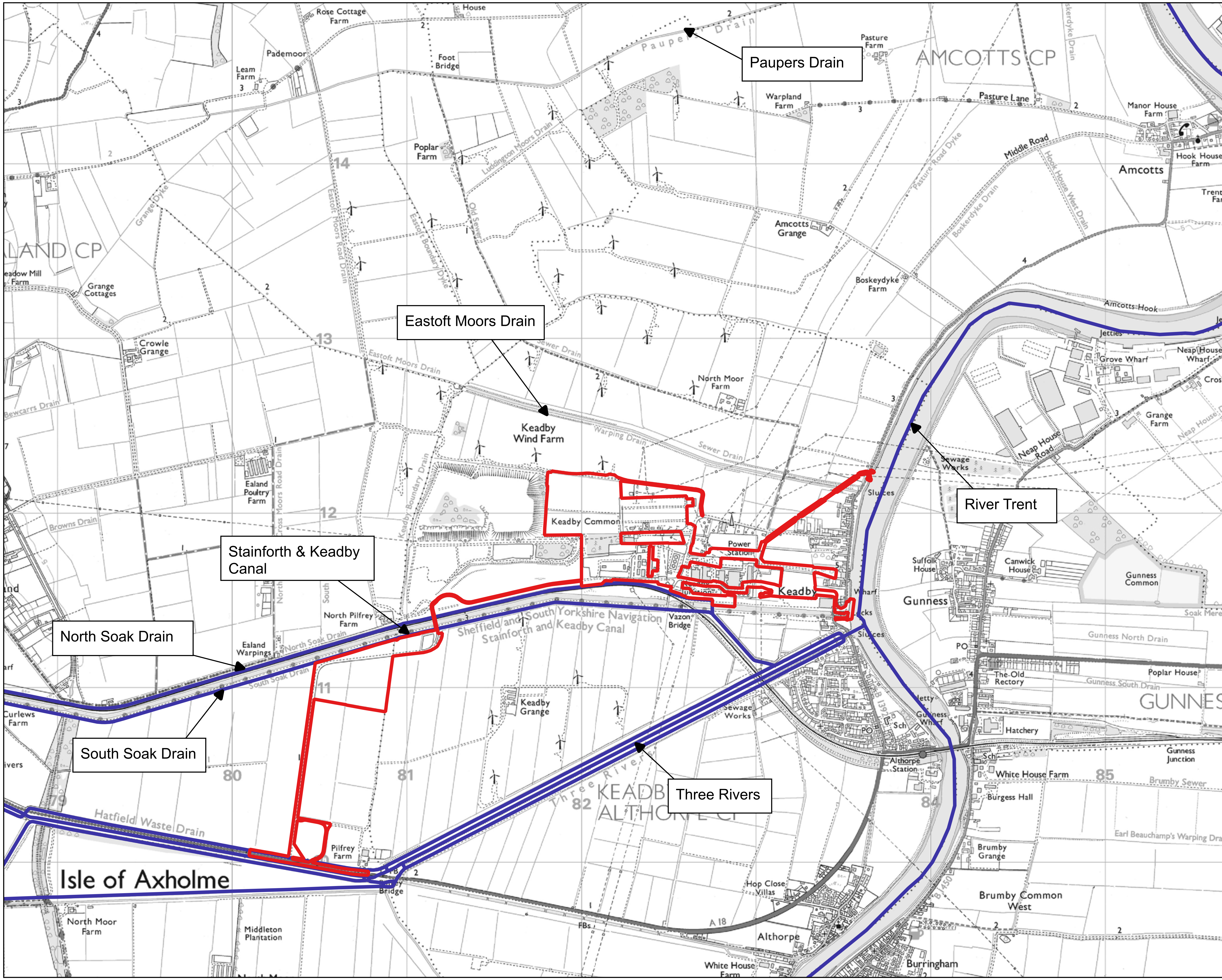
12A2.8.8 In the breach scenarios the majority of flow enters the model via the breach and therefore the Proposed Development has more of an effect locally as flows are diverted around the raised plots. Increases in maximum flood depth of between 0.01m and 0.10m are shown across the existing Keadby power station and part of Keadby village (including undeveloped land) north of the canal. Larger increases in flood depth are shown in the Keadby power station site immediately east of where the main infrastructure and AGI will be located. The increase in flood depth is typically in the region of 0.3m. These increases are typically modest compared with existing flood depths.

12A2.8.9 In the breach scenarios higher flood depths are shown along part of the rail line which runs between the North Soak Drain and the Canal. Flooding is also shown to the railway line in the baseline scenario therefore whilst the increase in flood depth is reasonably large it is likely the operation of the railway would be compromised in this type of event in any case. The change in flood depth at identified properties across the study area has also been assessed. In the defended scenarios minimal change in flood depth (<0.001m) is shown. In the breach scenarios some properties are shown to have an increase in flood depth of up to 0.090m. The largest increase shown to a residential property is 0.060m. In most instances the existing modelled flood depths are significant, several hundred millimetres or over a metre in places.

12A2.8.10 The increases in maximum flood depths due to the Proposed Development are typically minor in comparison with the existing flooding shown and are not considered to make any material change to the flood risk for the affected land, properties and infrastructure. These breach scenarios are unlikely to occur in practice as they require a major defence failure to occur in combination with the tidal flood event.

12A2.8.11 Overall, the modelling provides a robust, conservative assessment of tidal flood risk and fulfils its role in informing the FRA and supporting the Application. The modelling demonstrates the proposed mitigation measures are effective in reducing risk to the Proposed Development to an acceptable level and the Proposed Development will not lead to any unacceptable increase in flood risk elsewhere.

ATTACHMENT A. FIGURES



Project

Keadby Next Generation Power Station

LEGEND

Proposed Development Site

Main Rivers

NOTES

Reproduced from Ordance Survey digital map data © Crown copyright 2025. All rights reserved. License number AC0000808122.
Contains Ordnance Survey data © Crown Copyright and database right 2025.
Contains Environment Agency information © Environment Agency and/or database right.

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 1: Location Plan

Project number

60721867

Scale at A3 Not to scale

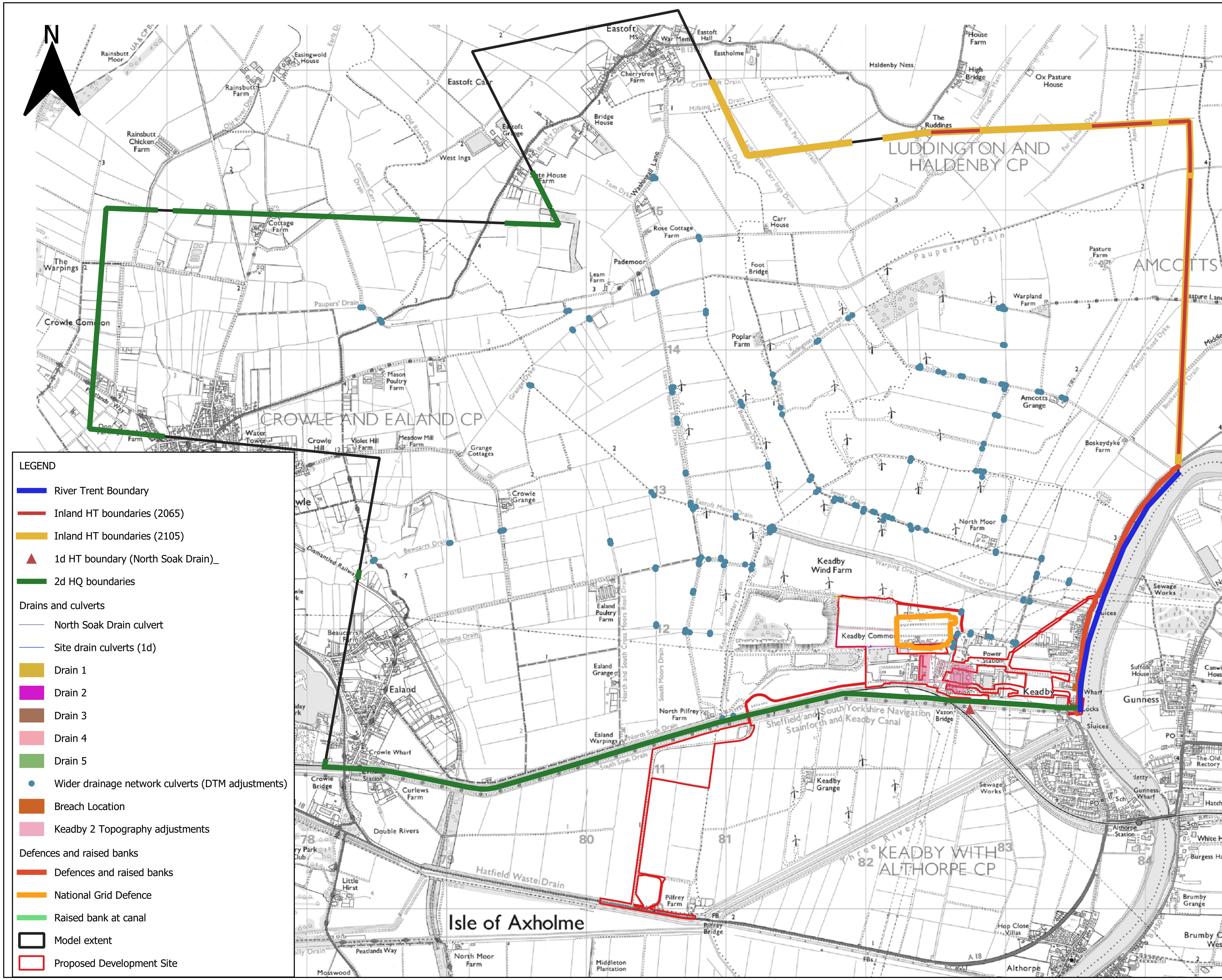
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

NOTES

Reproduced from Ordance Survey digital map data © Crown copyright 2025. All rights reserved. License number AC0000808122.
Contains Ordnance Survey data © Crown Copyright and database right 2025.
Contains Environment Agency information © Environment Agency and/or database right.

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 2a: Keadby NGPS Model Schematic (overview)

Project number

60721867

Scale at A3: Not to scale

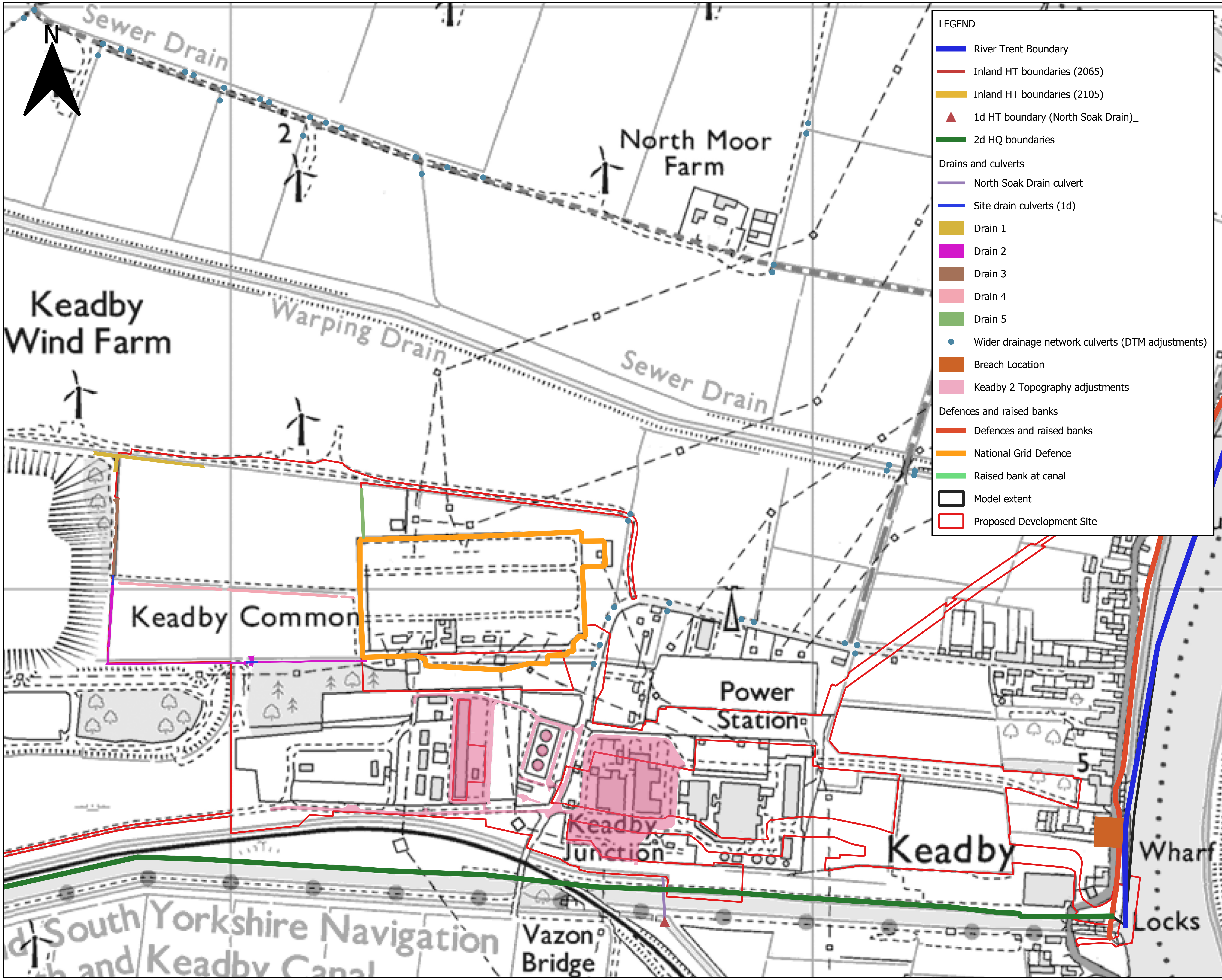
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 2b: Keadby NGPS Model Schematic (detail)

Project number

60721867

Scale at A3 Not to scale

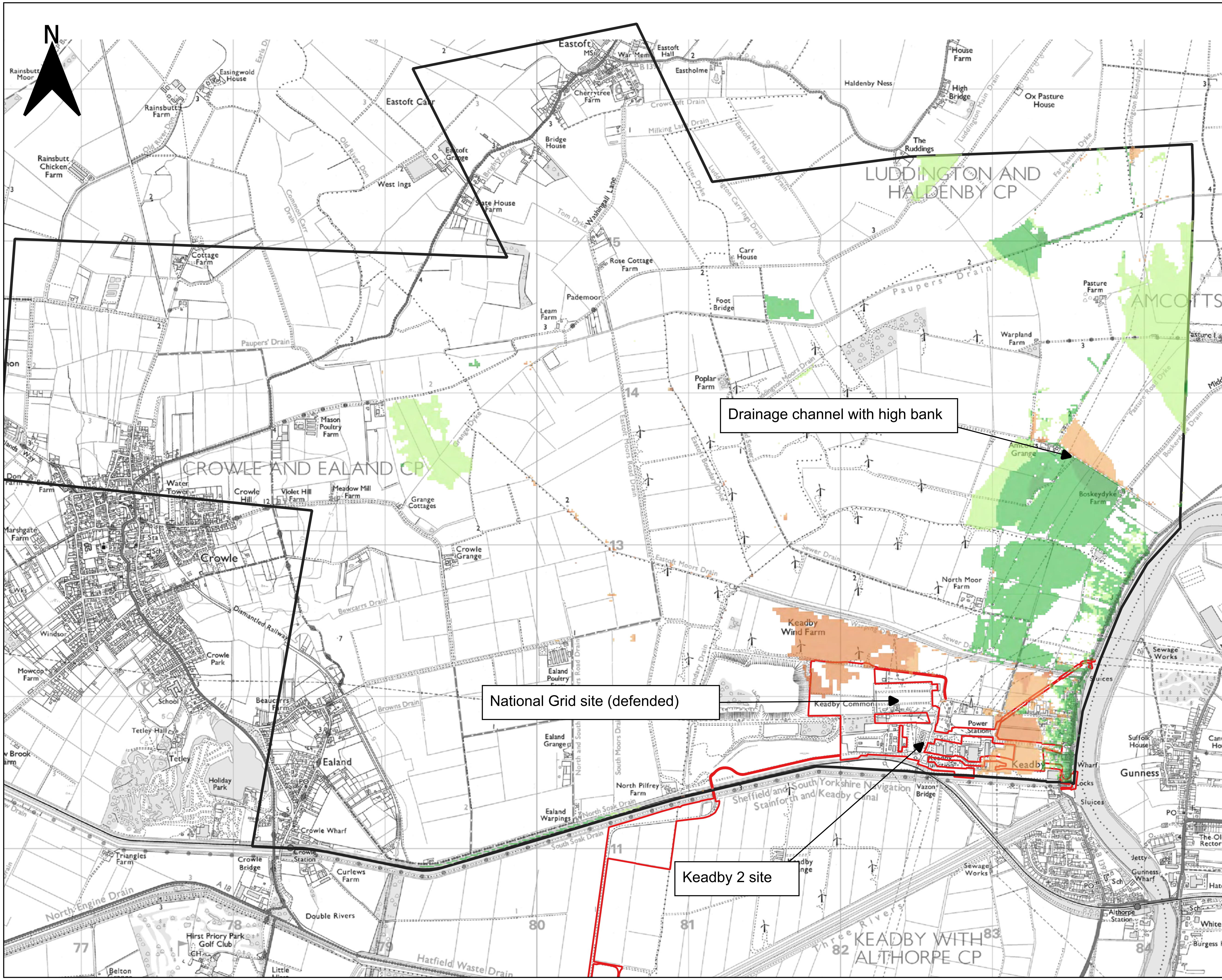
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

AECOM

Rev
2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent

Difference in peak flood level (m)

- <= -0.60
- -0.60 to -0.30
- -0.30 to -0.10
- -0.10 to -0.05
- -0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 0.60
- > 0.60

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 3a: Comparison with EA Tidal Trent peak flood levels (2065)

Project number

60721867

Scale at A3 Not to scale

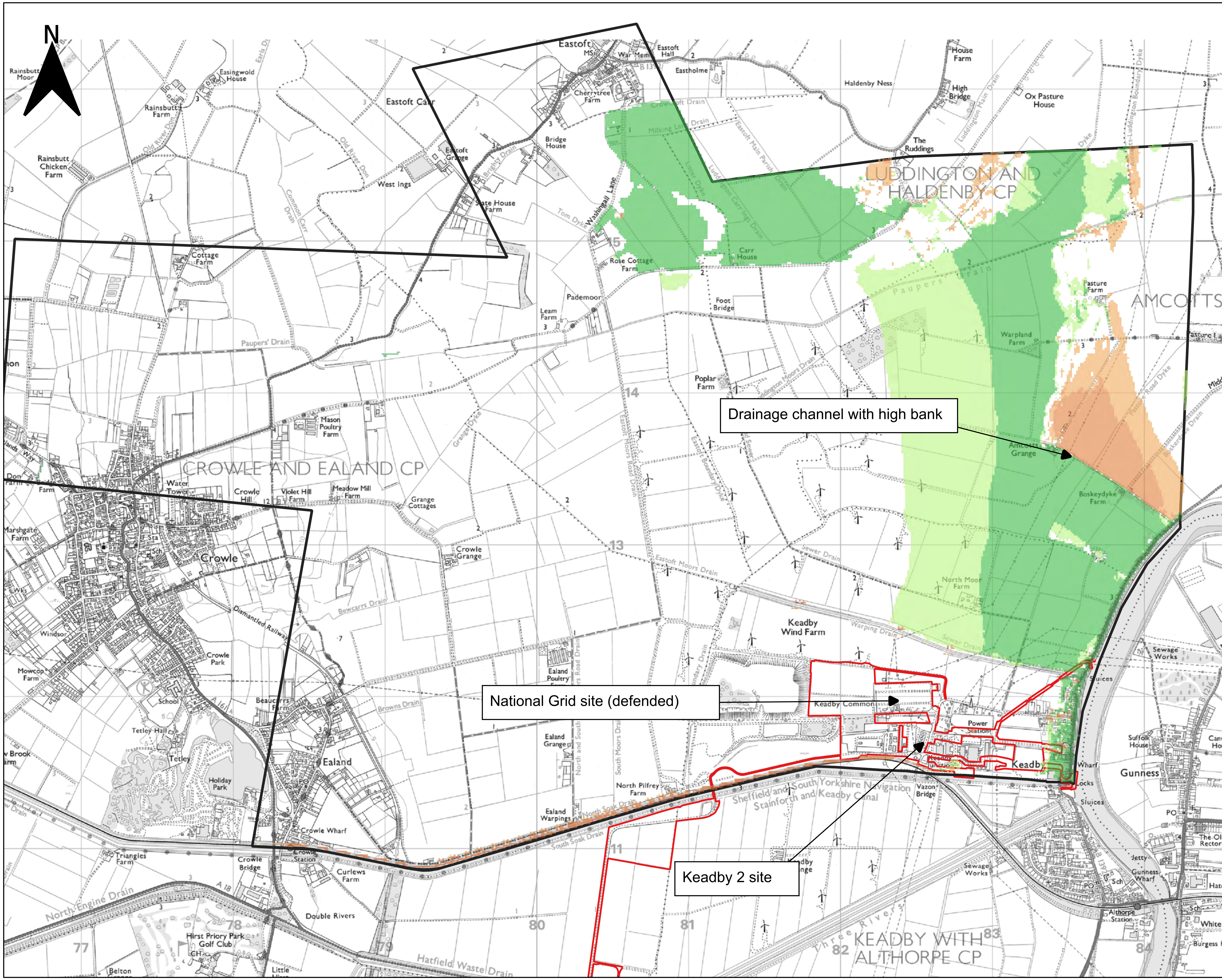
Date

14/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

Proposed Development Site

Model Extent

Difference in peak flood level (m)

- <= -0.60
- -0.60 to -0.30
- -0.30 to -0.10
- -0.10 to -0.05
- -0.05 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 0.60
- > 0.60

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 3b: Comparison with EA Tidal Trent peak flood levels (2105)

Project number

60721867

Scale at A3 Not to scale

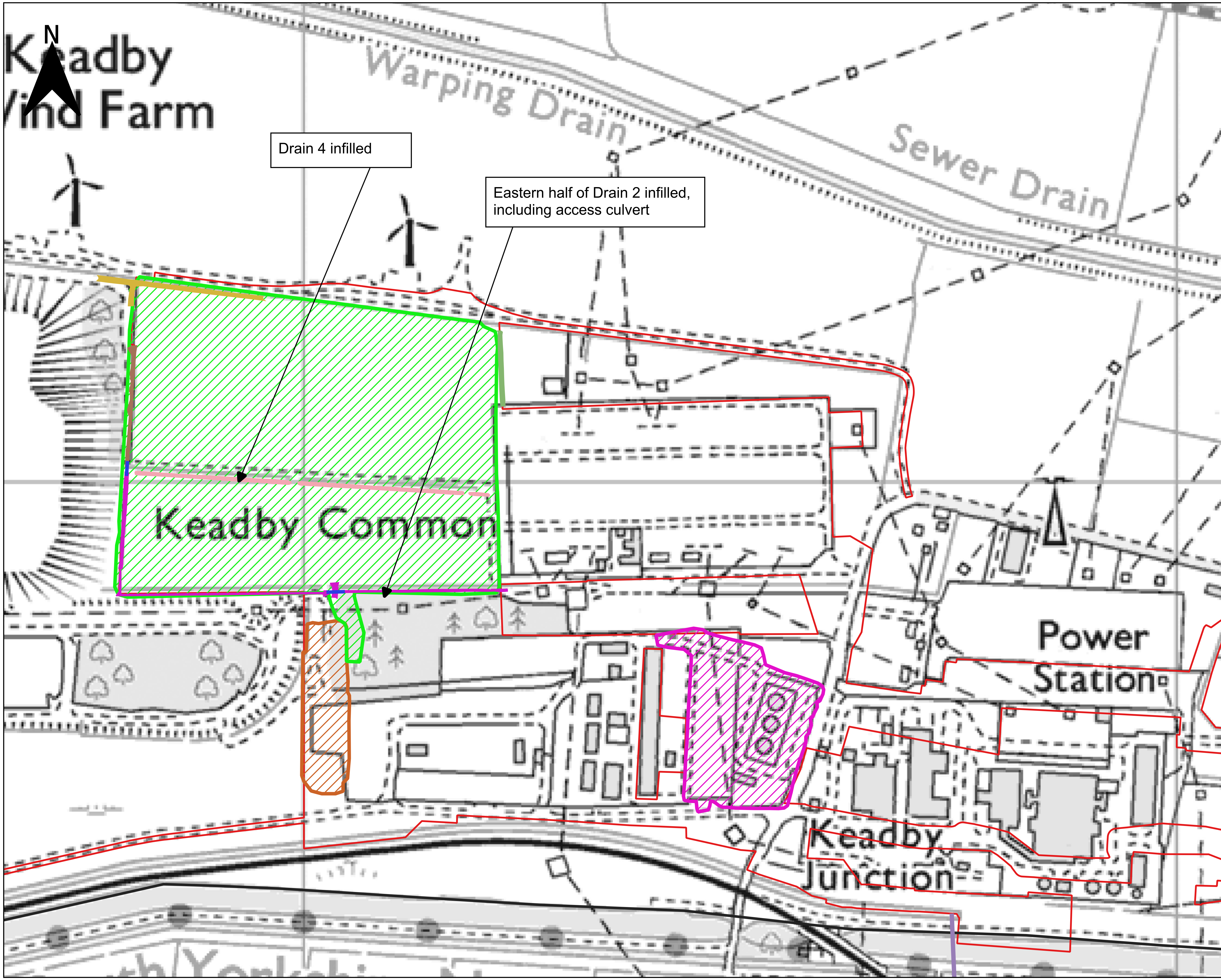
Date

14/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

Drains and culverts

- North Soak Drain culvert
- Site drain culverts (1d)
- Drain 1
- Drain 2
- Drain 3
- Drain 4
- Drain 5

Proposed Development (raised ground)

- A: Main infrastructure
- B: AGI
- C: Administration & control
- Proposed Development Site

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 4: Proposed Development model

Project number

60721867

Scale at A3 Not to scale

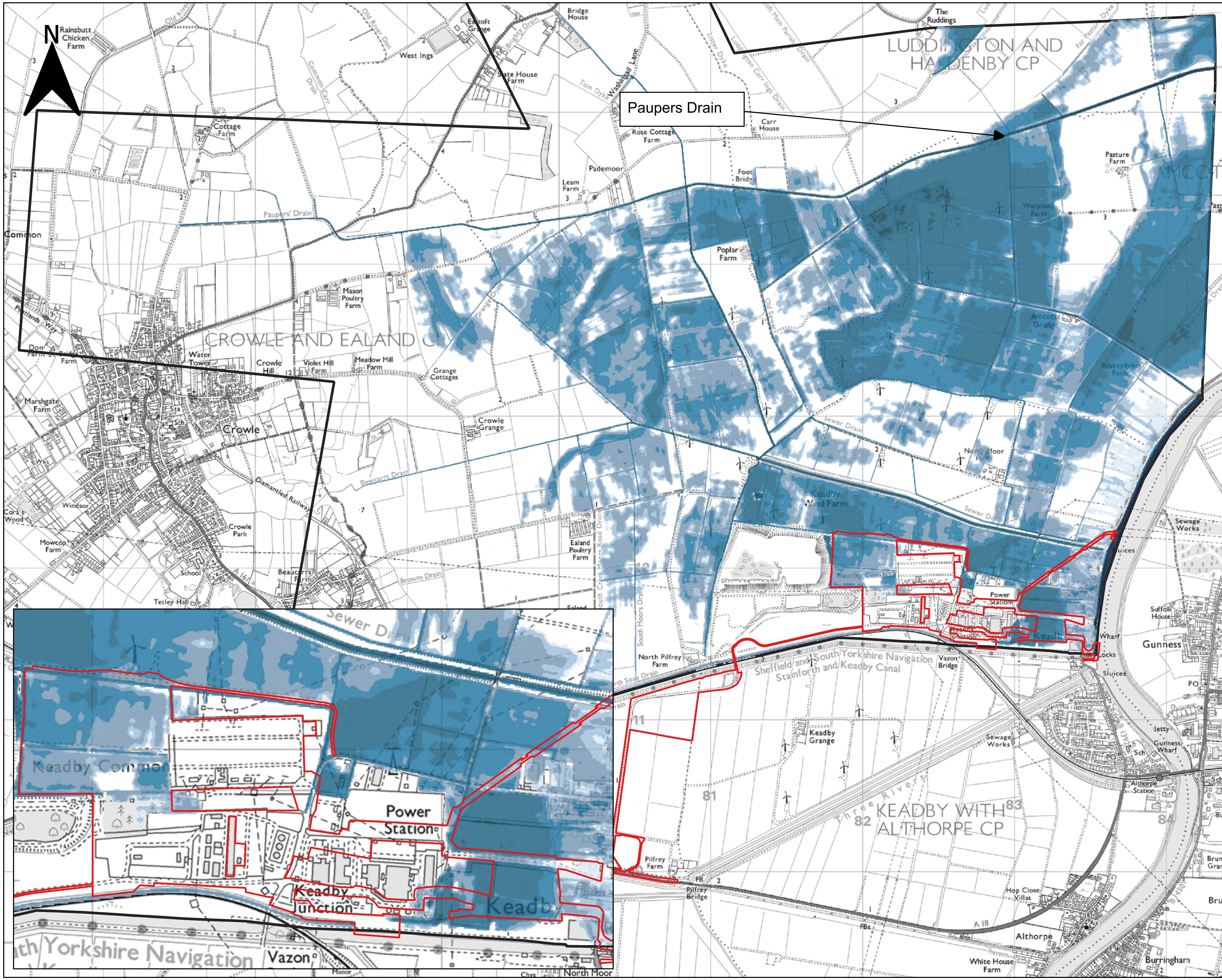
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

Proposed Development Site

Model Extent

Modelled flood depth (0.5% AEP, 2065, Defended)

m

<= 0.02

0.02 to 0.10

0.10 to 0.30

0.30 to 0.60

0.60 to 1.20

1.20 to 2.00

> 2.00

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 5a: Baseline - Modelled Flood Depths (Defended, 2065)

Project number

60721867

Scale at A3 Not to scale

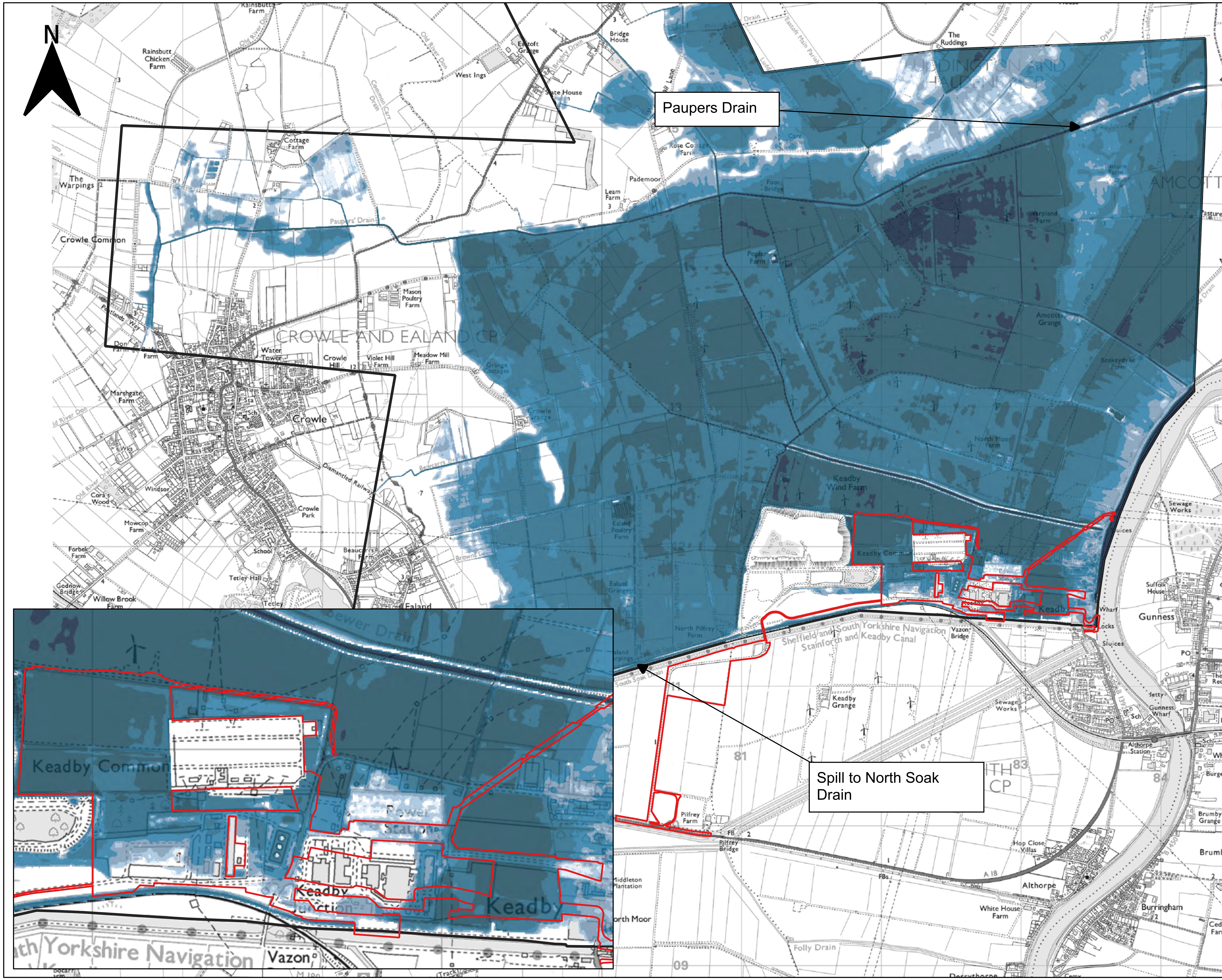
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

Proposed Development Site

Model Extent

Modelled flood depth (0.5% AEP, 2105, Defended)

m

<= 0.02

0.02 to 0.10

0.10 to 0.30

0.30 to 0.60

0.60 to 1.20

1.20 to 2.00

> 2.00

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 5b: Baseline - Modelled Flood Depths (Defended, 2105)

Project number

60721867

Scale at A3 Not to scale

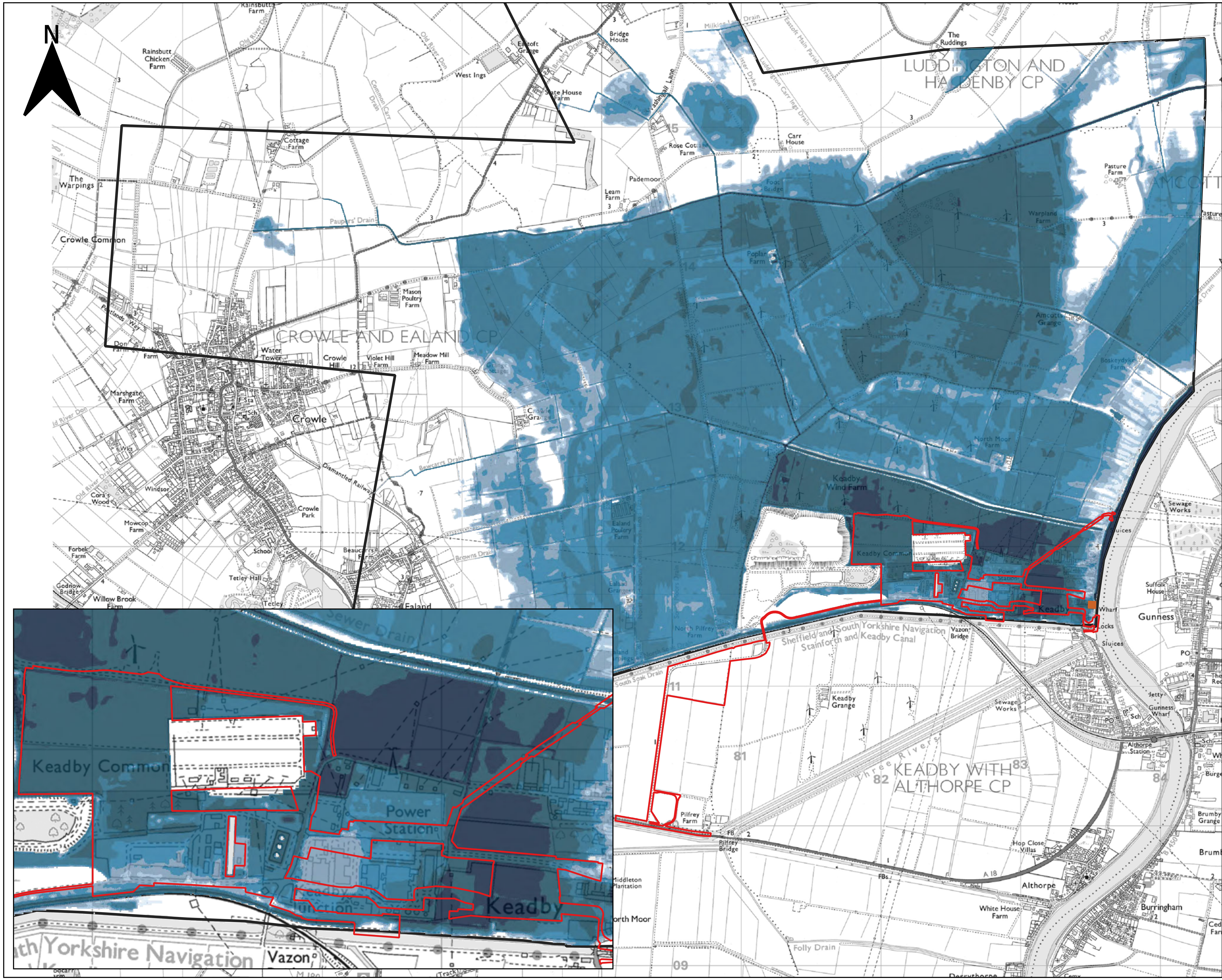
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

Proposed Development Site

Model Extent

Breach Location

Modelled flood depth
(0.5% AEP, 2105, Breach)
m

<= 0.02

0.02 to 0.10

0.10 to 0.30

0.30 to 0.60

0.60 to 1.20

1.20 to 2.00

> 2.00

NOTES

Reproduced from Ordance Survey digital map data © Crown copyright 2025. All rights reserved. License number AC0000808122.
Contains Ordnance Survey data © Crown Copyright and database right 2025.
Contains Environment Agency information © Environment Agency and/or database right.

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 6a: Baseline - Modelled Flood Depths (Breach, 2065)

Project number

60721867

Scale at A3 Not to scale

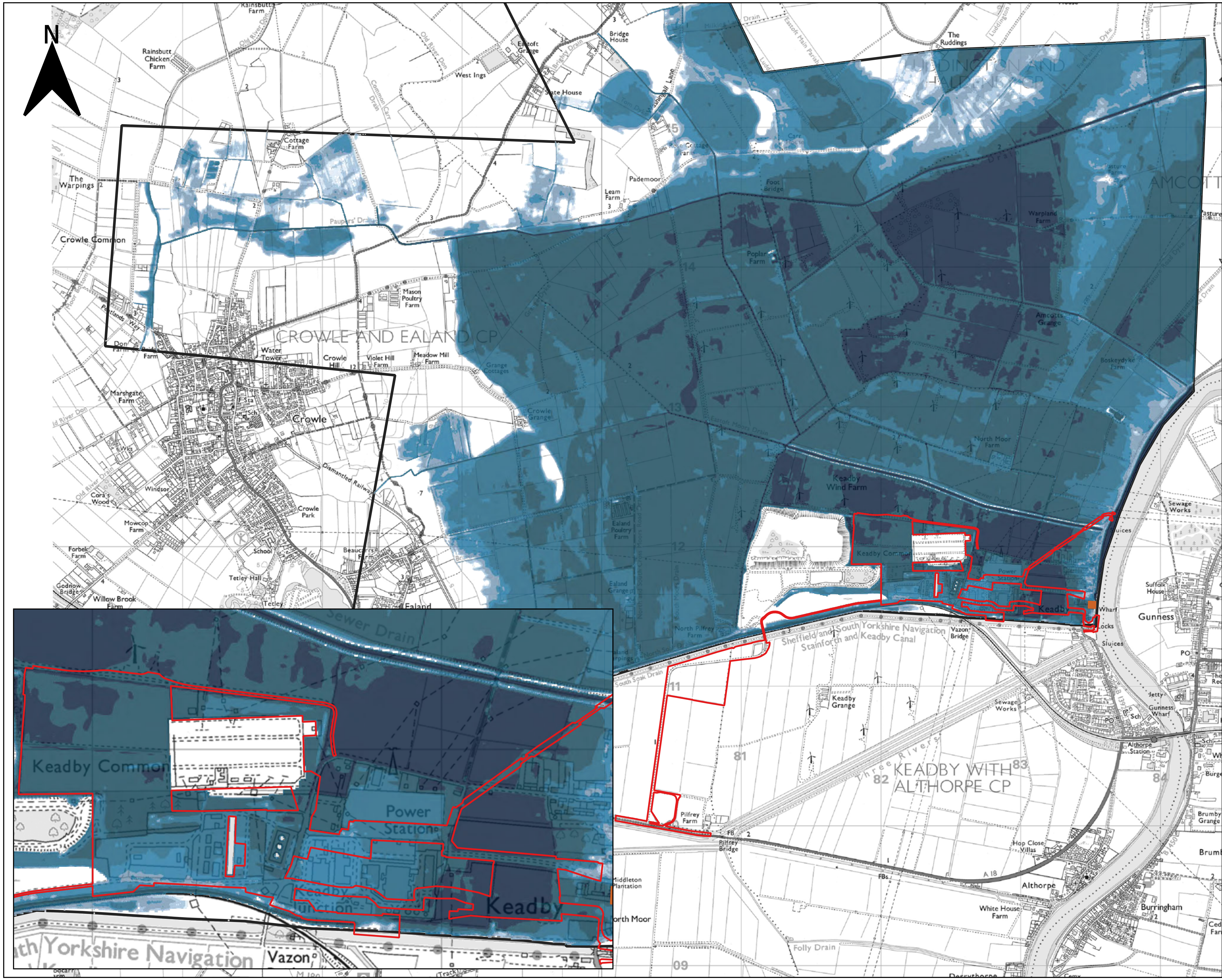
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

Proposed Development Site

Model Extent

Breach Location

Modelled flood depth (0.5% AEP, 2105, Breach)

m

<= 0.02

0.02 to 0.10

0.10 to 0.30

0.30 to 0.60

0.60 to 1.20

1.20 to 2.00

> 2.00

NOTES

Reproduced from Ordance Survey digital map data © Crown copyright 2025. All rights reserved. License number AC0000808122.
Contains Ordnance Survey data © Crown Copyright and database right 2025.
Contains Environment Agency information © Environment Agency and/or database right.

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 6b: Baseline - Modelled Flood Depths (Breach, 2105)

Project number

60721867

Scale at A3 Not to scale

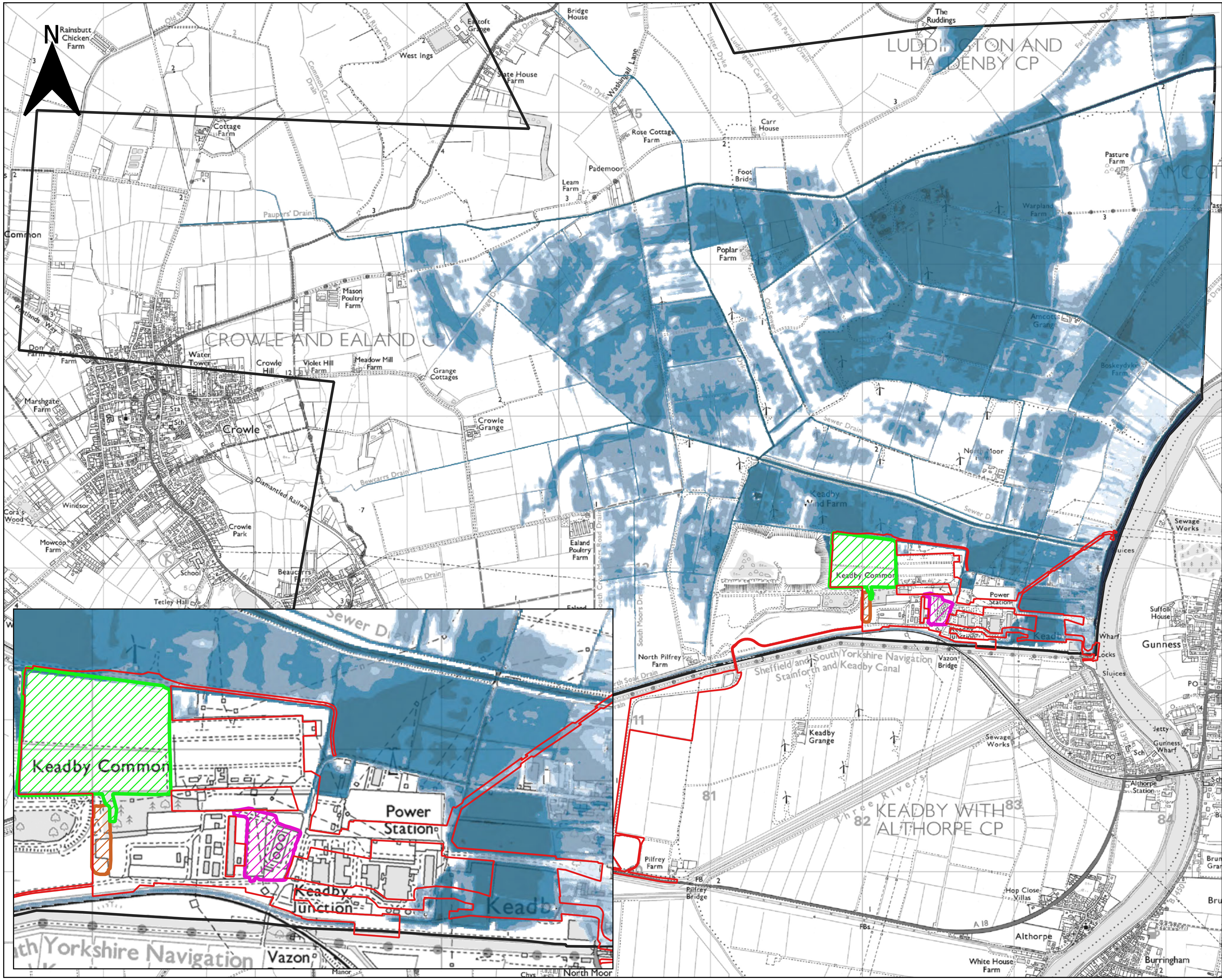
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent
- A: Main infrastructure
- B: AGI
- C: Administration & control

Modelled flood depth (0.5% AEP, 2065, Defended)

m

- <= 0.02
- 0.02 to 0.10
- 0.10 to 0.30
- 0.30 to 0.60
- 0.60 to 1.20
- 1.20 to 2.00
- > 2.00

NOTES

Reproduced from Ordance Survey digital map data © Crown copyright 2025. All rights reserved. License number AC0000808122.
Contains Ordnance Survey data © Crown Copyright and database right 2025.
Contains Environment Agency information © Environment Agency and/or database right.

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 7a: Proposed Development - Modelled Flood Depths (Defended, 2065)

Project number

60721867

Scale at A3 Not to scale

Date

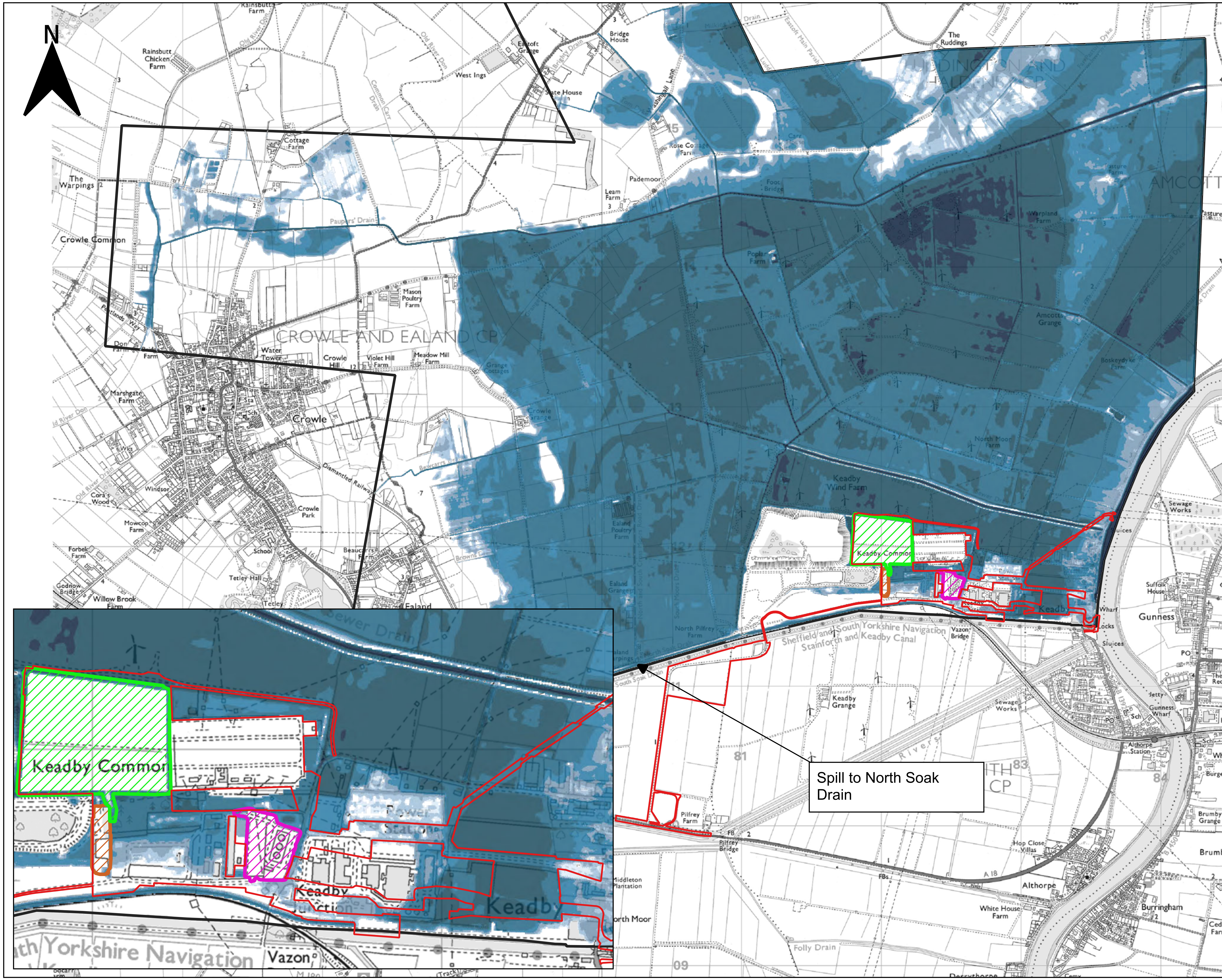
13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

AECOM

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent
- A: Main Infrastructure
- B: AGI
- C: Administration & control

Modelled flood depth (0.5% AEP, 2105, Defended)

m

- <= 0.02
- 0.02 to 0.10
- 0.10 to 0.30
- 0.30 to 0.60
- 0.60 to 1.20
- 1.20 to 2.00
- > 2.00

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 7b: Proposed Development - Modelled Flood Depths (Defended, 2105)

Project number

60721867

Scale at A3: Not to scale

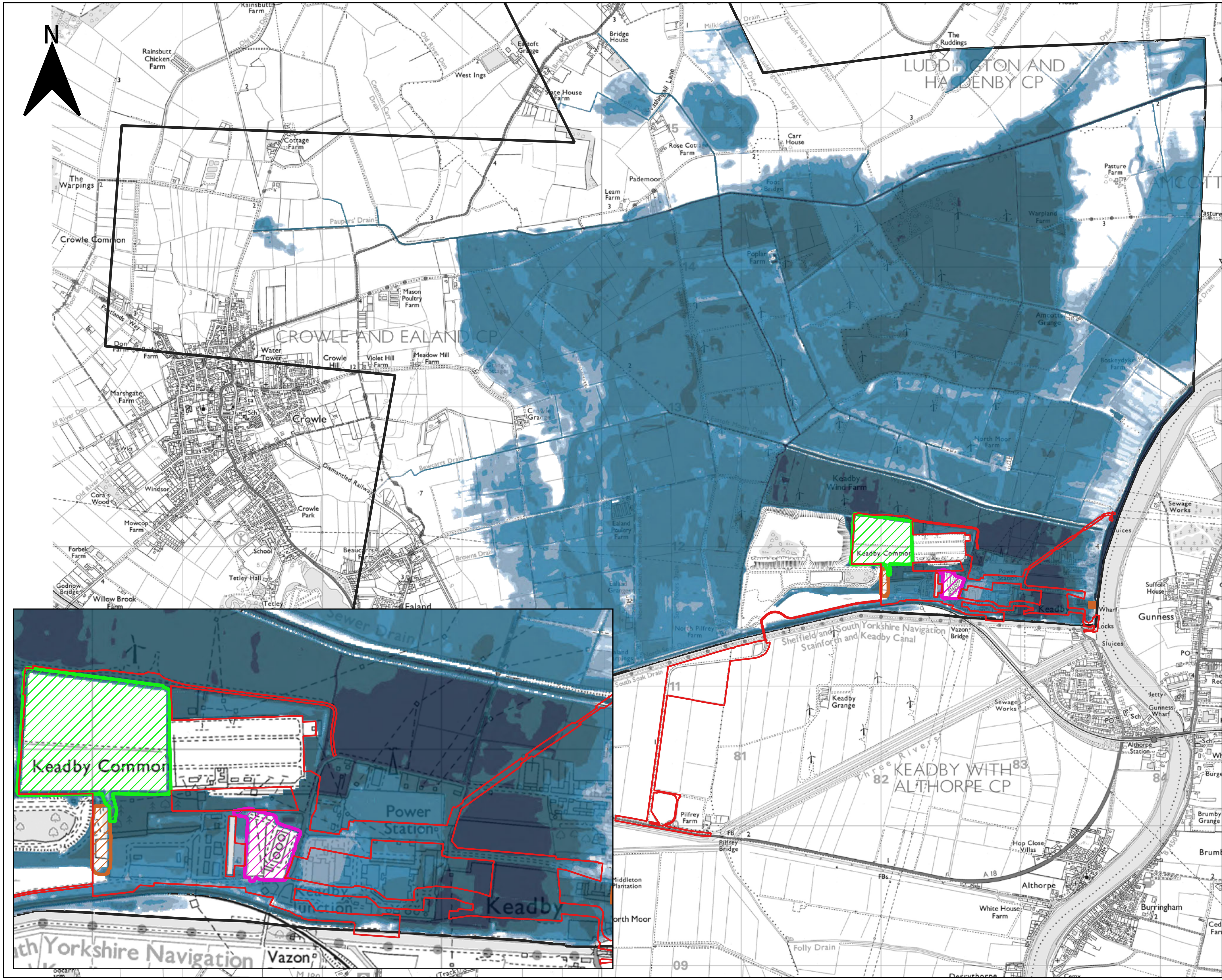
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Breach Location
- Model Extent
- A: Main Infrastructure
- B: AGI
- C: Administration & control

Modelled flood depth (0.5% AEP, 2065, Breach)

m

- <= 0.02
- 0.02 to 0.10
- 0.10 to 0.30
- 0.30 to 0.60
- 0.60 to 1.20
- 1.20 to 2.00
- > 2.00

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 8a: Proposed Development - Modelled Flood Depths (Breach, 2065)

Project number

60721867

Scale at A3 Not to scale

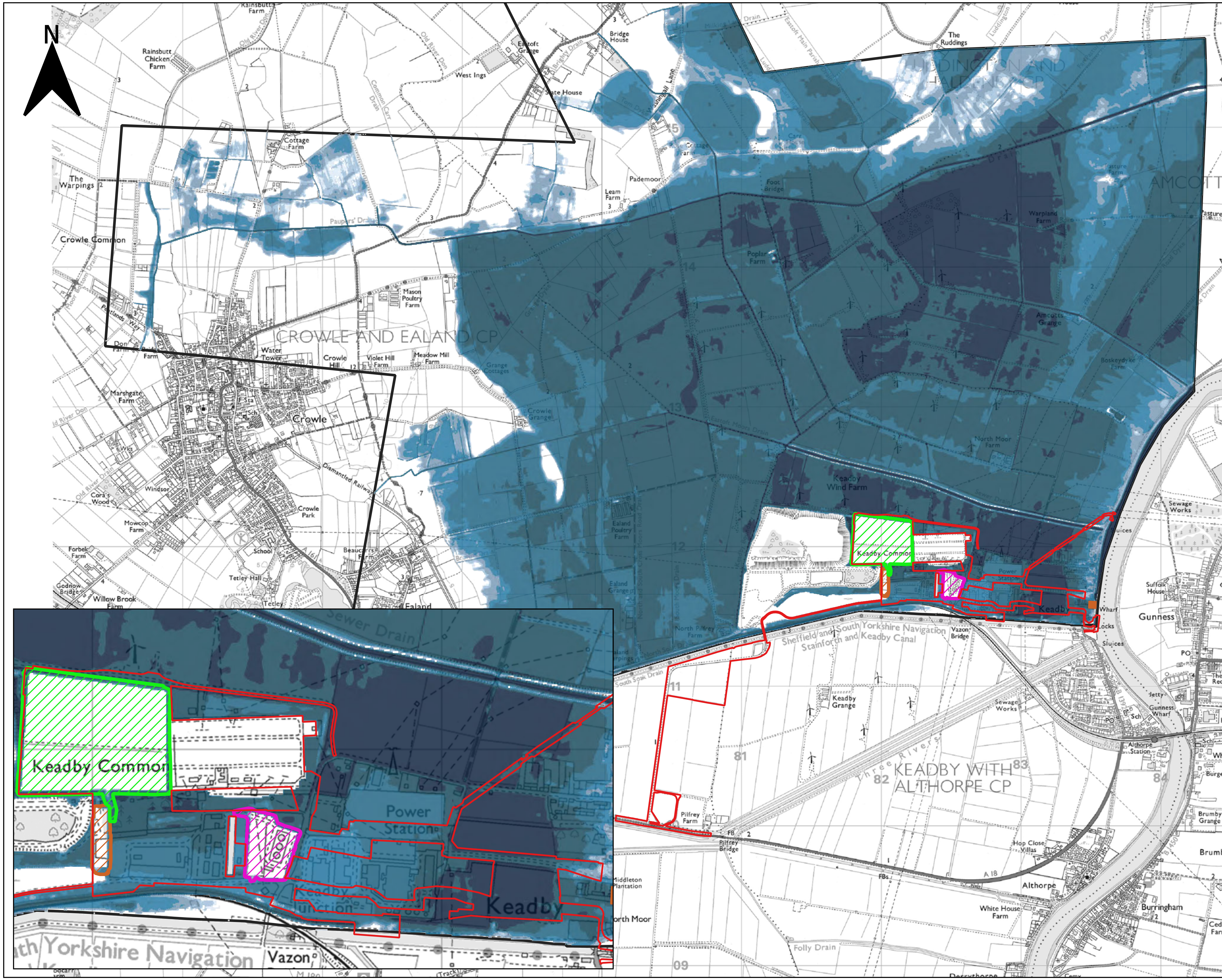
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

Proposed Development Site
Breach Location
Model Extent
A: Main Infrastructure
B: AGI
C: Administration & control

Modelled flood depth
(0.5% AEP, 2105, Breach)
m

<= 0.02
0.02 to 0.10
0.10 to 0.30
0.30 to 0.60
0.60 to 1.20
1.20 to 2.00
> 2.00

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 8b: Proposed Development - Modelled Flood Depths (Breach, 2105)

Project number

60721867

Scale at A3 Not to scale

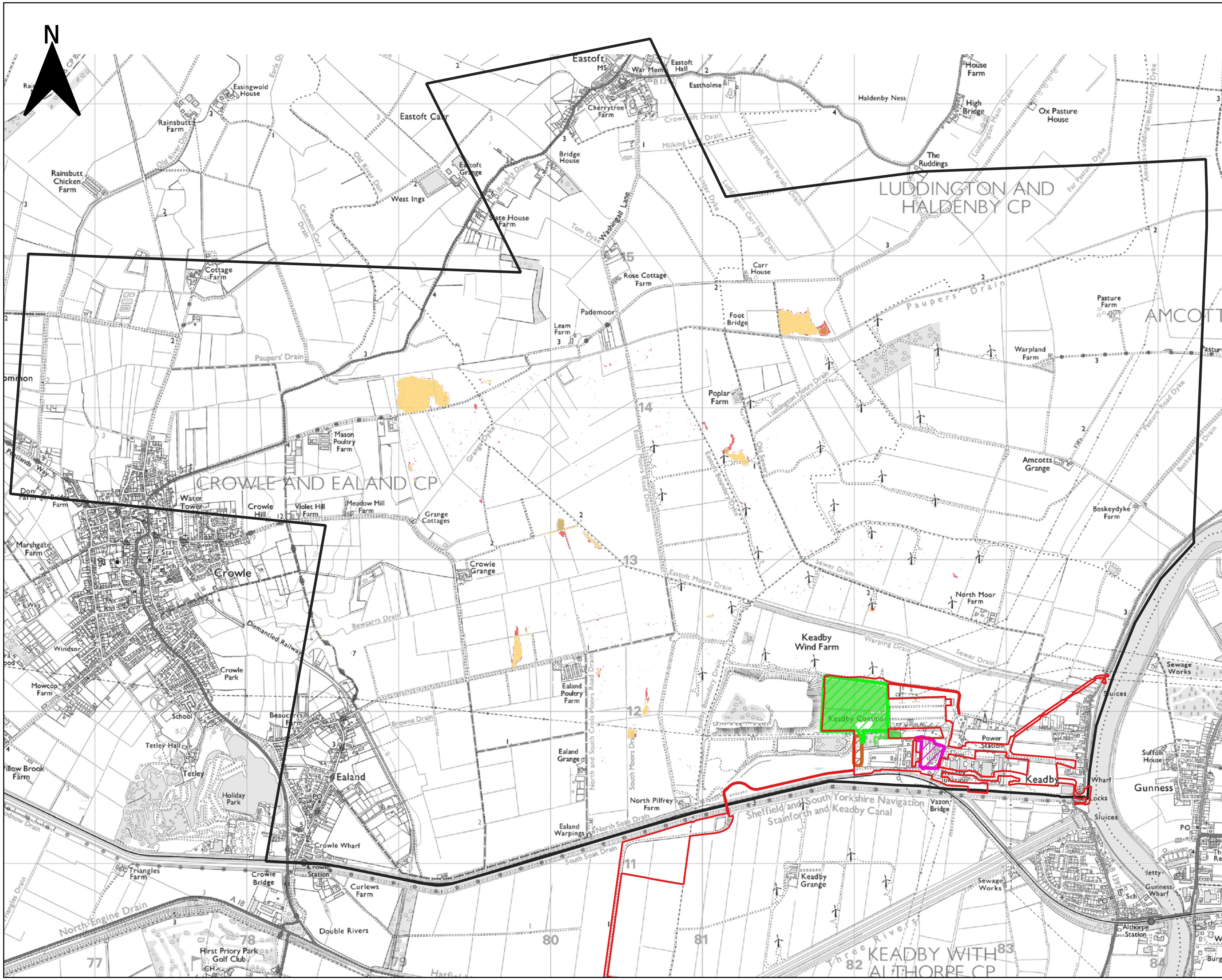
Date

13/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent
- A: Main Infrastructure
- B: AGI
- C: Administration & control

Change in maximum flood depth (0.5% AEP, 2065, Defended)

m

- <= -1.00
- -1.00 to -0.30
- -0.30 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 1.00
- > 1.00

Wet / Dry areas

- Was wet now dry
- Was dry now wet

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 9a: Change in maximum flood depths (Defended, 2065)

Project number

60721867

Scale at A3 Not to scale

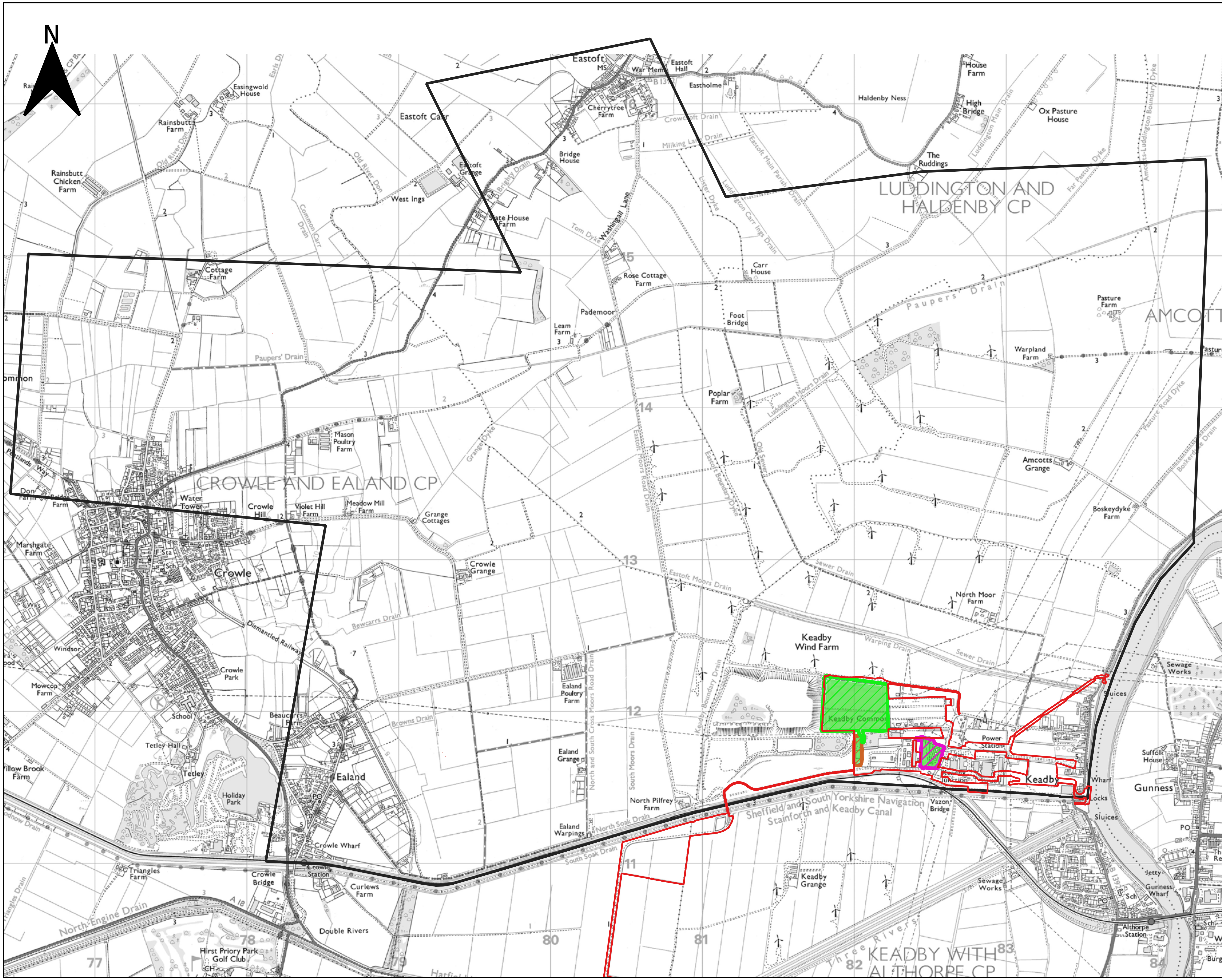
Date

14/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent
- A: Main Infrastructure
- B: AGI
- C: Administration & control

Change in maximum flood depth (0.5% AEP, 2105, Defended)

m

- <= -1.00
- -1.00 to -0.30
- -0.30 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 1.00
- > 1.00

Wet / Dry areas

- Was wet now dry
- Was dry now wet

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 9b: Change in maximum flood depths (Defended, 2105)

Project number

60721867

Scale at A3 Not to scale

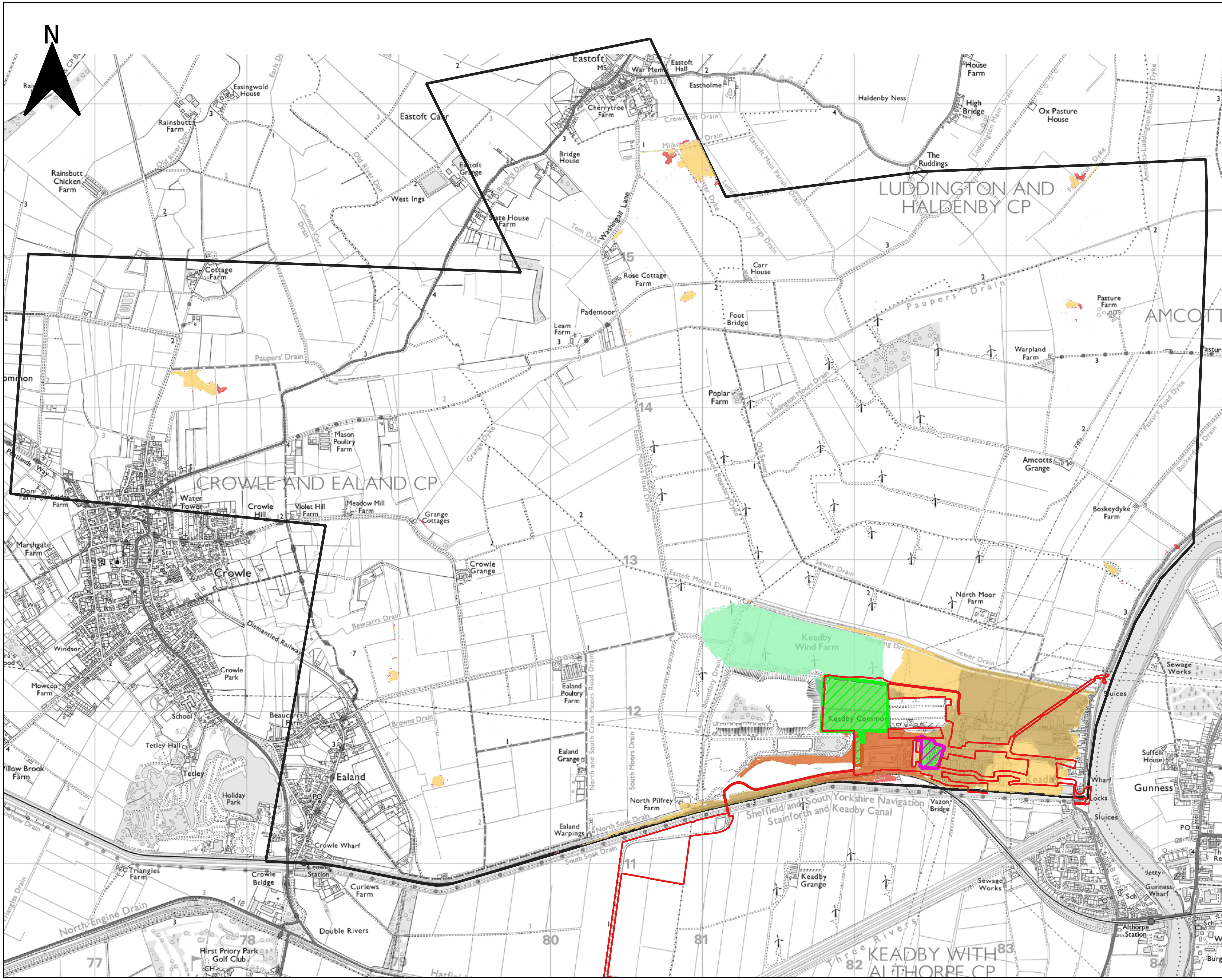
Date

14/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent
- A: Main Infrastructure
- B: AGI
- C: Administration & control

Change in maximum flood depth (0.5% AEP, 2065, Breach)

m

- <= -1.00
- -1.00 to -0.30
- -0.30 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 1.00
- > 1.00

Wet / Dry areas

- Was wet now dry
- Was dry now wet

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 10a: Change in maximum flood depths (Breach, 2065) - overview

Project number

60721867

Scale at A3 Not to scale

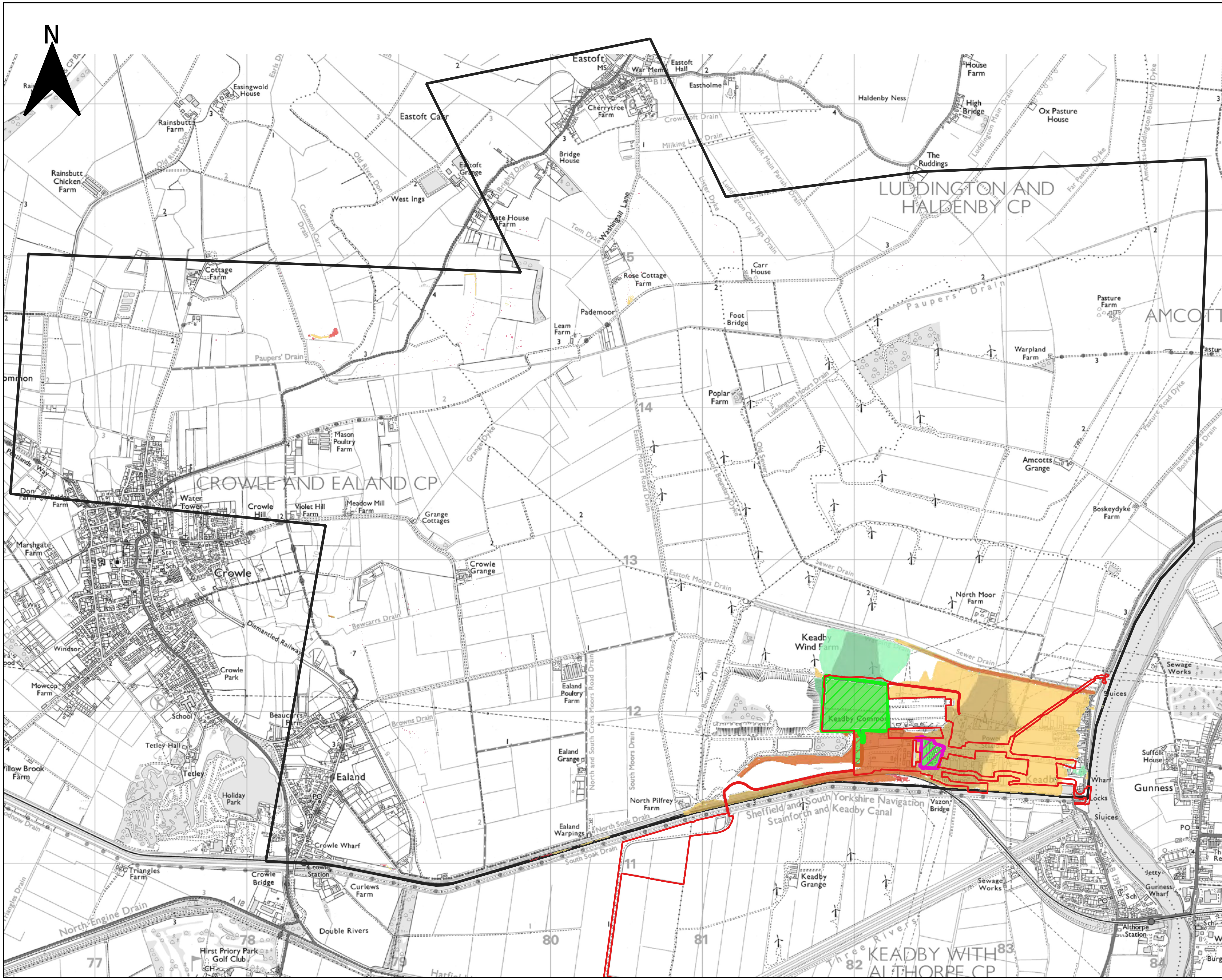
Date

14/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent
- A: Main Infrastructure
- B: AGI
- C: Administration & control

Change in maximum flood depth (0.5% AEP, 2105, Breach)

m

- <= -1.00
- -1.00 to -0.30
- -0.30 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 1.00
- > 1.00

Wet / Dry areas

- Was wet now dry
- Was dry now wet

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 10b: Change in maximum flood depths (Breach, 2105) - overview

Project number

60721867

Scale at A3 Not to scale

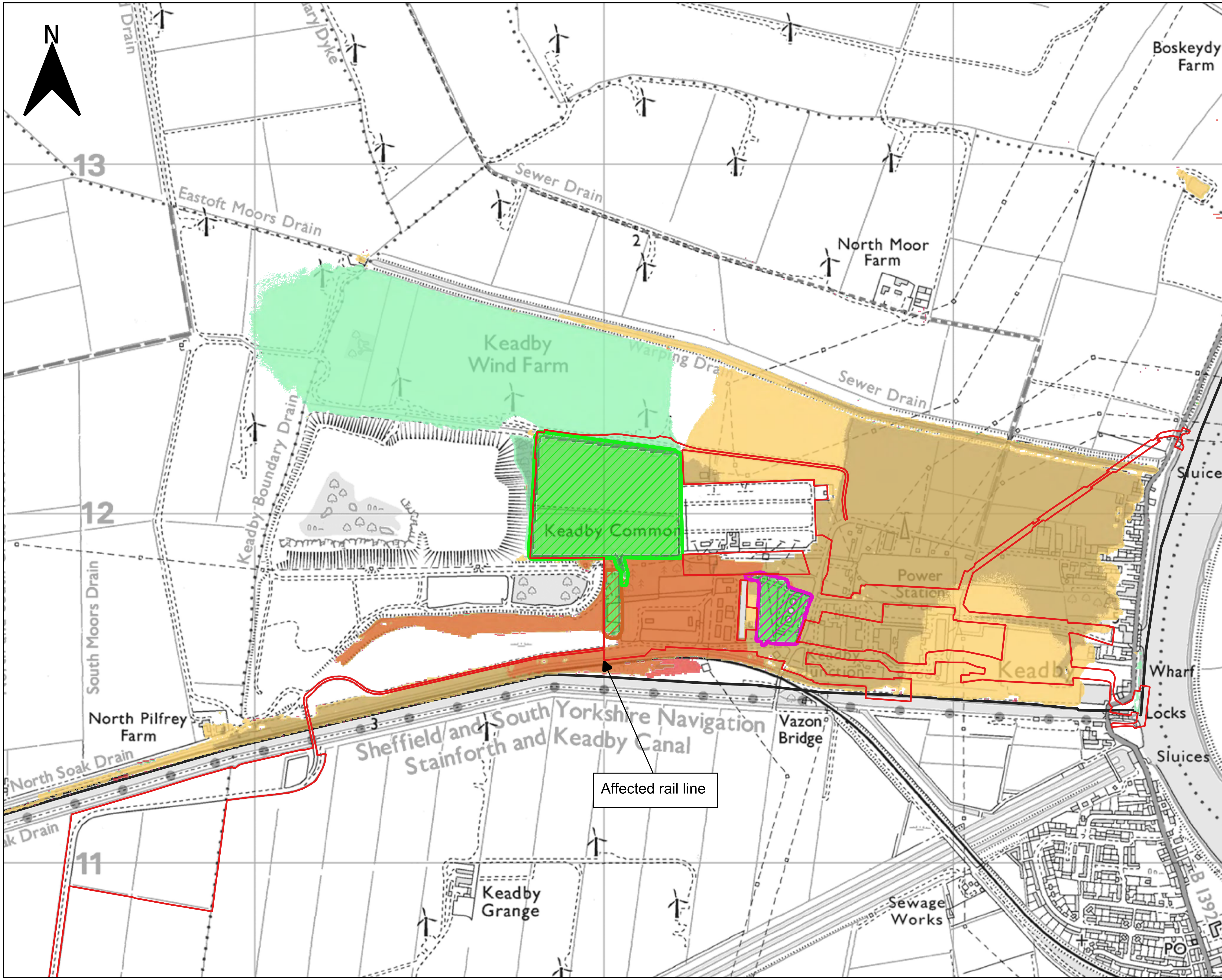
Date

14/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent
- A: Main Infrastructure
- B: AGI
- C: Administration & control

Change in maximum flood depth (0.5% AEP, 2065, Breach)

m

- <= -1.00
- -1.00 to -0.30
- -0.30 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 1.00
- > 1.00

Wet / Dry areas

- Was wet now dry
- Was dry now wet

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 11a: Change in maximum flood depths (Breach, 2065) - detail

Project number

60721867

Scale at A3 Not to scale

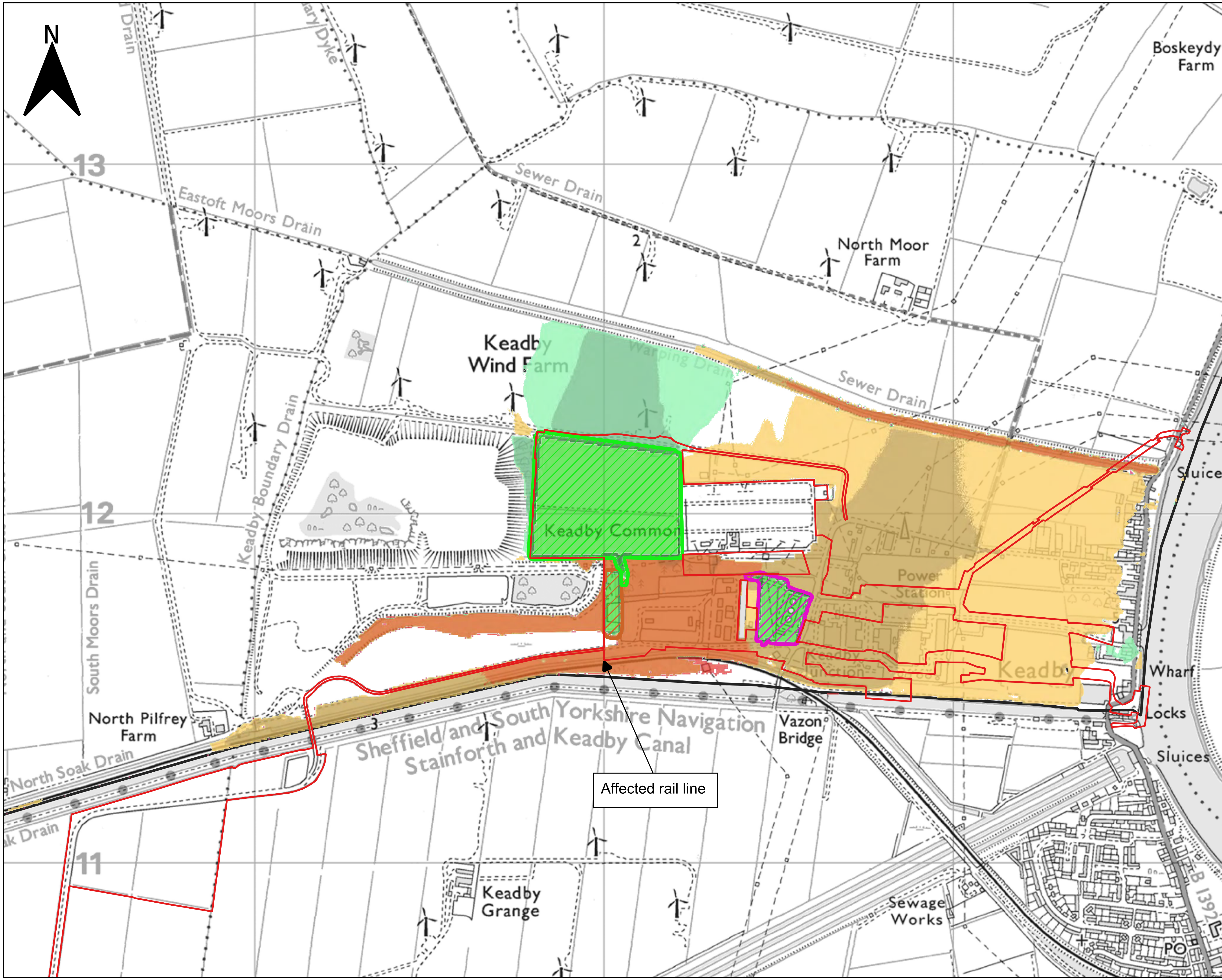
Date

14/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

Rev

2



Project

Keadby Next Generation Power Station

LEGEND

- Proposed Development Site
- Model Extent
- A: Main Infrastructure
- B: AGI
- C: Administration & control

Change in maximum flood depth (0.5% AEP, 2105, Breach)

m

- <= -1.00
- -1.00 to -0.30
- -0.30 to -0.10
- -0.10 to -0.05
- -0.05 to -0.01
- -0.01 to 0.01
- 0.01 to 0.05
- 0.05 to 0.10
- 0.10 to 0.30
- 0.30 to 1.00
- > 1.00

Wet / Dry areas

- Was wet now dry
- Was dry now wet

NOTES

Figure Title

Appendix 12A, Annex 2 - Attachment A

Figure 11b: Change in maximum flood depths (Breach, 2105) - detail

Project number

60721867

Scale at A3 Not to scale

Date

14/08/2025

AECOM
AECOM
6th Floor
3 Rivergate
Temple Quay
Bristol
BS1 6EW

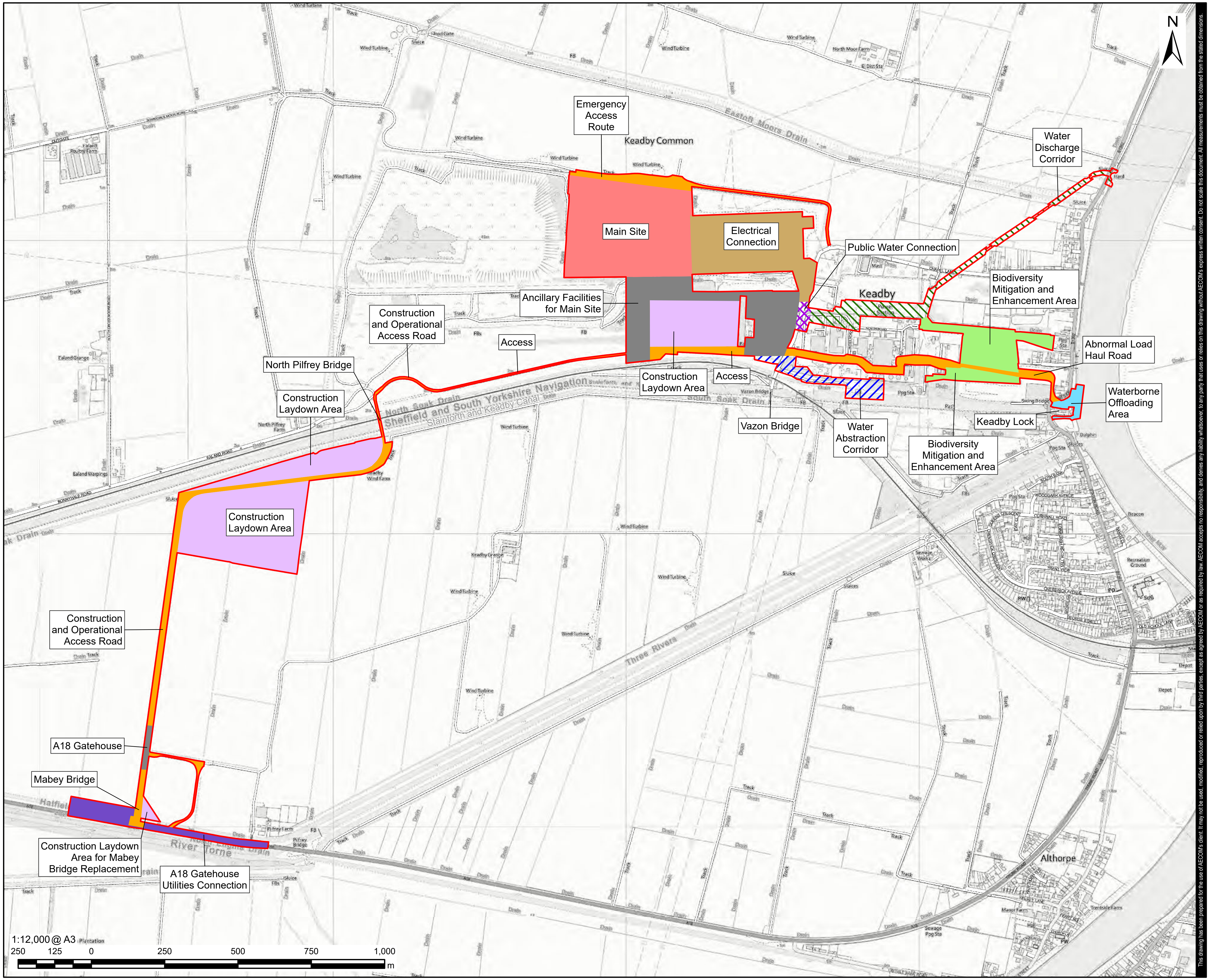
Rev

2

Figure 12 has been redacted as it contains sensitive information.

ATTACHMENT B. INDICATIVE SITE LAYOUT

Revision: 0 Drawn: MAB Checked: SM Approved: CMQ Date: 2025-08-06



Filename: I:\5004 - Information Systems\60721867_Keadby_Hydrogen_DCO\02_Maps\ES_Report\Chapter_3_Figures\Chapter_3_Figures.aprx

This drawing has been prepared for the use of AECOM's client. It may not be used, modified, reproduced or relied upon by third parties, except as agreed by AECOM or as required by law. AECOM accepts no responsibility, and denies any liability whatsoever, to any party that uses or relies on this drawing without AECOM's express written consent. Do not scale this document. All measurements must be obtained from the stated dimensions.

AECOM

PROJECT

Keadby Next Generation Power Station

CONSULTANT

AECOM Limited
Midpoint,
Alencon Link,
Basingstoke, RG21 7PP
www.aecom.com

LEGEND

- Proposed Development Site

Indicative Parts of the Site:

- A18 Gatehouse Utilities Connection
- Access
- Ancillary Facilities for Main Site (this Covers the AGIs, Admin & Control Building)
- Biodiversity Mitigation and Enhancement Area
- Construction Laydown Area
- Electrical Connection
- Main Site
- Public Water Connection (Previously Called Towns Water Connection)
- Water Abstraction Corridor
- Water Discharge Corridor
- Waterborne Offloading Area

NOTES

ISSUE PURPOSE

ENVIRONMENTAL STATEMENT

PROJECT NUMBER

60721867

FIGURE TITLE

Indicative Parts of the Site Plan

FIGURE NUMBER

Figure 3.3

ATTACHMENT C. EXISTING MODEL REVIEWS

Contents

Plates

Tables

12A2C. Aquatic Ecology baseline

12A2C.1. Introduction

12A2C.1.1. This Annex summarises the review of existing model data to determine its suitability and application to the Keadby Next Generation Power Station (the 'Proposed Development') Flood Risk Assessment (FRA). Three models have been referenced in the FRA:

- Environment Agency (EA) Tidal Trent Model (Jacobs, 2023)
- EA River Torne Model (Capita AECOM, 2017)
- Keadby 3 FRA Breach Model (AECOM, 2023)

12A2C.2. EA Tidal Trent Model (2023)

12A2C.2.1. The EA 2023 Tidal Trent model is the latest available model for the Trent and includes simulation of a number of tidal and fluvial dominated scenarios. The Flood Modeller-Tuflow model extends from Newark on Trent to the Humber Estuary. As well as the River Trent in the vicinity of the Site it includes the Three Rivers and North and South Soak Drains watercourses.

12A2C.2.2. The latest model incorporates new defence survey data (2016) and 2020 LIDAR data. The River Trent channel between Winthorpe and Trent Falls is represented with a series of cross sections with gully lines used for tributaries. A 25m grid size is used for the floodplain.

12A2C.2.3. Fluvial inflows, originally developed in 2013, were reviewed and deemed representative of the 'present day' (2021) estimates and therefore retained in the model. Water levels at the downstream model extent were extracted from the model of the Humber Estuary (2021) developed for the Humber 2100+ project, which used the 2018 extreme coastal flood boundaries dataset and included joint probability analysis of fluvial and tidal events.

12A2C.2.4. The model was calibrated against six events. The calibration was deemed to provide confidence in the model with modelled levels within or close to the threshold of 0.15m. For tidal events the calibration showed an underprediction of water level at the Keadby gauge of 0.34m and 0.37m in the two largest tidal events, a trend that was seen in previous studies.

12A2C.2.5. Breach analysis of 42 locations was included in the Tidal Trent Modelling. Breach 03 is closest to the Site, at Keadby, slightly north of Trent Road.

12A2C.2.6. As confirmed by the EA, the Tidal Trent is deemed to present a conservative representation of fluvial flood risk from the Trent tributaries (including the Three Rivers and North and South Soak Drains), because:

- Keadby pumping station is not operational in the model.
- The channels are represented in 2d.
- The modelled channel bed levels are higher when compared to the surveyed channel sections used in the River Torne model (Capita AECOM, 2017).

12A2C.2.7. Overall, the EA Trent model is considered suitable to support this FRA and provides the most up to date information on expected in channel flood levels in the **River Trent** for a range of scenarios. Whilst the fluvial flows were derived some years ago, with subsequent changes in available data and flood estimation methods, the EA study included a hydrology review and the model has been calibrated to observed events. However the modelled scenarios do not specifically align with the assessment scenarios for this FRA. **Table 12A2C.1** compares the FRA and available model scenarios detailing how these have been used in this FRA.

12A2C.2.8. The EA Trent model also includes a scenario where the downstream boundary levels under the climate change scenario were extracted from the Humber estuary model, rather than simply adjusted for predicted sea level rise. The results indicate that applying sea level rise directly to the River Trent is a precautionary approach, with an approximate 860mm difference in levels at the downstream boundary. This has been considered when interpreting the results for the assessment.

12A2C.2.9. Whilst the EA Trent model provides the most up to date information on in-channel water levels, the AECOM breach model (see below) originally developed for the Keadby 3 FRA is deemed to provide a more accurate assessment of flood impacts at the Site following a breach in the defences. The AECOM model uses a smaller grid size (5m compared with 25m) and includes topographic survey and design information to improve representation of the drains and ground levels in and around the Site. The modelled breach location has also been selected to be specifically relevant to the Site.

Table 0A2C.1: Comparison of FRA and Trent Model Scenarios

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
Fluvial: 2030 (construction, start of operation)				
1% AEP Defended	18% (2020s)	1% AEP Defended	0%	Fluvial design event Model results show very similar flood extent for both scenarios, not affecting the main development site. The 29% scenario has been assessed as a precautionary approach.
		1% AEP Defended	29%	
0.1% AEP	18% (2020s)	0.1% AEP	0%	Extreme event check Modelled flows slightly low which has been considered in the assessment.
Fluvial: 2065 (Expected maximum design life)				
1% AEP Defended	23% (2050s)	1% AEP Defended	29%	Modelled climate change is close to the assessment scenario
1% AEP	38% (2050s)	1% AEP Defended	39%	

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
Defended (Credible Maximum)				
Fluvial: 2105 (Precautionary maximum design life)				
1% AEP Defended	39% (2080s)	1% AEP Defended	39%	Modelled climate change matches the assessment scenario
1% AEP Defended (Credible Maximum)	62% (2080s)	1% AEP Defended	62%	
Tidal: 2030 (construction, start of operation)				
0.5% AEP Defended	80.4mm (sea level rise)	0.5% AEP Defended	0mm	Tidal design event Modelled tide level possibly slightly low but does not impact on the assessment

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
0.1% AEP Defended	80.4mm (sea level rise)	0.1% AEP Defended	0mm	Extreme event check Modelled tide level possibly slightly low but does not impact on the assessment
Tidal: 2065 (Expected maximum design life)				
0.5% AEP Defended	444mm (sea level rise)	0.5% AEP Defended	516mm (2071 UE)	Tidal design event Modelled tide level slightly high therefore presents a precautionary estimate
0.5% AEP Breach	444mm (sea level rise)	0.5% AEP Breach 03	0mm (2021)	Residual risk event Similar modelled scenario not available however EA Trent model results show the River Trent levels at Keadby are much less sensitive to changes in downstream tide level (an approximate 1.3m difference downstream results in only an approximate 370mm difference at Keadby). The range is considered in the FRA.
		0.5% AEP Breach 03	1340mm (2121 UE)	

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
				Breach results not available for this assessment however Keadby 3 Breach model is available.
0.5% AEP Defended (Credible Maximum)	1.9m (sea level rise)	N/A	N/A	Residual risk event Similar scenario has not been modelled. Qualitative assessment undertaken for the FRA. The 1.9m sea level rise estimate is to 2100 therefore this is a precautionary estimate for sea level rise to 2065.
Tidal: 2105 (Precautionary maximum design life)				
0.5% AEP Defended	1079mm (sea level rise)	0.5% AEP Defended	1340mm (2121 UE)	Tidal design event Modelled tide level too high however EA Trent model results show the River Trent levels at Keadby are much less sensitive to changes in downstream tide level (an approximate 350mm difference downstream results in only an approximate 80mm difference at Keadby). The higher level provides a precautionary estimate.

FRA Scenario	Applicable climate change adjustment	Available Trent Model Scenarios	Modelled climate change allowance	Comment
0.5% AEP Breach	1079mm (sea level rise)	0.5% AEP Breach 03	1340mm (2121 UE)	Residual risk event Modelled tide level is too high however levels in the River Trent at Keadby are less sensitive to this change. The higher level provides a precautionary estimate. Breach results not available for this assessment however Keadby 3 Breach model is available.
0.5% AEP Defended (Credible Maximum)	1.9m (sea level rise)	N/A	N/A	Residual risk event Similar scenario has not been modelled. Qualitative assessment undertaken for the FRA.

EA River Torne Model (2017)

12A2C.2.10. The River Torne model was developed to assess fluvial flood risk across the Isle of Axholme. It includes the Rivers Torne and Idle with their associated tributaries. The model uses available topographic survey of the majority of the drains and river channels of interest, which appears to include the Three Rivers and North and South Soak Drains in the vicinity of the Site. The floodplain is represented using 1m and 2m LiDAR data, flown in 2011 and 2008 respectively.

12A2C.2.11. The model is a 1d/2d FMP-TUFLOW model covering the Proposed Development study area. Model inflows were derived for 26-subcatchments, informed by Internal Drainage Board (IDB) boundaries, topography, and locations of pumping stations. The inflows via pumping stations were refined according to modelled operational data. Water levels in the River Trent were extracted from the EA 2014 Trent model to provide downstream boundary conditions for the model, assuming fluvial baseflow combined with a Mean High Water Spring tidal boundary.

12A2C.2.12. The model and hydrology were calibrated using three events (November 2000, January 2000 and December 2012). Spot gauging was also undertaken to verify pump capacity at Keadby pumping station. Data limitations reduce the overall confidence in the calibration however good calibration was achieved at key locations for the November 2000 and December 2012 events. The model appeared to under predict runoff for the January 2008 event, considered likely due to the catchment state (antecedent rainfall and baseflow).

12A2C.2.13. Results are available for a range of fluvial flood events, including climate change scenarios, from the 50% AEP to the 0.1% AEP.

12A2C.2.14. Overall, the EA Torne model is considered suitable to support this FRA. Whilst it is several years old, the model has been calibrated to observed data and changes in standard hydrological methods are less relevant to this type of catchment dominated by artificial drainage and pumping. In consultation the EA agreed with this conclusion, subject to confirmation regarding updates to climate change allowances and availability of more recent LiDAR data since the model was completed. These were checked as detailed below.

Climate change allowances

12A2C.2.15. As detailed in the FRA, and confirmed by the EA in their statutory consultation response, the appropriate fluvial climate change allowances for the FRA are as follows:

- Higher Central (used for assessment of the impact of fluvial flood risk to the development, and the assessment of off-site impacts from the development).
- 2050s (covers the 2065 assessment year): 23%
- 2080s (covers the 2105 assessment year): 39%
- Upper End (used for assessment of the credible maximum climate change scenario).
- 2050s: 38%
- 2080s: 62%

12A2C.2.16. It should be noted the Higher Central allowance has been selected for assessment of off-site impacts due to the presence of Essential Infrastructure close to the Main Site. However fluvial flooding is more dominant in the area south of the Stainforth and Keadby Canal where surrounding land uses would typically be classed as 'less vulnerable' to flooding. In which case the Central climate change allowance is applicable.

12A2C.2.17. The River Torne model includes results for the 1% AEP event with climate change uplifts of 20%, 30% and 50%. As a precautionary approach the modelled 1% AEP +30% is used for the 2065 assessment year and 1% AEP +50% for the 2105 assessment year.

12A2C.2.18. The Torne model report includes tabulated flows for the four FEH inflows. Comparison of the 0.1% AEP peak flows to 1% AEP peak flows shows these vary from around +40% to +100%. However the 0.1% AEP flood extent is typically larger than the 1% AEP +50% extent (**Plate 12A2C.1**), indicating the modelled flows are generally higher in the 1000 year event. It is therefore proposed to use the model outputs for the 1000 year event for consideration of the credible maximum climate change scenario.

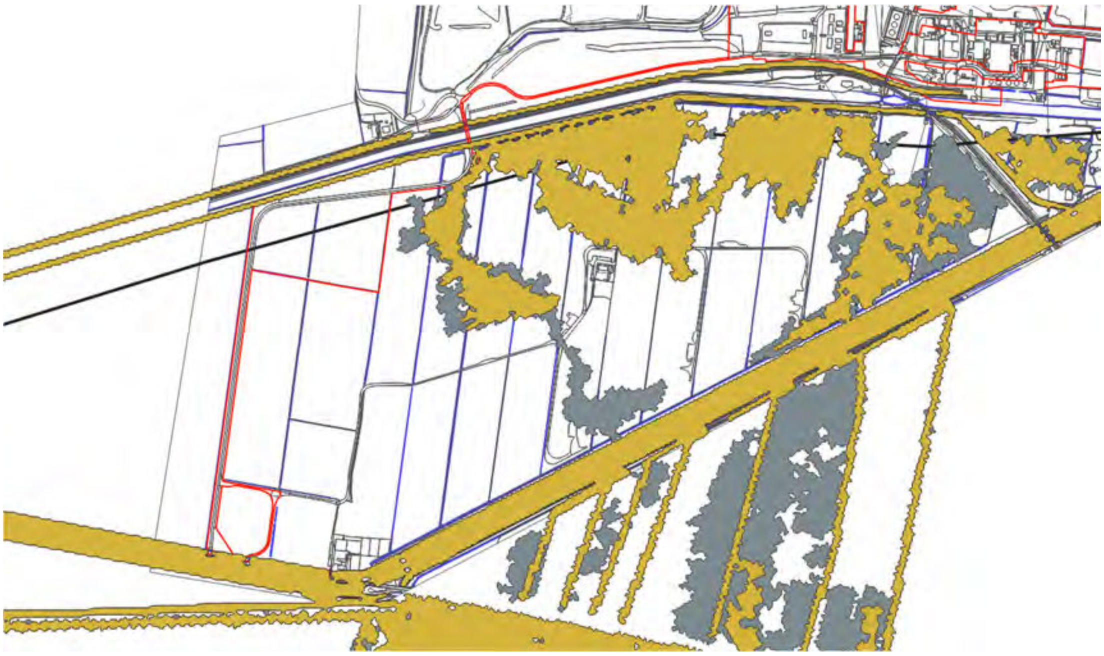


Plate 0A2C.1: Torne modelled flood extents: 1% +50% (orange) and 0.1% (grey)

Lidar updates

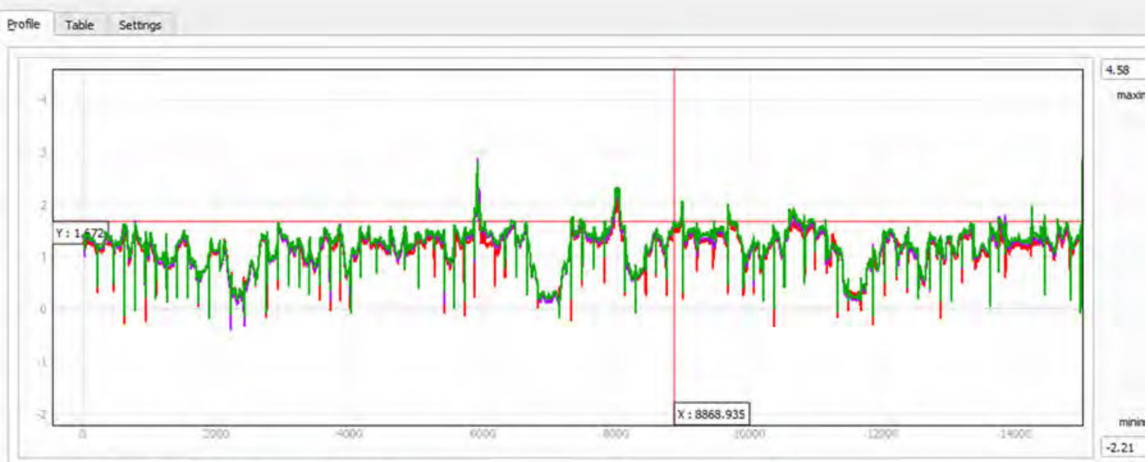
12A2C.2.19. The current available 1m composite DTM incorporates LiDAR data flown in 2018 in this area. There is also 1m 2021 LiDAR available through the National LiDAR programme. The LiDAR used in the model is of 1m and 2m resolution dating from 2011 and 2008. **Plate 12A2C.2** overleaf shows a comparison of the LiDAR in the area south of the canal where fluvial flooding occurs.

12A2C.2.20. The comparison shows the model DTM follows the same pattern as more recent LiDAR and is typically around 100mm lower than the NLP DTM and 150mm lower than the composite DTM. Larger differences are shown at drain crossings etc, where it is expected the higher resolution data would be more accurate. These are in line with typical quoted accuracies for LiDAR.

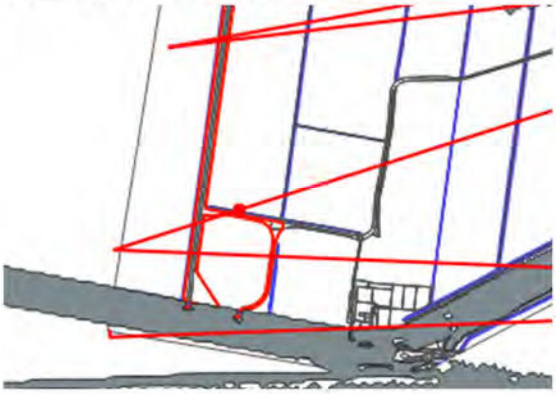
12A2C.2.21. As the differences are reasonably consistent across the area it is expected the flooding locations and extents shown by the model would remain similar were it to use more recent LiDAR data. The modelled flood levels (m AOD) may be 100 – 150mm higher (to give the same flood depth) but there is nothing to indicate the modelled overland flow routes and extents would see any significant change.

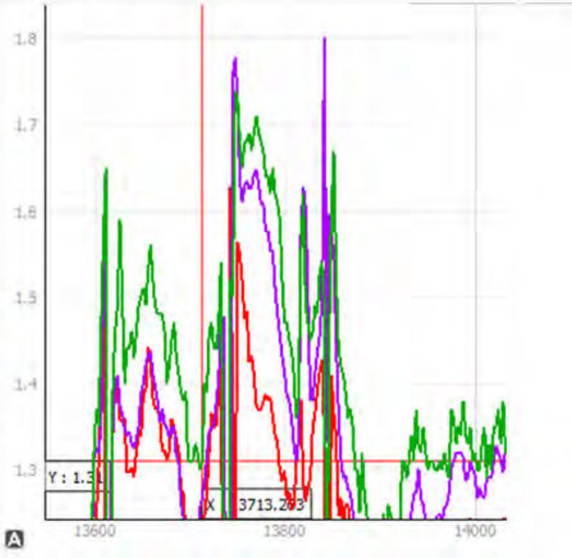
12A2C.2.22. On this basis it is considered the Torne model provides suitable information for the Proposed Development FRA. The majority of the Site boundary lies outside the Torne modelled 0.1% AEP flood extent. Significant ground raising is not proposed in the area of fluvial flood risk. Fluvial flooding is not expected to present any significant constraint to the Proposed Development, nor is the development anticipated to have any significant effect on fluvial flooding, as any displacement of floodwaters will be minor and localised and can be considered with a qualitative assessment. The Mabey Bridge crossing (which is located within the Torne model extent) is a clear span structure outside of the modelled flood extent. Modelled in-channel water levels will be influenced by the survey channel sections and therefore changes in the DTM have less effect.

Levels across the area south of the canal

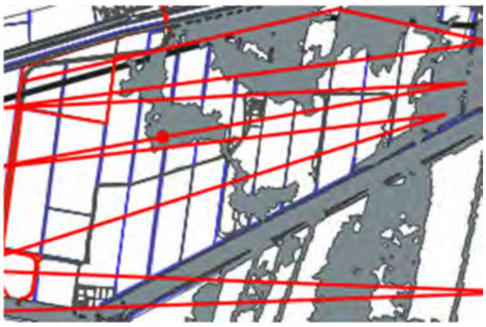


Proposed access, near A18





Flooded area near to proposed construction laydown area



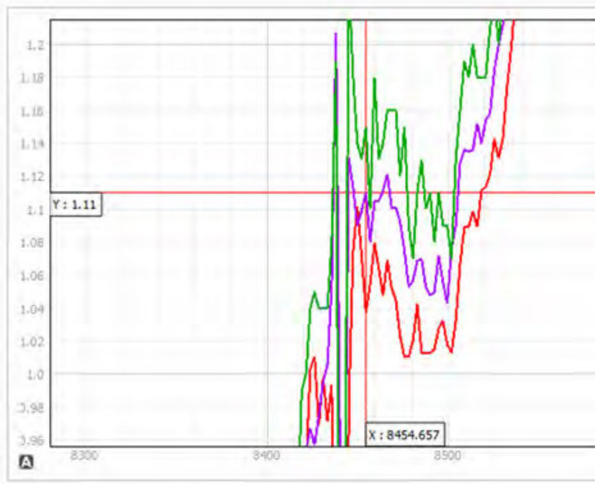


Plate 0A2C.2 LiDAR comparison (Red – Torne model DTM, Purple = 2021 NLP Lidar, Green = composite DTM; 0.1% flood extent shown in grey)

12A2C.3. Keadby 3 FRA Breach Model (2023)

12A2C.3.1. AECOM developed a Tuflow model to assess the impact of a breach in the River Trent defences during a tidal flood event at the Site. The model was developed specifically for the Keadby 3 assessment, and therefore a breach location was selected that was judged to provide critical conditions for the Site. The model was subsequently updated in 2023 to support further design development and reflect changes at the Site.

12A2C.3.2. The AECOM model has more detailed topographic resolution than the EA Trent model. The model uses a 5m grid resolution for ground levels and incorporates available survey to represent local drains and recent and ongoing developments at the Keadby Power Station site. The model also includes representation of the recently constructed flood defence at the National Grid site adjacent to the Site. This defence is estimated to be 2.4m high (above adjacent ground).

12A2C.3.3. The modelled breach location is near Trent Road. The breach width is set to 50m with a base level of 2.8m AOD, representing ground level at the toe of the defence. In accordance with EA guidance the breach would typically be assumed to be closed after a period of 30 hours however the breach has been left open for the duration of the model simulation as a precautionary approach considering the potential difficulty in closing a breach at this location. Sensitivity testing showed the breach duration had no noticeable impact on peak flood levels at the Site.

12A2C.3.4. The AECOM model used flood level data from the previous EA Trent model to provide the inflow to the breach model. The inflow boundary has a peak level of 6.23m AOD which compares with (precautionary) estimates of 6.32m AOD (2065) and 6.56m AOD (2105) for the equivalent scenario using the latest EA Trent model. The EA Trent model results for the alternative 2105 climate change scenario (where downstream levels are extracted from the Humber Estuary model) has a peak level of 6.33m AOD. A comparison shows the shape of the inflow hydrographs are similar and therefore the volume of inflow is likely to be similar.

12A2C.3.5. The latest Tidal Trent model shows flood risk in the study area due to overtopping of defences in addition to risk were a breach to occur. The Keadby 3 model has therefore been updated to use the latest tidal inflows from the EA Tidal Trent model (2023), and to simulate both defended (overtopping) and breach scenarios. Full details are provided in the Model Report (Annex 2 of **ES Volume II Appendix 12A:** Flood Risk Assessment (**Application Document Ref. 6.3**).

ATTACHMENT D. PROPERTY ASSESSMENT

Attachment D – Keadby Next Generation Model Report: Property Assessment

Refer to Figure 12 (Attachment A) for property locations - Please note this Figure has been redacted in this issue.

Table 12A2D.1: Change in maximum flood depths at properties

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
1	[redacted]	[redacted]	Farm building	0.249	0.249	0.001	1.337	1.337	0.000	0.923	0.926	0.004	1.706	1.711	0.006
2	[redacted]	[redacted]	Mixed use (single home and office)	0.001	0.001	0.000	0.923	0.923	0.000	0.033	0.036	0.003	0.923	0.923	0.000
3	[redacted]	[redacted]	Mixed use (residential (single home) and office)				0.323	0.323	0.000				0.691	0.697	0.005
4	[redacted]	[redacted]	Mixed use (residential (single home) and office)	0.030	0.030	0.000	0.986	0.986	0.000	0.030	0.030	0.000	0.994	0.993	-0.001
5	[redacted]	[redacted]	Farm building				0.899	0.899	0.000	0.485	0.488	0.004	1.270	1.276	0.006
6	[redacted]	[redacted]	Mixed use (residential and farm building)				0.939	0.939	0.000	0.526	0.529	0.003	1.309	1.314	0.006
7	[redacted]	[redacted]	Mixed use (residential and farm building)				0.076	0.076	0.000				0.446	0.452	0.006

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
8	[redacted]	[redacted]	Mixed use (residential and farm building)				0.768	0.768	0.000	0.354	0.358	0.003	1.137	1.143	0.006
9	[redacted]	[redacted]	Mixed use (residential and farm building)				0.577	0.577	0.000	0.163	0.167	0.003	0.946	0.952	0.006
10	[redacted]	[redacted]	Mixed use (residential and farm building)				0.886	0.886	0.000	0.472	0.476	0.003	1.255	1.261	0.006
11	[redacted]	[redacted]	Mixed use (residential and farm building)				0.748	0.748	0.000	0.335	0.338	0.003	1.118	1.123	0.006
12	[redacted]	[redacted]	Farm buidling	0.222	0.222	0.000	1.062	1.062	0.000	0.649	0.652	0.003	1.432	1.437	0.005
13	[redacted]	[redacted]	Residential (detached house)	0.151	0.151	0.000	0.331	0.331	0.000	0.181	0.181	0.000	0.349	0.350	0.002
14	[redacted]	[redacted]	Residential (bungalow)	0.162	0.162	0.000	0.344	0.344	0.000	0.177	0.190	0.013	0.394	0.417	0.023
15	[redacted]	[redacted]	Farm buildling	0.078	0.078	0.000	0.238	0.238	0.000	0.367	0.425	0.058	0.577	0.624	0.046
16	[redacted]	[redacted]	Residential (detached house)	0.256	0.256	0.000	0.529	0.529	0.000	0.381	0.437	0.055	0.650	0.685	0.035
17	[redacted]	[redacted]	Garage	0.033	0.033	0.000	0.116	0.116	0.000	0.507	0.565	0.058	0.720	0.766	0.046

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
18	[redacted]	[redacted]	Garage				0.129	0.129	0.000	0.067	0.125	0.058	0.289	0.333	0.044
19	[redacted]	[redacted]	Garage	0.414	0.414	0.000	0.629	0.629	0.000	0.549	0.606	0.058	0.780	0.822	0.042
20	[redacted]	[redacted]	Residential (detached house)	0.170	0.170	0.000	0.429	0.429	0.000	0.222	0.241	0.019	0.459	0.468	0.009
21	[redacted]	[redacted]	Residential	0.183	0.183	0.000	0.338	0.338	0.000	0.351	0.407	0.056	0.561	0.607	0.045
22	[redacted]	[redacted]	Garage	0.117	0.117	0.000	0.192	0.192	0.000	0.117	0.124	0.008	0.276	0.314	0.038
23	[redacted]	[redacted]	Residential (detached house)	0.270	0.270	0.000	0.426	0.426	0.000	0.280	0.280	0.000	0.441	0.448	0.007
24	[redacted]	[redacted]	Residential (detached house)	0.271	0.271	0.000	0.390	0.390	0.000	0.275	0.277	0.002	0.439	0.463	0.025
25	[redacted]	[redacted]	Residential (bungalow)	0.102	0.102	0.000	0.167	0.167	0.000	0.103	0.104	0.001	0.243	0.283	0.040
26	[redacted]	[redacted]	Garage	0.057	0.057	0.000	0.102	0.102	0.000	0.607	0.665	0.058	0.824	0.870	0.046
27	[redacted]	[redacted]	Residential (terraced housing)	0.099	0.099	0.000	0.140	0.140	0.000	0.367	0.421	0.055	0.579	0.624	0.044
28	[redacted]	[redacted]	Garage	0.048	0.048	0.000	0.173	0.173	0.000	0.754	0.811	0.058	0.971	1.016	0.046
29	[redacted]	[redacted]	Garage	0.027	0.027	0.000	0.156	0.156	0.000	0.730	0.788	0.058	0.947	0.993	0.046
30	[redacted]	[redacted]	Garage	0.130	0.130	0.000	0.196	0.196	0.000	0.829	0.887	0.058	1.046	1.091	0.046
31	[redacted]	[redacted]	Residential (bungalow)	0.118	0.118	0.000	0.200	0.200	0.000	0.716	0.772	0.057	0.932	0.977	0.045
32	[redacted]	[redacted]	Garage	0.168	0.168	0.000	0.313	0.313	0.000	1.023	1.080	0.058	1.239	1.285	0.045
33	[redacted]	[redacted]	Garage	0.240	0.240	0.000	0.349	0.349	0.000	1.051	1.108	0.057	1.267	1.312	0.045

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
34	[redacted]	[redacted]	Residential (terraced housing)	0.180	0.180	0.000	0.370	0.370	0.000	1.090	1.145	0.055	1.302	1.347	0.044
35	[redacted]	[redacted]	Garage				0.465	0.465	0.000	1.174	1.232	0.058	1.389	1.435	0.046
36	[redacted]	[redacted]	Residential (semi-detached)	0.137	0.137	0.000	0.354	0.354	0.000	1.070	1.126	0.056	1.284	1.329	0.045
37	[redacted]	[redacted]	Residential (semi-detached)	0.059	0.059	0.000	0.601	0.601	0.000	1.323	1.378	0.055	1.536	1.580	0.044
38	[redacted]	[redacted]	Residential (semi-detached)	0.053	0.053	0.000	0.790	0.790	0.000	1.508	1.563	0.055	1.721	1.765	0.045
39	[redacted]	[redacted]	Residential (semi-detached)				0.758	0.758	0.000	1.474	1.530	0.056	1.687	1.732	0.045
40	[redacted]	[redacted]	Garage	0.023	0.023	0.000	0.922	0.922	0.000	1.628	1.687	0.058	1.842	1.889	0.046
41	[redacted]	[redacted]	Residential (bungalow)	0.000			0.440	0.440	0.000	1.156	1.212	0.056	1.370	1.415	0.045
42	[redacted]	[redacted]	Residential (terraced housing)	0.302	0.302	0.000	0.543	0.543	0.000	0.351	0.373	0.022	0.598	0.619	0.020
43	[redacted]	[redacted]	Residential (bungalow)	0.391	0.391	0.000	0.607	0.607	0.000	0.501	0.543	0.042	0.742	0.774	0.032
44	[redacted]	[redacted]	Residential (semi-detached)	0.265	0.265	0.000	0.552	0.552	0.000	0.630	0.680	0.050	0.868	0.906	0.038

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
45	[redacted]	[redacted]	Residential (semi-detached)	0.473	0.473	0.000	0.716	0.716	0.000	0.934	0.985	0.051	1.160	1.200	0.041
46	[redacted]	[redacted]	N/A	0.318	0.318	0.000	0.563	0.563	0.000	0.900	0.951	0.051	1.127	1.168	0.041
47	[redacted]	[redacted]	Residential (semi-detached)	0.480	0.480	0.000	0.708	0.708	0.000	1.017	1.068	0.051	1.240	1.282	0.042
48	[redacted]	[redacted]	Residential (bungalow)	0.348	0.348	0.000	0.588	0.588	0.000	0.886	0.937	0.051	1.109	1.151	0.042
49	[redacted]	[redacted]	Residential (semi-detached)	0.180	0.180	0.000	0.400	0.400	0.000	1.131	1.182	0.052	1.343	1.386	0.043
50	[redacted]	[redacted]	Residential (terraced housing)	0.147	0.147	0.000	0.397	0.397	0.000	1.126	1.178	0.052	1.338	1.381	0.043
51	[redacted]	[redacted]	Industrial Building	0.161	0.161	0.000	0.553	0.553	0.000	1.285	1.337	0.052	1.500	1.542	0.043
52	[redacted]	[redacted]	Industrial Building	0.258	0.258	0.000	0.643	0.643	0.000	1.374	1.426	0.052	1.587	1.630	0.043
53	[redacted]	[redacted]	Water Tank	0.266	0.266	0.000	0.682	0.682	0.000	1.414	1.466	0.052	1.628	1.670	0.043
54	[redacted]	[redacted]	Farm Building	0.061	0.061	0.000	0.276	0.276	0.000	0.203	0.255	0.051	0.431	0.471	0.039
55	[redacted]	[redacted]	Farm Building	0.305	0.305	0.000	0.512	0.512	0.000	0.613	0.664	0.051	0.831	0.873	0.042
56	[redacted]	[redacted]	Garage	0.145	0.145	0.000	0.339	0.339	0.000	0.162	0.163	0.000	0.353	0.352	-0.001
57	[redacted]	[redacted]	Garage	0.348	0.348	0.000	0.760	0.760	0.000	0.385	0.389	0.004	0.788	0.786	-0.002
58	[redacted]	[redacted]	Garage	0.188	0.188	0.000	0.624	0.624	0.000	0.241	0.256	0.015	0.659	0.654	-0.004

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
59	[redacted]	[redacted]	Pumping Station	0.012	0.012	0.000	0.463	0.463	0.000	0.356	0.359	0.003	0.526	0.516	-0.010
60	[redacted]	[redacted]	Residential (terraced housing)	0.075	0.075	0.000	0.267	0.267	0.000	1.056	1.061	0.005	1.135	1.112	-0.023
61	[redacted]	[redacted]	Residential (bungalow)	0.277	0.277	0.000	0.524	0.524	0.000	2.215	2.224	0.008	2.358	2.343	-0.014
62	[redacted]	[redacted]	Residential (bungalow)	0.245	0.245	0.000	0.474	0.474	0.000	1.832	1.838	0.006	1.954	1.944	-0.011
63	[redacted]	[redacted]	Residential (bungalow)	0.320	0.320	0.000	0.574	0.574	0.000	1.701	1.707	0.006	1.800	1.793	-0.007
64	[redacted]	[redacted]	Residential	0.280	0.280	0.000	0.566	0.566	0.000	1.793	1.801	0.007	1.899	1.889	-0.010
65	[redacted]	[redacted]	Residential (detached house)	0.280	0.280	0.000	0.506	0.506	0.000	1.508	1.516	0.008	1.606	1.606	0.000
66	[redacted]	[redacted]	Industrial Building	0.240	0.240	0.000	0.321	0.321	0.000	0.244	0.241	-0.003	0.278	0.280	0.001
67	[redacted]	[redacted]	Industrial Building	0.181	0.181	0.000	0.265	0.265	0.000	0.646	0.651	0.005	0.738	0.733	-0.005
68	[redacted]	[redacted]	Residential	0.080	0.080	0.000	0.137	0.137	0.000	0.051	0.048	-0.003	0.070	0.074	0.003
69	[redacted]	[redacted]	Industrial Building	0.062	0.062	0.000	0.134	0.134	0.000	0.472	0.477	0.005	0.564	0.559	-0.005
70	[redacted]	[redacted]	Industrial Building	0.212	0.212	0.000	0.360	0.360	0.000	0.881	0.885	0.004	0.976	0.971	-0.005
71	[redacted]	[redacted]	Industrial Building	0.192	0.192	0.000	0.256	0.256	0.000	0.559	0.564	0.004	0.657	0.652	-0.005

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
72	[redacted]	[redacted]	Industrial Building				0.134	0.134	0.000	1.163	1.169	0.005	1.281	1.276	-0.005
73	[redacted]	[redacted]	Industrial Building												
74	[redacted]	[redacted]	Industrial Building												
75	[redacted]	[redacted]	Residential (detached house)	0.213	0.213	0.000	0.864	0.864	0.000	1.542	1.602	0.060	1.751	1.801	0.050
76	[redacted]	[redacted]	Farm Building	0.210	0.210	0.000	0.897	0.897	0.000	1.592	1.650	0.058	1.795	1.843	0.049
77	[redacted]	[redacted]	Farm Building	0.662	0.662	0.000	1.282	1.282	0.000	2.025	2.078	0.053	2.232	2.275	0.043
78	[redacted]	[redacted]	Industrial Building				0.519	0.519	0.000	1.298	1.348	0.050	1.506	1.546	0.040
79	[redacted]	[redacted]	Industrial Building				0.414	0.414	0.000	1.188	1.237	0.049	1.389	1.430	0.041
80	[redacted]	[redacted]	Industrial Building				0.386	0.387	0.000	1.135	1.185	0.050	1.328	1.371	0.043
81	[redacted]	[redacted]	Industrial Building				0.691	0.691	0.000	1.518	1.566	0.049	1.730	1.769	0.039
82	[redacted]	[redacted]	Industrial Building				0.515	0.515	0.000	1.261	1.311	0.051	1.455	1.498	0.044
83	[redacted]	[redacted]	Industrial Building				0.035	0.035	0.000	0.752	0.805	0.053	0.942	0.990	0.048
84	[redacted]	[redacted]	Industrial Building				0.333	0.333	0.000	1.166	1.213	0.047	1.374	1.412	0.038

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
85	[redacted]	[redacted]	Industrial Building	0.062	0.062	0.000	0.748	0.748	0.000	1.565	1.612	0.047	1.768	1.807	0.039
86	[redacted]	[redacted]	Industrial Building	0.561	0.561	0.000	1.235	1.235	0.000	2.090	2.136	0.046	2.297	2.334	0.037
87	[redacted]	[redacted]	Industrial Building							0.647	0.699	0.052	0.834	0.882	0.048
88	[redacted]	[redacted]	Industrial Building				0.522	0.522	0.000	1.303	1.352	0.049	1.494	1.536	0.042
89	[redacted]	[redacted]	Industrial Building				0.064	0.064	0.000	0.923	0.969	0.045	1.130	1.166	0.036
90	[redacted]		Industrial Building				0.456	0.456	0.000	1.103	1.170	0.068	1.314	1.370	0.056
91	[redacted]	[redacted]	Industrial Building				0.411	0.411	0.000	1.053	1.121	0.068	1.263	1.320	0.057
92	[redacted]	[redacted]	Industrial Building				0.058	0.058	0.000	0.688	0.758	0.070	0.897	0.956	0.059
93	[redacted]	[redacted]	Farm Building	0.146	0.147	0.001	1.111	1.111	0.000	1.734	1.805	0.071	1.940	2.001	0.061
94	[redacted]	[redacted]	Farm Building	0.045	0.046	0.001	1.010	1.010	0.000	1.633	1.704	0.071	1.840	1.900	0.061
95	[redacted]	[redacted]	Farm Building	0.140	0.140	0.001	1.105	1.105	0.000	1.726	1.799	0.073	1.934	1.995	0.061
96	[redacted]	[redacted]	Farm Building	0.817	0.817	0.001	1.782	1.782	0.000	2.402	2.476	0.074	2.610	2.673	0.063
97	[redacted]	[redacted]	Industrial Building				0.473	0.473	0.000	1.084	1.165	0.081	1.291	1.363	0.072

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
98	[redacted]	[redacted]	Industrial Building							0.262	0.320	0.058	0.452	0.506	0.053
99	[redacted]	[redacted]	Industrial Building							0.259	0.320	0.060	0.451	0.507	0.056
100	[redacted]	[redacted]	Industrial Building							0.252	0.315	0.063	0.445	0.505	0.060
101	[redacted]	[redacted]	Industrial Building				0.103	0.103	0.000	0.849	0.911	0.062	1.043	1.100	0.056
102	[redacted]	[redacted]	Industrial Building				0.147	0.147	0.000	0.884	0.946	0.062	1.079	1.135	0.057
103	[redacted]	[redacted]	Industrial Building				0.205	0.205	0.000	0.923	0.985	0.061	1.117	1.173	0.056
104	[redacted]	[redacted]	Industrial Building							0.279	0.368	0.089	0.479	0.563	0.083
105	[redacted]	[redacted]	Water Towers - within development area												
106	[redacted]	[redacted]	Water Towers - within development area												

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
107	[redacted]	[redacted]	Water Towers - within development area												
108	[redacted]	[redacted]	Industrial Building - within development area				0.794	0.000	-0.794	1.385	0.000	-1.385	1.588	0.000	-1.588
109	[redacted]	[redacted]	Farm building				0.562	0.562	0.000	0.237	0.277	0.040	0.934	0.940	0.005
110	[redacted]	[redacted]	Farm building				0.848	0.848	0.000	0.508	0.521	0.013	1.221	1.226	0.005
111	[redacted]	[redacted]	Farm building				0.758	0.758	0.000	0.421	0.447	0.025	1.131	1.136	0.005
112	[redacted]	[redacted]	Farm buidling				0.872	0.872	0.000	0.523	0.525	0.002	1.245	1.251	0.006
113	[redacted]	[redacted]	Residential				0.692	0.692	0.000	0.348	0.352	0.004	1.065	1.071	0.005
114	[redacted]	[redacted]	Farm building				0.813	0.813	0.000	0.463	0.464	0.001	1.187	1.192	0.006
115	[redacted]	[redacted]	Residential				0.795	0.795	0.000	0.446	0.448	0.002	1.169	1.174	0.006
116	[redacted]	[redacted]	Farm building				0.754	0.754	0.000	0.399	0.400	0.001	1.127	1.133	0.006
117	[redacted]	[redacted]	Residential				0.609	0.609	0.000	0.253	0.254	0.001	0.982	0.988	0.006
118	[redacted]	[redacted]	Farm building				1.410	1.411	0.000	1.042	1.043	0.001	1.783	1.789	0.006

Property Ref	E	N	Type	Defended, 2065			Defended, 2105			Breach, 2065			Breach, 2105		
				Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)	Baseline depth (m)	Proposed development depth (m)	Difference (m)
119	[redacted]	[redacted]	Mixed use (residential and farm building)				1.292	1.292	0.000	0.908	0.910	0.001	1.665	1.670	0.006
120	[redacted]	[redacted]	Farm building				1.273	1.273	0.000	0.895	0.896	0.001	1.646	1.652	0.006
Largest increase						0.001			0.000			0.089			0.083
Largest decrease (excl properties in development area)						0.000			0.000			-0.003			-0.023
Largest residential increase						0.000			0.000			0.060			0.050
Largest residential decrease						0.000			0.000			0.060			0.050

ANNEX 3 - OUTLINE DRAINAGE STRATEGY

Contents

Plates

Tables

12A3. Outline Drainage Strategy

12A3.1. Introduction

Overview

12A3.1.1. This **Outline Drainage Strategy** (**Application Document Ref. 7.6**) has been prepared by AECOM on behalf of Keadby Next Generation Limited ('The Applicant') which is a subsidiary of SSE plc. It forms part of the application for a Development Consent Order (DCO) ('the Application'), that has been submitted to the Secretary of State (the 'SoS') for Energy Security and Net Zero under Section 37 of 'The Planning Act 2008' ('the 2008 Act').

12A3.1.2. The Applicant is seeking development consent for the construction, operation and maintenance of a new combined cycle gas turbine ('CCGT') electricity generating station on land at, and in the vicinity of, the existing Keadby Power Station, Trentside, Keadby, Scunthorpe DN17 3EF ('the Site').

12A3.1.3. The Keadby Next Generation Power Station ('the Proposed Development') is a new CCGT electricity generating station with a capacity of up to 910MW electrical output. The CCGT electricity generating station will be designed to run on 100% hydrogen and able to run on 100% natural gas or a blend of natural gas and hydrogen and will be located on land to the west of Keadby 1 and Keadby 2 Power Stations. The Proposed Development includes connections for cooling water, electricity, hydrogen and natural gas, and construction laydown areas and other associated development. It is described in full in **Environmental Statement (ES) Volume I Chapter 4**: The Proposed Development (**Application Document Ref. 6.2**).

The Purpose and Structure of this Document

12A3.1.4. This Strategy provides a review of the existing drainage within the Site to determine if surface water can be effectively drained and not increase flood risk elsewhere.

12A3.1.5. The Main Site for the Proposed Development is located adjacent to the National Grid 400kV substation that connects the existing gas fired Keadby 1 and 2 Power Stations to the National Grid. Publicly available historical mapping indicates that the only prior use of the Main Site is agricultural land. For the purposes of this Drainage Strategy this is considered to be 'greenfield' and it is assumed that any areas of permanent development within the Site will be classified as impermeable ground throughout the works.

12A3.1.6. Certain sections of the Site will be designated for construction and maintenance laydown, including both developed (brownfield) and undeveloped (greenfield) land. For the purposes of this Strategy, it is assumed that all areas, except for the laydown zone within the Main Site, will not become impermeable and will maintain their current surface water runoff response.

12A3.1.7. This Strategy will provide existing greenfield runoff rates for the areas undergoing permanent development and land raising. Additionally, runoff rates will be provided for the laydown area changing from greenfield to brownfield. The document will also provide an overview of any attenuation required due to the Proposed Development across the Site.

12A3.1.8. Certain areas within the Proposed Development are undergoing circa 3m of land raising. It is assumed that all areas of raised land will be classified as impervious land within this Strategy.

12A3.2. Standards and Guidance

12A3.2.1. There are a number of national and local policy requirements which need consideration in the design of any drainage strategy to ensure that the Proposed Development will be sustainable and can, if possible, contribute to a decreased flood risk elsewhere.

National Planning Policy Framework

12A3.2.2. NPPF requires that new development should not increase flood risk both on the Site and in the area surrounding it. This effectively means that surface water runoff should not exceed the peak volumes already generated on the site and that betterment should be provided where possible.

North Lincolnshire Council SuDS Guidance

12A3.2.3. North Lincolnshire Council (NLC) have created a SuDS guidance document which stipulates the expectations of NLC for designers and developers in regard to the use of SuDS. This guidance document has been produced based on best practice guidelines from the Ciria SuDS manual.

12A3.2.4. The document details the requirements for SuDS, appropriate design processes and discusses various types of SuDS. Specific NLC requirements for drainage projects are also detailed with a checklist given for the required steps to be taken for the adoption of SuDS.

Building Standards Regulations 2000 Part H

12A3.2.5. The Building Standards Regulations 2000 Part H requires that surface water runoff be preferentially discharged first to soakaways, then to surface watercourses and finally to sewers

12A3.3. Design Principles and Impact Avoidance Measures

Surface Water Drainage – The Site

12A3.3.1. In line with the Building Standards Regulations infiltration has been considered first as a potential drainage solution. British Geological Survey (BGS) maps indicate that the Site is underlain by Alluvium with clay, silt and sand. As soils of this type typically have low permeability it is not likely that infiltration will be a viable method of surface water discharge. Additionally, the groundwater table depth is known to be shallow, although how frequently it raises to its highest level and how quickly it drains down is uncertain. Given the soil types and the high groundwater table infiltration based drainage is not considered to be viable.

12A3.3.2. The Main Site for the Proposed Development has been estimated to have an area of approximately 15.11Ha. This accounts for all areas of permanent development within the site. The proposed construction laydown areas (future maintenance areas) have been estimated to be 10.79Ha. There is no current development on the Main Site and it is anticipated that existing runoff rates from the Main Site will be equivalent to greenfield runoff rate.

12A3.3.3. The Site is currently relatively flat and existing drainage is to nearby land drain ditches which ultimately discharge to the River Trent. Relative drains and ownership are indicated in **ES Volume III Figure 12.6:** Internal Drainage Board (IDB) Assets (**Application Document Ref. 6.4**). The majority of drains within the Site boundary are SSE owned and maintained. However, some sections of IDB assets are within the site boundary. The proposal includes the infilling of the eastern side of Ditch 2 (**see Plate 12A3.1**) to allow the raised land to the north. This will not impact the behaviour of the existing drainage network because Ditch 2 is connected to the wider network at both ends. The area to the north that drained to this part of the ditch is being developed and will use the proposed drainage network instead. To the south, a connection to the ditch, where it crosses the red line boundary to the east, will be retained. This will be used to discharge the proposed drainage system to the south. The form of this connection will be developed in detailed design. Any development works that interfere with or alter the operation or maintenance of these land drains will require consent from the asset owners. It is believed that the land drains discharge through a pumped system. There is an existing attenuation pond to the south-east of the Main Site which serves the Keadby 2 site. However, it is unclear exactly which areas drain into the structure and how it operates. It likely discharges into nearby land drain B to the north and has no impact on the proposed drainage system.

12A3.3.4. The Environment Agency (EA) Risk of Flooding from Surface Water flood maps indicate that there are some areas of the Site which do not positively drain to any discharge point. It is assumed that ponding in these areas eventually dissipates through a combination of slow infiltration and evaporation.

12A3.3.5. The Proposed Development will permanently increase the total impermeable area on the Site. Within the Main Site there will be a number of bunded areas which will collect surface water and drain it to a separate on-site treatment facility. This reduced runoff has not been accounted for at this stage of design as the area is considered negligible.

12A3.3.6. For the purpose of this Drainage Strategy, it has been assumed that the area of the Main Site that houses the permanent development is totally impermeable.

12A3.3.7. As the Main Site and the permanent development areas to the south and south-east of the Main Site are separate it is anticipated that drainage of the two areas will be separate. For that reason, there will be two separate attenuation storage areas required; one serving the Main Site and one serving the areas south of the Main Site.

12A3.3.8. As the Proposed Development on the Main Site will increase from a largely greenfield site to fully impermeable it is anticipated that a conventional drainage network will provide drainage for the majority of this area. This may include linear drainage assets such as slot drains as well as gully pits and carrier drains. Impermeable areas should be minimised to reduce the total runoff and in permeable areas SuDS such as swales may be considered. Where impermeable areas cannot be reduced other source control methods such as rainwater harvesting should be considered and utilised where appropriate. At this stage, these additional source control methods have not been considered, but will be at the detailed design stage.

12A3.3.9. The Main Sites laydown area is to be surrounded by permanent land raising of impermeable ground. This area will require additional drainage to discharge surface water. It is noted that some surface runoff will infiltrate and evaporate but it is likely during prolonged or flashy rainfall events ponding will occur. Therefore, a sump and pump should be installed to discharge at the greenfield runoff rate for the laydown area. The surface water would be discharge from this area into Drain 3. It is recommended that drainage is installed surrounding the laydown area within the raised impermeable land to minimise inflows to the area.

12A3.3.10. During construction, temporary drainage measures will be established to manage surface water on Site, prevent its run-off to surrounding land drains and direct water away from the proposed working areas. The exact drainage measures that will be employed are the responsibility of the appointed Contractor(s) to design and manage. Typical construction drainage measures may include establishment of temporary drainage ditches or dikes, attenuation ponds to enable any sediment to drop out of suspension and temporary connections to existing drainage networks (should discharge of accumulated water be required).

Surface Water Drainage – Laydown Areas

12A3.3.11. Within the construction laydown areas there exists small areas of brownfield site. Due to the conditions of the construction laydown areas remaining largely unchanged throughout construction and operation of the Proposed Development there has been no consideration of surface water runoff attenuation. It is assumed these areas will continue to be permeable throughout construction and operation.

12A3.3.12. It is anticipated that the runoff rate from the construction laydown areas may increase during the construction and operational phases due to anticipated compaction and (in some places) vegetation loss. However, due to a high-water tables and flat site, it is likely to have minimal impact on the existing run off rates for the Site. This includes all haulage and access routes within these areas.

12A3.3.13. The construction laydown areas will be a combination of partially permeable ground and hard standing. During construction the appointed Contractor must implement standard surface water management procedures. Upon completion of the Proposed Development, the construction laydown areas will be used as maintenance areas during operation. As such, it is not required to install any additional drainage networks for the south section of the Site.

Discharge

12A3.3.14. Drainage within the Site itself will likely be gravity driven if suitable gradients can be achieved. As the Site layout is indicative only and the Proposed Development areas within the site are being raised, at this stage it cannot be determined if pumped drainage will be required for general site drainage but it is assumed not to be. This is to be confirmed during design development; however, best practice dictates that this should be minimised. Pump control systems should be housed in an elevated location if possible, above the critical flood level to ensure that full control of the pump system is maintained at all times.

12A3.3.15. An indicative development layout has identified that site drainage will discharge via an Internal Drainage Board (IDB) watercourse, not through the existing Water Discharge Corridor used for cooling water and effluent discharge for Keadby 1 and Keadby 2. The discharge rate must be consented and agreed upon with the drainage board, and in this strategy limited to greenfield runoff rates for the Site. Maintaining greenfield runoff rates will preserve the network capacity outside the development site and will not affect the drainage board-controlled pumping to the River Trent.

12A3.3.16. The likely point for discharge from the Main Site will be via Drain 1 (Glew Drain) shown on . Drain 5 could also be considered for discharge but poses tighter constraints and therefore Drain 1 is the preferred option. For the attenuation area to the south, the preferred discharge point is via Drain 2. It is vital a small section of Drain 2 is not infilled adjacent to the Site boundary on the east. This will minimise the extent of the outlet and reduce risks with proposed utilities. At detailed design specific discharge points will be selected which do not interfere with the existing ditch network and surrounding habitat.

12A3.3.17. Exceedance routes for drainage assets within the Proposed Development will be directed away from critical infrastructure and towards the system discharge points. These routes will be developed as part of the detailed design.

12A3.3.18. In scenarios where the ditch network becomes full while the land remains dry, the permanent development drainage system to the south will be unable to discharge as it is not located within the land raising. Leading to a reduced level of service and quicker basin filling. Conversely, the Main

Site system will be elevated and continue to discharge, potentially worsening conditions in the surrounding areas slightly. However, the discharge rate will still adhere to greenfield standards.

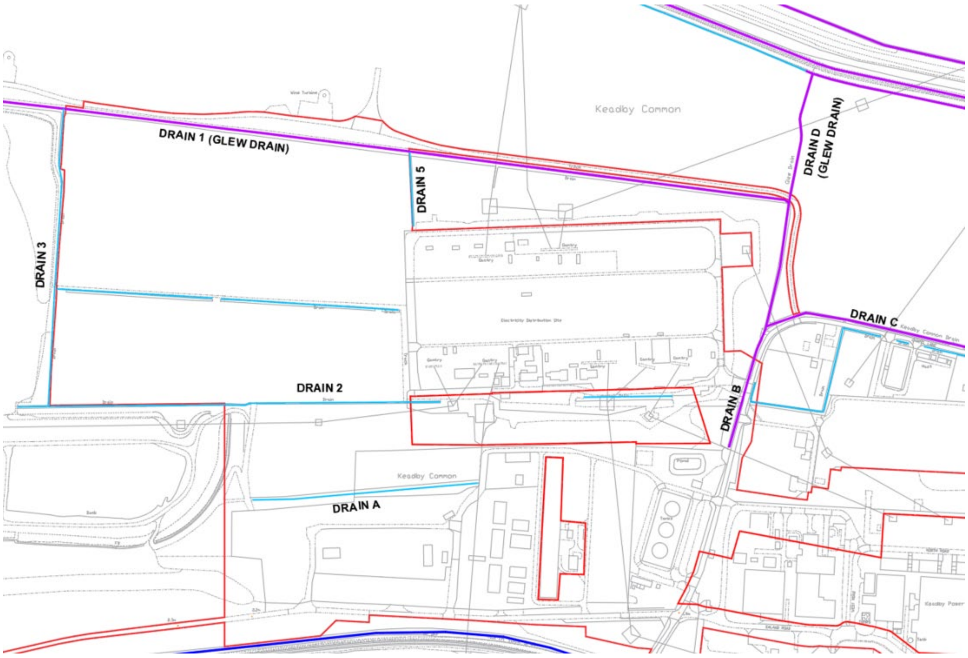


Plate 12A3.1 Existing land drains in and around the Site (From ES Figure 12.1)

Climate Change Allowance

12A3.3.19. The surface water management strategy must ensure that there is no increase in flood risk to surrounding areas. The design storm event for this requirement is anticipated to be the 100-year return period event, with an additional 45% allowance for climate change (Upper Limit). This aligns with the climate change allowances for the Proposed Development's catchments.

12A3.3.20. According to the NLC SuDS guidance document, no water should be stored above ground up to and including the 1 in 100-year event, unless it is stored in a SuDS component. Consequently, the Proposed Development must be designed to prevent flooding across the site, adhering to the same 100-year return period event with an additional 45% allowance for climate change.

12A3.3.21. A 45% allowance for increased rainfall intensity due to climate change was incorporated into the design storm event. This figure corresponds with the upper-end estimation of potential peak rainfall intensity increases due to climate change anticipated for the 2070s.

Groundwater Table

12A3.3.22. The groundwater table has been identified as being generally between 0.9m and 3.0m below ground level. This is within the expected range for the location of the Site, although is shallow. The shallow groundwater table will pose a design challenge for buried pipelines and attenuation systems. It is preferred that attenuation and drainage networks are located in raised ground due to the existing groundwater levels. This can help with the design of a gravity driven drainage network.

12A3.3.23. Consideration will need to be given to floatation resistance for all buried assets and as far as possible installation depths should be kept above the groundwater table to reduce this risk. Buried pipes may need to be encased in concrete to resist floatation if they are at a greater depth than 0.9m. Conversely, pipes buried at a shallow depth are liable to require a concrete surround to resist loading.

Fluvial and Tidal Flood Impacts

12A3.3.24. The Site is located in Flood Zone 3a, indicating a significant risk of fluvial flooding. Currently, the site is protected by existing flood defences. However, land raising is proposed for areas where critical infrastructure is located, to mitigate risks in the event of defence failure or exceedance. Intervening areas will not be raised. Consequently, the risk of flooding to the Proposed Development, any drainage networks, and attenuation within the raised areas will be minimal.

12A3.3.25. Attenuation or drainage within the non-raised sections of the site will be at high risk of flooding if defences fail. In this defence failure scenario, where the wider ditch network fills up and tidal flow overtops the defences. The discharge of this attenuation area would be restricted. Additionally, any rainfall within the non-raised areas of the Site would fall on the floodwater and contribute directly to river flow leaving The Site. This is the current site response and would not worsen if the proposed drainage within the non-raised areas becomes inundated due to defence failure. Under flooded conditions the system will capture a volume of flow and discharge it at the designed rate, so the wider system will be helped in recovering once the tide recedes.

12A3.3.26. The Site is also at risk of tidal flooding due to its location within the River Trent's tidal region. As noted above the Site is currently protected by existing flood defences. However, if they fail or in the defended (climate change) event a similar situation would be applicable, as stated above.

12A3.3.27. The detailed design of the surface water drainage network will account for fluvial and tidal inundation risk by ensuring that inspection and maintenance of assets can be easily undertaken following flood events. Additionally, sensitive drainage assets, such as pumps, should be isolated and protected from inundation using sluice gates or similar mechanisms that can be closed prior to forecasted fluvial and tidal flood events. It is expected that sensitive assets would be preferentially located on raised land where this risk is removed.

Land Raising

12A3.3.28. The Proposed Development comprises critical infrastructure so the permanent infrastructure will need to be on raised land to ensure it is protected from flood risk. The drainage design will need to consider both areas that will be above and below the critical flood level. The majority of the Main Site is proposed to undergo a circa 3m land raise, this will aid with a gravity driven drainage network towards the proposed attenuation. This is also the case for the permanent development to the south of the Main Site. Land raising will also allow for increased depths of attenuation

12A3.3.29. Land raising is unlikely to result in any flow path disruption for the Site. No increase in runoff will occur as a result of land raising, all surface water within the land raised areas will be attenuated and discharged at greenfield runoff rates into the surrounding network. Potential impacts on non-raised areas have been accounted for on the Main Site laydown area. It will require additional drainage and pumping to prevent accumulation of surface water within the non-raised area.

12A3.3.30. Infiltration within the land raised sections has not been accounted for at this stage. At detailed design areas exposed to possible infiltration will need to be reviewed to see if it may contribute to additional flows within the surrounding ditch network. Toe drainage may be required surrounding the raised land areas that may contribute additional flows. However, at this stage of design there is not enough information to confirm if this is required and potential flows.

Water Quality

12A3.3.31. Using the Simple Index Approach from CIRIA SuDS Manual (C753) an indication of the potential surface water run off for the site was assessed. Due to the nature of The Proposed Development, it would fall under the "Medium" pollution hazard category due to all high risk areas being bunded and managed separately, leaving access roads, paths and other low risk areas to collect stormwater. The description of this level of hazard includes; commercial yard and delivery areas, non-residential car parking with frequent change, and all roads except low traffic roads and trunk roads/motorways. For medium pollution sites the SIA applies the following pollution hazard indices:

- Total Suspending Solids (TSS) – 0.7
- Metals – 0.6
- Hydrocarbons – 0.7

12A3.3.32. For the Proposed Development to meet these requirements along with the proposed attenuation areas, a series of other SuDS features may be required. An example of this could be a swale and detention basin connected in series. This would be detailed later in design, but is expected to be easily incorporated into the site layout.

12A3.4. Baseline Conditions

Greenfield Runoff

12A3.4.1. The greenfield runoff rate for the Main Site and permanent development areas included in the land raising to the south and south-east of the Main Site have been estimated using the ReFH2 software with FEH 2022 data. The Main Site is approximately 10.89Ha and the permanent development is approximately 4.22Ha, based on the Indicative Site Layout as shown in **ES Volume III Figure 3.3:** Indicative Parts of the Site Plan (**Application**

Document Ref. 6.4). The current peak greenfield runoff rates for these areas are given in **Table 12A3.1**.

Table 12A3.1: Site Greenfield Runoff Rates

Return Period (years)	Main Site Runoff Rate (l/s)	Permanent Development Runoff Rate (l/s)
1	9.4	3.7
2	11.0	4.2
5	16.3	6.3
10	20.2	7.8
30	26.8	10.4
50	30.0	11.6
75	32.8	12.7
100	34.8	13.5
200	10.1	15.6
1000	56.4	21.8

12A3.4.2. The greenfield runoff rate for the Main Site Laydown Area has also been estimated using the ReFH2 software with FEH 2022 data. The area is approximately 3.01Ha and based on the Indicative Proposed Power Station Layout, Elevations and Sections Plans (**Application Document Ref. 2.6**). This area has been treated separately at it will be prone to ponding and will require pumping of surface water at greenfield run off rates. Drainage design within this area is to be considered during detailed design to account for the ponding. The current peak greenfield runoff rates for these areas are given in **Table 12A3.2**.

Table 12A3.2. Main Site Laydown Area Greenfield Runoff Rate

Return Period (years)	Greenfield Runoff Rate (l/s)
1	2.6
2	3.0
5	4.5
10	5.6
30	7.4

Return Period (years)	Greenfield Runoff Rate (l/s)
50	8.3
75	9.0
100	9.6
200	11.1
1000	15.5

12A3.4.3. The proposed drainage will limit discharge to the wider ditch network to maintain greenfield Qbar rates. For storms larger than the 2-year return period, this will represent a reduction in discharge rate with an increase in discharge duration when compared to the natural greenfield response. This will allow the wider catchment to better manage flow rates through the system.

Attenuation Requirements

12A3.4.4. As the runoff rates generated on Site will be greater than the greenfield runoff rate, attenuation systems will be required to store runoff prior to discharge. Attenuation for the Main Site and permanent development to the south and south-east of the Main Site may be considered independently from each other, however if a pumped discharge system is used there may be operational benefits to combining the discharge systems in one location. This may be upstream, or downstream of attenuation. The permanent development areas south and south-east of the Main Site are in two distinct areas; this has been accounted for in the calculations, but the detailed design stage will consider if a separate attenuation pond and discharge point is needed or if the surface flows can be passed to the main system.

12A3.4.5. As the topography and ground water levels may limit the maximum depth of attenuation features, particularly with attenuation to the south of the Main Site, source control methods such as rainwater harvesting and permeable paving should be considered as supplementary attenuation systems to reduce the burden on any detention basins or storage tanks. In this assessment, the total attenuation has been estimated for the Main Site and permanent development separately, but it would be possible to share this across a number of assets.

12A3.4.6. Storage volume calculations have been undertaken for the critical storm duration of the 2-year return period storm event plus climate change allowance. A discharge rate of 15.0 l/s (Qbar) for the Main Site and permanent development to the south has been used. This value is equal to the existing 100-year return period greenfield runoff rate. The storage volume estimate has been made using the quick storage estimate tool within the Info Drainage 2022. Source Control Program; results are shown in **Table 12A3.3**. FEH 2022 point descriptors were used to undertake this analysis.

Table 12A3.3. Required Attenuation Volumes

Area	Rainfall Event	Impermeable Area (ha)	Minimum Storage Requirement (m^3)	Maximum Storage Requirement (m^3)
Main Site	1 in 100 Years +45% Climate Change	10.89	11426	11680
Permanent Development South of Main Site	1 in 100 Years +45% Climate Change	4.22	4209	4459

Attenuation Sizing

12A3.4.7. High level calculations have been undertaken to provide a conceptual representation of the possible required attenuation pond for the Proposed Development. Preliminary sizing of the Main Site attenuation is considered to fit in the location shown indicatively on Indicative Proposed Power Station Layout, Elevations and Sections Plans (**Application Document Ref. 2.6**) for the maximum storage required. No consideration has currently been accounted for the permanent development in the south of the site.

12A3.4.8. The attenuation pond dimensions, and storage volume of the structure are shown in **Table 12A3.4**. To make efficient use of the available space in the indicative location, a rectangular shaped pond with 1 in 4 slopes with rounded corners was considered. The Main Site Attenuation Pond Sizing is able to allow for a deep structure due to the land raising. However, for the Permanent Development Pond is at ground level and therefore the depth has been minimised to account for the high water table. Further information and design calculations would be required to confirm the maximum allowable depth of the attenuation pond.

Table 12A3.4. Main Site Attenuation Pond Sizing

Parameter	Value	Description
Length	97m	Length of pond at the surface
Width	56m	Width of pond at the surface
Depth	2.9m	Depth of attenuation pond
Total Volume	11755m^3	Total volume of attenuation pond

Table 12A3.5. Permanent Development Pond Sizing

Parameter	Value	Description
Length	91m	Length of pond at the surface
Width	35m	Width of pond at the surface
Depth	1.9m	Depth of attenuation pond
Total Volume	4,036m^3	Total volume of attenuation pond

12A3.4.9. The Proposed Development will require the attenuation of surface water runoff to ensure the development maintains existing greenfield runoff rates within the Site. It is likely that the areas currently shown on the indicative layout for attenuation of surface water runoff within the Main Site and the permanent development to the south provides sufficient space for an attenuation pond.

12A3.5. Conclusions

12A3.5.1. The Outline Drainage Strategy outlines an approach to managing surface water runoff and mitigation of flood risks associated with the Proposed Development. The Strategy adheres to national and local policy requirements, ensuring that the Proposed Development does not increase flood risk either on-site or in the surrounding areas.

12A3.5.2. The Drainage Strategy has considered the existing run off from the Site to provide a combination of conventional drainage networks and SuDS to manage the surface water runoff. This primarily includes the use of an attenuation ponds, but it has also highlighted the potential usage of rainwater harvesting and permeable paving.

12A3.5.3. Attenuation requirements have been identified within the Drainage Strategy. The system would store runoff and ensure discharge at Qbar rates, making sure that runoff does not exceed current greenfield runoff rates. Preliminary sizing of the attenuation ponds has been provided, with consideration to the high groundwater levels and their impact on the possible depth of attenuation in areas not undergoing land raising.

12A3.5.4. An allowance for increased rainfall intensity due to climate change has been incorporated into the preliminary sizing of the attenuation.

12A3.5.5. The Strategy considers the challenges posed by shallow groundwater levels. Furthermore, the Site's location is within Flood Zone 3a which has resulted in the need for land raising to protect critical infrastructure in the event of flood defence failure. The land raising is likely to aid the development of a gravity driven drainage system in these areas.

12A3.5.6. The Drainage Strategy aligns with the National Planning Policy Framework, NLC SuDS Guidance and Building Standards Regulations, ensuring that the Proposed Development meets all relevant requirements.

12A3.5.7. Overall, the Outline Drainage Strategy aims to provide a robust review of the Proposed Development and the changing drainage requirements from construction to operation for the Site. The Strategy highlights the need for a sustainable method of attenuation for the Proposed Development. This Strategy demonstrates the commitment to sustainable development practices and ensures that the Proposed Development will not adversely impact the surrounding environment.

12A3.6. References

- British Geological Survey Maps Accessed at https://geologyviewer.bgs.ac.uk/?_ga=2.137441776.1351070069.1740153124-256215716.1740153124
- North Lincolnshire Council (2017) SuDS and Flood Risk Guidance Document Rev I April 2017
- Ordnance Survey maps available at Old-maps.co.uk Accessed at https://explore.osmaps.com/?lat=53.99842&lon=-4.3306&zoom=5.6016&style=Standard&type=2d
- Office of the Deputy Prime Minister (2002) The Building Regulations 2000, Drainage and Water Disposal (Approved Document H)

ANNEX 4 - KEADBY CCS POWER STATION CANAL LOCK GATE ASSESSMENT

This annex includes an assessment of the impacts of the changes to Keadby Lock Gate prepared for the Keadby CCS Power Station application. Within this document the 'normal' water level for the canal is quoted as 4.35 mAOD, crest level for the gate quoted as 4.12 mAOD and the canal overtopping level quoted as 4.6 mAOD. Subsequent information from the CRT received in October 2022 indicates that the normal canal water level is 2.76 mAOD and the lowest surveyed crest level for Keadby lock gate as 2.55 mAOD. It is understood the levels in the October 2022 assessment are correct, however the findings of the Keadby CCS Power Station assessment are still deemed to be valid when considering the relative change in levels in the canal that would occur.

KEADBY 3
CARBON CAPTURE
POWER STATION

A collaboration between SSE Thermal and Equinor

Document Ref: 9.16

Planning Inspectorate Ref: EN010114

The Keadby 3 (Carbon Capture Equipped Gas Fired Generating Station) Order

Land at and in the vicinity of the Keadby Power Station site, Trentside, Keadby, North Lincolnshire

Summary of Canal Water Abstraction Assessment

The Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure Regulations 2009 - Regulation 5(2)(a) The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

Applicant: Keadby Generation Limited

Date: May 2022

DOCUMENT HISTORY

Document Ref	9.16 Summary of Canal Water Abstraction Assessment		
Revision	3.0		
Author	Jacob Graham		
Signed		**Date**	May 2022
Approved By	Susan Evans/Richard Lowe		
Signed		**Date**	May 2022
Document Owner	AECOM		

GLOSSARY

Abbreviation	**Description**
DCO	Development Consent Summary
ES	Environmental Statement
HMSO	Her Majesty's Stationary Office
OEP	Office for Environmental Protection
NPS	National Policy Statements
BEIS	Business, Energy and Industrial Strategy
WFD	Water Framework Directive
SCADA	Supervisory Control and Data Acquisition
SSSI	Site of Special Scientific Interest
SAC	Special Area of Conservation
CEMP	Construction Environmental Management Plan
AOD	Above Ordnance Datum
NCA	National Character Area
EIA	Environmental Impact Assessment
HRA	Habitats Regulations Assessment
LWS	Local Wildlife Site

CONTENTS

APPENDICES

1.0 STAINFORTH AND KEADBY CANAL WATER ABSTRACTION ASSESSMENT

1.1 Introduction

1.1.1 This assessment summarises the potential effects of the proposed minor modifications to the lock gates at Keadby Lock Scheduled Monument. The modifications were not identified to be required at the time of preparing the Environmental Statement (ES) submitted with the Development Consent Order (DCO) application. The applicant for the proposed modifications to the Keadby Lock gate is the Canal and River Trust.

1.1.2 The proposal is to raise the lock gate at Keadby Lock by 300mm to prevent that overflowing water from being lost into the River Trent. Currently that water overtops Keadby lock at 230mm over the lock gate; this equates to a flow rate of around 37 Ml/d. By retaining that water, this water efficiency proposal would supply sufficient additional water (27.4 Ml/d) required for abstraction for cooling use in the Proposed Development, in line with the principles of sustainable development.

1.1.3 This assessment is included as an addendum to the DCO Application [**APP-043** to **APP-159**] and provides the assessments relating to the potential water abstraction at the Stainforth and Keadby Canal, updating the following chapters and appendices of the ES:

- **Chapter 11**: Biodiversity and Nature Conservation (ES Volume I – Application Document Ref. 6.2.11) [**APP-054**];
- **Chapter 12:** Water Environment and Flood Risk (ES Volume I – Application Document Ref. 6.2.12) [**APP-055**];
- **Appendix 12A:** Flood Risk Assessment (ES Volume II – Application Document Ref. 6.3.20) [**APP-084**];
- **Appendix 12B:** Water Framework Directive Assessment Report (ES Volume II – Application Document Ref. 6.3.21) [**APP-085**];
- **Chapter 15**: Cultural Heritage of the ES Volume (ES Volume I – Application Document Ref. 6.2.15) [**APP-058**]; and
- **Appendix 15A**: Cultural Heritage Desk Based Assessment (ES Volume II – Application Document Ref. 6.3.29) [**APP-093**].

1.2 Legislation, Planning Policy and Guidance

1.2.1 The Environment Act 2021 (‘The Act’) (Her Majesty’s Stationary Office (HMSO) 2021) was given Royal Assent after the submission of the Application and sets out legislation to provide a post-Brexit environmental framework for the United

Kingdom. In summary, The Act includes new legislation such as: binding targets on / water quality, biodiversity, and resource efficiency.

1.2.2 The majority of The Act is not yet in force. The Office for Environmental Protection (OEP) has been brought into effect but is yet to receive its enforcement powers in England that would apply to the Proposed Development. The Applicant will continue to monitor implementation of The Act throughout the course of Examination and will consider the need for changes where they apply to policy or plans and their implementation, during the course of Examination.

1.2.3 Draft revised National Policy Statements (NPS) for energy infrastructure were published by the Department for Business, Energy and Industrial Strategy (BEIS) on 6 September 2021 following submission of the Application. Consultation closed on 29 November 2021 and BEIS is now considering consultation feedback. The draft revised NPS are capable of being an "important and relevant" consideration in the final decision making balance by the Secretary of State on the Application.

1.3 Methodology

1.3.1 The general assessment methodology and topic-specific methodologies, relevant legislation, policy and guidance, key assumptions and limitations set out in the submitted ES Volume I, Chapters 2-7 submitted with the Application (Application Document Refs. 6.2.2 – 6.2.7) [**APP-045** to **APP-050**] remain unchanged, unless specifically stated in this Addendum.

1.4 Relevant Additional Information

1.4.1 Since submission of the Application, Additional Information that has been prepared on behalf of the Canal and River Trust or that has been submitted into examination that is relevant to this assessment includes:

- Habitats Regulations Assessment Appropriate Assessment Report (Application Document Ref. 5.12) [**REP1-006**]; and
- Scheduled Monument Consent Application Heritage Impact Assessment (prepared on behalf of the Canal and River Trust) and reproduced in Appendix C below.

1.4.2 Other Additional Information has been gathered by the Applicant, and where relevant, this is presented in this chapter including:

- Keadby 3 Cooling Water Abstraction Flood Risk Technical Note (AECOM, 2021a, see Appendix B); a review of flood risk to take into account the potential impact of changes to operation of the canal due to the proposed modification to the Keadby Lock gates.
- Water Framework Directive – Screening Assessment Modification Works to Keadby Lock - Stainforth and Keadby Canal technical note.

1.4.3 A Keadby Lock Gate Modification Options Appraisal report (Arcadis, 2022) has been produced which analyses six proposed options to modify the Keadby Lock Gate. The options are:

- Option 1 - Fit a plank horizontally to the upstream face of the gate, with a height of 300mm.
- Option 2 - Install planks in gaps between existing timbers to a height of 300mm.
- Option 3 - Fit a baulk to the existing bar.
- Option 4 - Fit planks in gaps between existing vertical timbers up to the top bar of the gate.
- Option 5 - Remove planking between intermediate and top bars and install a mechanised tipping weir.
- Option 6 - Install a demountable stop plank system.

1.4.4 Both Option 1 and Option 2 were deemed to be equally viable, to perform in a similar manner, and meet the Canal and River Trust's requirements. The report found that in selecting the options, the main driving factor is the appearance, due to the heritage value of the lock. Option 1 has been presented to Historic England and is assessed in this report.

1.5 Consultation

1.5.1 Engagement is ongoing with statutory consultees in order to inform them of the proposed changes to the Keadby Lock gate.

1.5.2 A Water Abstraction Licence pre-application meeting was conducted between the Applicant, the Canal and River Trust ('the Trust') and the Environment Agency, on 5th November 2021. This discussed the water efficiency measures to enable water from the Stainforth & Keadby Canal to supply Keadby 3. The Trust proposed raising the height of Keadby Lock Gate. Discussions followed regarding the assessment of alternative options, the pattern of operation, how fisheries may be impacted, how abstraction will be controlled, the need for Water Framework Directive (WFD) assessment and separate water abstraction licences, estimations of low flow scenarios and the impact on the Trent's hydrograph.

1.5.3 A pre-application consultation was also undertaken with Historic England on 9th December 2020. This focused on the purpose of the scheme, a discussion of design options, and agreement of the documentation that would be required to accompany an application for Scheduled Monument Consent.

1.5.4 All options considered for the proposed development are presented in the Options Appraisal Report (Arcadis, 2022). Consultation identified Option 1 as Historic England's preferred option for this modification to the existing Keadby

Lock gates, but Option 2 was also identified as the preferred option for the gates if they are to be replaced in their entirety in the future.

1.6 Updated Baseline Conditions

Existing Baseline

Water Environment

1.6.1 The proposed change to the Keadby Lock gate does not alter the existing baseline conditions for the water environment as described in **Chapter 12:** Water Environment and Flood Risk (ES Volume I – Application Document Ref. 6.2.12) [**APP-055**].

1.6.2 Further information on the existing baseline of the Stainforth and Keadby Canal is included within the Keadby 3 Cooling Water Abstraction Flood Risk Technical Note (AECOM, 2021a) (Appendix B).

Cultural Heritage

1.6.3 The proposed change to the Keadby Lock gate does not alter the existing baseline conditions for cultural heritage as described in **Chapter 15**: Cultural Heritage (ES Volume I – Application Document Ref. 6.2.15) [**APP-058**]. Further information on the listing description and historical background of the Keadby Lock gate is included within the Keadby Lock Scheduled Monument Consent Application Heritage Impact Assessment report (Appendix C).

Other Technical Chapters

1.6.4 The existing baseline for all other technical disciplines included within the ES remain as reported within the submitted ES [**APP-051 to APP-062**].

Future Baseline

Water Environment

1.6.5 The Canal & River Trust will control the incoming water flow from River Don, and intake volumes will remain as reported within the submitted ES, therefore the future baseline conditions will not change for water environment.

Cultural Heritage

1.6.6 The future baseline remains as reported within the submitted ES, therefore the future baseline conditions will not change for Cultural Heritage.

Other Technical Chapters

1.6.7 The future baseline for all other technical disciplines included within the ES remain as reported within the submitted ES [**APP-051 to APP-062**].

1.7 Development Design and Impact Avoidance

Construction

Water Environment

1.7.1 The SCADA (Supervisory Control and Data Acquisition) technology used by the Trust is designed to minimise variation from the normal maintained water level and is set with a 50 mm +/- tolerance; therefore any breach of this tolerance will result in the sluices automatically adjusting in order to maintain the required water level. If necessary, the Trust would utilise an existing by-wash weir to act as an overflow in the event that the Proposed Development did not draw as much water from the Canal as was expected and if levels in the Canal temporarily rose as a result, until the SCADA system rebalanced water levels.

1.7.2 Therefore, as there will be no change to the water level in the canal, no further design and impact avoidance measures during construction are proposed as a result of the changes to the Keadby Lock gate, above those stated in **Chapter 12**: Water Environment and Flood Risk (ES Volume I – Application Document Ref. 6.2.12) [**APP-055**].

Cultural Heritage

1.7.3 No further design and impact avoidance measures during construction are proposed as a result of the changes to the Keadby Lock gate, above those stated in **Chapter 15**: Cultural Heritage (ES Volume I – Application Document Ref. 6.2.15) [**APP-058**].

Other Technical Chapters

1.7.4 The construction design and impact avoidance measures for all other technical disciplines included within the ES remain as reported within the submitted ES [**APP-051 to APP-062**].

Operation

Water Abstraction

1.7.5 No further design and impact avoidance measures during the operational phase are proposed as a result of the changes to the Keadby Lock gate.

Cultural Heritage

1.7.6 No further design and impact avoidance measures during the operational phase are proposed as a result of the changes to the Keadby Lock gate.

Other Technical Chapters

1.7.7 The operation design and impact avoidance measures for all other technical disciplines included within the ES remain as reported within the submitted ES [**APP-051 to APP-062**].

1.8 Likely Impacts and Effects

Construction Effects

Air Quality

1.8.1 Typical small construction plant to be used for the proposed works, which will not produce any significant pollutants. There are no changes to the effects described within **Chapter 8**: Air Quality (ES Volume I – Application Document Ref. 6.2.8) [**APP-051**].

Noise and Vibration

1.8.2 The works proposed are minor physical modifications to an existing lock gate. The noise levels arising during these minor modifications will be temporary and are not anticipated to be audible above existing construction noise levels from the Proposed Development. There are no changes to the effects described within **Chapter 9**: Noise and Vibration (ES Volume I – Application Document Ref. 6.2.9) [**APP-052**].

Traffic and Transportation

1.8.3 The Stainforth and Keadby Canal is used for recreational sailing within interests maintained by the Trust who operate Keadby Lock. It is anticipated that as the applicant, the Trust would seek to schedule works to minimise disruption to mariners.

1.8.4 Trentside, Keadby (B1392) provides local access to Keadby village. However, it is not anticipated that this access will be affected by the proposals as no stopping up is proposed.

1.8.5 There are no changes to the effects described within **Chapter 10**: Traffic and Transportation (ES Volume I – Application Document Ref. 6.2.10) [**APP-053**].

Biodiversity and Nature Conservation

1.8.6 Although the boundary of the Keadby Lock intersects the boundary of the River Trent and therefore the Humber Estuary Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC) and Ramsar site, these designated areas would not be affected during implementation of the proposed minor modifications to increase the height of the Lock gate.

1.8.7 The modifications can be achieved without works within the boundary of these designations, so there would be no loss or disturbance of habitats within the designations. Further, the banks of the River Trent at this location are heavily modified (Plate 2) and would be unchanged by these proposed works, while the channel of the river at the lock gate is already affected by the established use of the lock gate. The proposed modifications would not alter the established use and conditions of the River Trent at this location.

1.8.8 No impacts to the designations are therefore anticipated, so there are no likely significant effects.

Plate 1 – Keadby Lock Scheduled Monument intersection with Humber Estuary Ramsar/SAC/SSSI

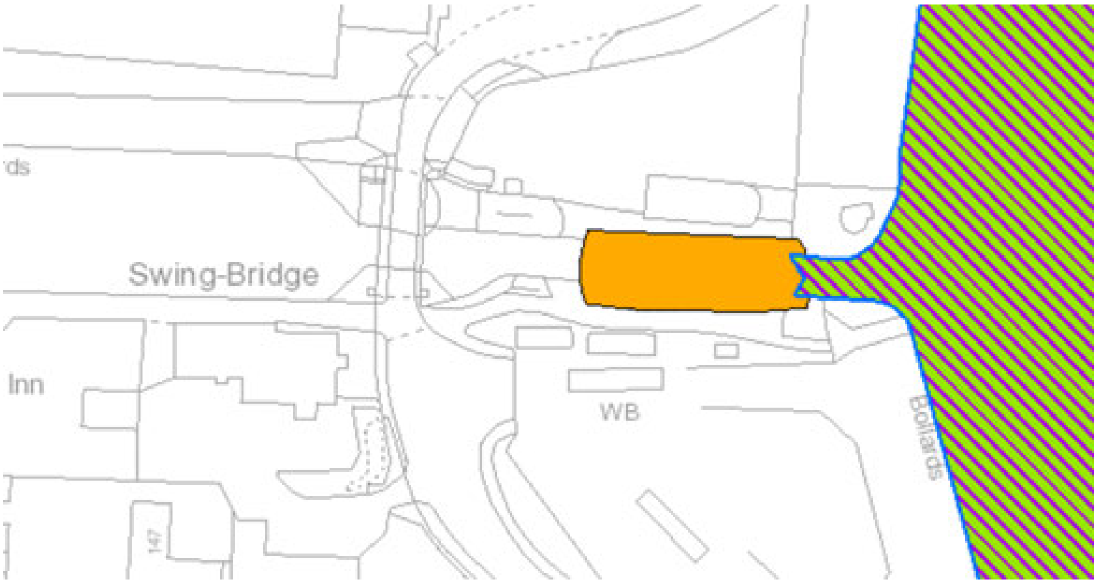


Plate 2 – Vertical reinforced man-made walls at intersection with River Trent

1.8.9 There are no changes to the effects described within **Chapter 11:** Biodiversity and Nature Conservation (ES Volume I – Application Document Ref. 6.2.11) [**APP-054**].

Water Environment and Flood Risk

1.8.10 During the construction phase, modifications will be made to the existing Keadby Lock. Given the small scale and localised nature of the works, and that there is no requirement to physically work within the waterbody, it is anticipated that all residual risk would be adequately mitigated through measures to protect the water environment which will be outlined in the Contractor's Construction Environmental Management Plan (CEMP), based on the Framework CEMP included in the DCO application (Application Document Ref. No. 7.1). As such there are no changes to the significance of effect reported for the Stainforth and Keadby Canal and River Trent in **Chapter 12**: Water Environment and Flood Risk (ES Volume I – Application Document Ref. 6.2.12) **[APP-055]**.

1.8.11 The Keadby 3 Cooling Water Abstraction Flood Risk Technical Note (AECOM, 2021a) (see Appendix A) has been prepared which assesses the impact of the proposed water efficiency measures on all relevant sections of the Stainforth and Keadby Canal, up to Doncaster Lock.

1.8.12 The Trust's SCADA will control the water level in the canal and maintain it at the 'Zero' (base) Level of 4.35m Above Ordnance Datum (AOD). As the canal will still be operating at the Zero Level, no additional alterations are required to contain the volume of water in the canal, and abstraction can take place whilst still allowing sufficient water levels for boats using the canal. The Flood Risk

Technical Note (AECOM, 2021a) (see Appendix B) finds a negligible impact on the flood risk of the canal as a result of the proposed work, with the mechanism remaining unchanged from the baseline flood risk. The SCADA technology is designed to minimise variation from the normal maintained water level and is set with a 50 mm +/- tolerance, therefore any breach of this tolerance will result in the sluices automatically adjusting in order to maintain the required water level. Therefore, should abstraction at Keadby 3 Carbon Capture Power Station temporarily cease, firstly the canal would remain at the Zero Level, but in the unlikely event that an increase of 50 mm above the Zero Level is observed, the SCADA automated system will operate to reduce the volume of water entering the canal and mitigate flood risk.

Geology, Hydrogeology and Land Contamination

1.8.13 The works proposed are minor modifications to an existing lock gate and will not involve releases to land or water that could affect water resources.

1.8.14 There are no changes to the effects described within **Chapter 13:** Geology, Hydrogeology and Land Contamination (ES Volume I – Application Document Ref. 6.2.13) [**APP-056**].

Landscape and Visual Amenity

1.8.15 The proposal is not located within or in the vicinity of any nationally designated landscapes. National Character Area (NCA) Profile 39: Humberhead Levels occurs in the vicinity and includes the Isle of Axholme Area of Special Historic Landscape Interest (designated locally for its extensive strip field system). However, the scale of the works is trivial with no realistic potential to affect the landscape character and perception of the NCA.

1.8.16 The surrounding area in the immediate vicinity is industrial. The only views could be glimpsed views from Trentside. There are no changes to the effects described within **Chapter 14**: Landscape and Visual Amenity of ES Volume I – Application Document Ref. 6.2.14) [**APP-057**].

Cultural Heritage

1.8.17 The proposed works involve the addition of one plank to the mid-rail of the upstream side of the upstream lock gates. The addition is a minimal visual alteration to this set of lock gates. Whilst the lock gates are not historic (the gates form part of the scheduled monument, but were replaced in 2015/16), their function and appearance make a contribution to the heritage significance of the lock. The gates are one pair of four pairs of matching gates present at the lock. Whilst the visual alteration to the gates is minimal, and will be largely imperceptible when weathered, the addition will alter one set of four sets of gates making one set slightly different to the other three. This very minor change will not alter the perception and understanding of the lock's architectural and historic interests. The proposal can therefore be achieved without impacting upon the significance and special interest of the lock.

1.8.18 Further information on heritage effects is included within the Keadby Lock Scheduled Monument Consent Application Heritage Impact Assessment report (AECOM, 2021b).

1.8.19 There are no changes to the effects described within **Chapter 15**: Cultural Heritage (ES Volume I – Application Document Ref. 6.2.15) [**APP-058**].

Socio-economics

1.8.20 There are no changes to the effects described within **Chapter 16**: Socio-economics (ES Volume I – Application Document Ref. 6.2.16) [**APP-059**].

Climate Change and Sustainability

1.8.21 There are no changes to the effects described within **Chapter 17**: Climate Change and Sustainability (ES Volume I – Application Document Ref. 6.2.17) [**APP-060**].

Major Accidents and Disasters

1.8.22 There is not anticipated to be any risk of major accidents or disasters relating to the proposed changes to the Keadby Lock gate. There are no changes to the effects described within **Chapter 18**: Major Accidents and Disasters (ES Volume I – Application Document Ref. 6.2.18) [**APP-061**].

Operation effects

Air Quality

1.8.23 No operational air quality effects are anticipated as a result of the proposed changes to the Keadby Lock gate. There are no changes to the effects described within **Chapter 8**: Air Quality (ES Volume I – Application Document Ref. 6.2.8) [**APP-051**].

Noise and Vibration

1.8.24 No operational noise and vibration effects are anticipated as a result of the proposed changes to the Keadby Lock gate. There are no changes to the effects described within **Chapter 9**: Noise and Vibration (ES Volume I – Application Document Ref. 6.2.9) [**APP-052**].

Traffic and Transportation

1.8.25 No operational traffic and transportation effects are anticipated as a result of the proposed changes to the Keadby Lock gate. There are no changes to the effects described within **Chapter 10**: Traffic and Transportation of (ES Volume I – Application Document Ref. 6.2.10) [**APP-053**].

Biodiversity and Nature Conservation

1.8.26 During the operational phase, although the proposals will involve the conservation of water (for the purposes of the cooling water abstraction) which currently weirs over the horizontal beams of Keadby Lock directly into the River Trent. The designations are not reliant on a specific volume of water supply from the canal, and the established function of the existing lock gate is to retain water within the canal except when the lock is in operation. The water utilised for Keadby 3 will still be discharged into the tidal River Trent on transit from the cooling system (albeit subject to some evaporative losses). The effects of use and discharge of cooling water on habitats within the River Trent have been assessed as part of the Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) Screening Report submitted to the Planning Inspectorate for that project and this has concluded no likely significant effect.

1.8.27 The Stainforth and Keadby Canal Corridor Local Wildlife Site (LWS) designation applies to the canal at this location, so this also intersects the location of the proposed Keadby Lock modifications (Plate 3).

Plate 3: Keadby Lock intersection with Stainforth and Keadby Canal Corridor LWS

1.8.28 The LWS comprises a 10km long watercourse and habitat corridor designated, and of county nature conservation value, for its aquatic and wetland plant interest, and the associated ancillary bank-top scrub and grassland habitats that supplement the biodiversity value of the LWS. The effects on the LWS during construction would be limited to temporary disturbance of a very limited area of channel at Keadby Lock and would therefore be not significant given the large size of the LWS. The minor nature of the proposed modifications mean that any impact would be comparable to or less than that associated with the existing purpose and operation of the lock gate.

1.8.29 Effects during operation of abstracting water from the LWS have previously been assessed in the EIA for the Keadby 3 Carbon Capture Power Station, submitted to the Planning Inspectorate and assessed as negligible (not significant).

1.8.30 If it became necessary to reactivate the by-wash weir it would require some removal of vegetation (common wetland species, particularly bulrush) that has accumulated within the weir structure while it has been disused. The Keadby Wetland LWS is located adjacent to the structure but, as access can be achieved via the towpath, no impacts to the LWS or its integrity are considered likely. This is currently considered to be unlikely to be required and is dealt with during the licence application.

1.8.31 While the potential presence of nesting birds cannot be fully discounted, nesting is not likely on the lock gate itself so there is not likely to be a conflict with general legal requirements. Nesting birds could utilise vegetation requiring removal to reactivate the by-wash weir. Standard good practice mitigation and timings would be applied to address this minor potential constraint so significant effects would not be anticipated.

1.8.32 Other protected and notable species would not reasonably be anticipated to be resident at the location of the lock gate given the established use and context of this location (Plate 4). Otter and bats may have an incidental presence in this area, but there are no features likely to be used as places of refuge by these species or that could be affected by the minor daytime works proposed. So, a significant effect is not likely on these or any other protected or notable species.

Plate 4: Habitat context and land use in the vicinity of the lock gate

1.8.33 It cannot be discounted that other protected species may occur in the vicinity of the by-wash weir. However, the very minor vegetation removal needed to reactivate the weir would not reasonably be anticipated to adversely affect the conservation status of any species. Legal compliance is mandatory so relevant inspections by an ecologist would be completed prior to these works, and mitigation would be agreed to ensure legal compliance.

Water Environment and Flood Risk

1.8.34 The proposed works will retain the required 27.4 Ml/d of water, which would otherwise typically discharge into the River Trent beyond Keadby Lock, for water cooling purposes required by the Proposed Development for baseload operations. The retention of water will be achieved by increasing the Keadby Lock gate threshold from 4.12m AOD to 4.35m AOD. The increase aligns with the current normal water level which will also be maintained following the modification works. When Keadby 3 is operational, following cooling duty and subject to evaporative losses, the water will be discharged into the River Trent. It is not anticipated that this would increase the risk of fluvial flooding (see Appendix B) as there would be no increase in water volume discharged to the Trent, following use in the Proposed Development compared to the baseline.

1.8.35 The retention of water is not going to increase the risk of canal flooding within the Keadby Lock and Thorne Lock pound, as the Trust has confirmed that overtopping would occur at levels of 4.6m AOD or greater. This is 250 mm greater than the proposed Keadby Lock threshold, and therefore any excess water would likely spill over into the River Trent (as currently). Along the canal from Keadby Lock through to Doncaster Lock the water levels are controlled by the SCADA sluice and lock control technology. Therefore, the flows will be constantly monitored and regulated to ensure the Zero Level is maintained.

1.8.36 If water levels were to increase upstream, the Don Aqueduct would likely act as a form of mitigation. The overspill element of the Don Aqueduct, which is at a similar level to the respective pound's (section of a canal between two locks) Zero Level, would ensure that any increases in water level would spill into the River Don.

1.8.37 The fluvial flood risk associated with both the River Trent and River Don are not likely to increase as a result of the proposed change. This is because the current maintained water level is not proposed to change and therefore the volume of any overspill is considered to be similar (or less) to that currently received.

1.8.38 The residual risk of blockage or periods of maintenance could hinder or temporarily pause the abstraction process which would result in the normal water level being exceeded without further controls. However, in this event, the installed SCADA technology would adjust the sluices which could mean water level rises upstream as each pound is likely to reduce the flow received to avoid deviation from the normal water levels. The Don Aqueduct is designed with an overspill which is assumed to have been designed to a level similar to the Zero Level for that pound. Any increase in water level would likely spill over into the River Don.

1.8.39 Overall, the proposed works are considered to have minimal impact on canal flood risk with the mechanisms of flooding remaining similar to that of the baseline, therefore both the risk of canal flooding and residual risk remains Neutral and not significant.

Geology, Hydrogeology and Land Contamination

1.8.40 No operational geology, hydrogeology and land contamination effects are anticipated as a result of the proposed changes to the Keadby Lock gate. There are no changes to the effects described within **Chapter 13**: Geology, Hydrogeology and Land Contamination (ES Volume I – Application Document Ref. 6.2.13) [**APP-056**].

Landscape and Visual Amenity

1.8.41 There are no changes to the effects described within **Chapter 14**: Landscape and Visual Amenity (ES Volume I – Application Document Ref. 6.2.14) [**APP-057**].

Cultural Heritage

1.8.42 No operational cultural heritage effects are anticipated as a result of the proposed changes to the Keadby Lock gate beyond those effects outlined within the construction section above. There are no changes to the effects described within **Chapter 15**: Cultural Heritage (ES Volume I – Application Document Ref. 6.2.15) [**APP-058**].

Socio-economics

1.8.43 There are no changes to the effects described within **Chapter 16**: Socio-economics (ES Volume I – Application Document Ref. 6.2.16) [**APP-059**].

Climate Change and Sustainability

1.8.44 There are no changes to the effects described within **Chapter 17**: Climate Change and Sustainability (ES Volume I – Application Document Ref. 6.2.17) [**APP-060**].

Major Accidents and Disasters

1.8.45 There is not anticipated to be any risk of major accidents or disasters relating to the proposed changes to the Keadby Lock gate. There are no changes to the effects described within **Chapter 18**: Major Accidents and Disasters (ES Volume I – Application Document Ref. 6.2.18) [**APP-061**].

1.9 Additional Mitigation, Monitoring and Enhancement Measures

1.9.1 No additional mitigation, monitoring and enhancement measures above those described in the submitted ES are required as a result of this proposed change.

1.10 Limitation or Difficulties of Additional Assessment

1.10.1 The limitations and/ or difficulties related to this document are consistent with those reported in the submitted ES.

1.11 Summary of Updated Likely Significant Residual Effects

1.11.1 There are no significant changes to the likely residual effects identified in the submitted ES, as a result of the proposed changes to the Keadby Lock gate. The residual effects would remain as reported within the submitted ES.

1.11.2 The proposed changes to the Keadby Lock gate will not lead to any changes to the assessment of cumulative and combined effects included within **Chapter 19**: Cumulative and Combined Effects (ES Volume I – Application Document Ref. 6.2.19) [**APP-062**].

1.12 References

AECOM (2021a) Keadby 3 Cooling Water Abstraction Flood Risk Technical Note.

AECOM (2021b) Keadby Lock Scheduled Monument Consent Application Heritage Impact Assessment report

Arcadis (2022) Keadby Lock Gate Modification Options Appraisal.

APPENDIX A: FLOOD RISK REVIEW

AECOM

To:

Prepared by: Luke Bland

Approved by: Richard Lowe

AECOM Infrastructure & Environment UK Limited
1 New York Street
Manchester M1 4HD
United Kingdom

[redacted]

Project name: The Keadby 3 Low Carbon Gas Power Station Project

Project ref: EN010114

From: AECOM

Date:04/22/2021

Technical Note

Subject – Keadby 3 cooling water abstraction flood risk

Introduction

AECOM Limited ('AECOM') has been commissioned by Keadby Generation Limited (KGL) to prepare a Flood Risk Technical Note, which will form part of an abstraction licence application by Canal and River Trust ('the Trust') to supply cooling water for a proposed low carbon gas fired generating station located on land within the Keady Power Station site at Keadby, Scunthorpe DN17 3EF known herein as 'Keadby 3'.

Purpose of this document

To support the operation of Keadby 3, there is a need for a water-cooling process to take place which will require a total volume of 27.4 Ml/d for baseload operation. The preferred option for sourcing cooling water is to abstract from the nearby Stainforth and Keadby Canal (here after referred to as 'the canal'). The abstraction is proposed to be located adjacent to the abstraction for Keadby 2 Power Station (under construction) between Keadby Lock and Thorne Lock on an impounded section of the canal.

The Trust is applying to the Environment Agency for an Abstraction Licence [CRT to confirm whether this is a new licence of variation with EA] to authorise the proposed Keadby 3 abstraction. This Technical Note assesses the potential flood risk impacts associated with the proposed abstraction from the canal. The design of the abstraction structure and associated civils works is at concept stage, and this assessment is based on the information currently available i.e. that the proposed abstraction is likely to be very similar to the recently constructed intake and abstraction for Keadby 2 Power Station. There may be a requirement for further analysis assessment once the detailed design for Keadby 3 is finalised.

In order to facilitate the proposed water abstraction from the canal without impacting the normal operating water level in the canal, upgrade works to the Keadby Lock threshold are required. These works, although minor in nature, have the potential to impact flood risk associated with the canal. For assessment purposes, the reach of potential impacts (i.e. study area) has been assumed to include the canal from Keadby Lock back to Doncaster Lock (the start of the Keadby Canal and its junction with the River Don). Therefore, this assessment has focussed on the Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal (Keadby Lock to Doncaster Lock).

Site description

The final proposed water abstraction location has not yet been finalised. However, in accordance with Rochdale Envelope principles, the application for Development Consent Order (DCO) includes an area within which the proposed abstraction would need to be sited (Work 4A).

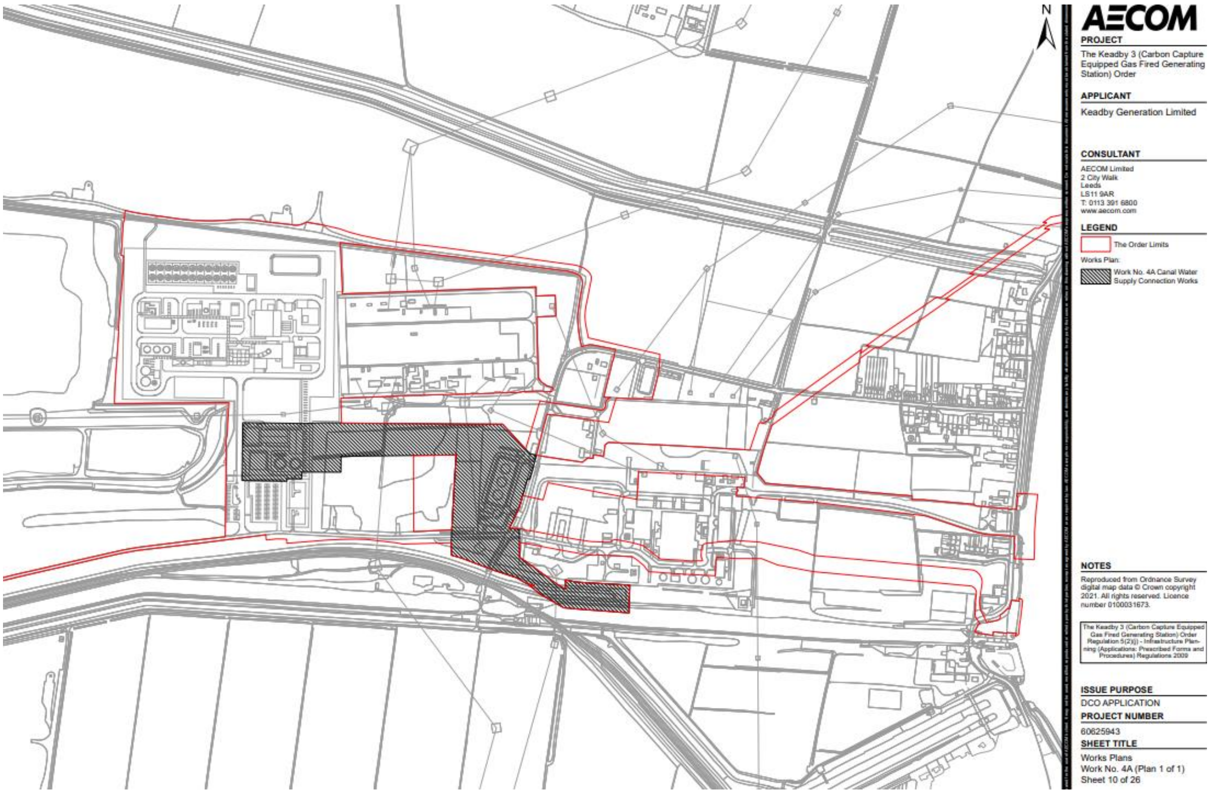


Figure 1: Location of Proposed Canal Water Abstraction (Work 4A)

The proposed abstraction would therefore be positioned on the northern bank of the canal located south of the main power plant within the proposed Keadby 3 site. The highlighted area on Figure 2 indicates the area within which the abstraction is proposed to be located and the position of Keadby Lock.

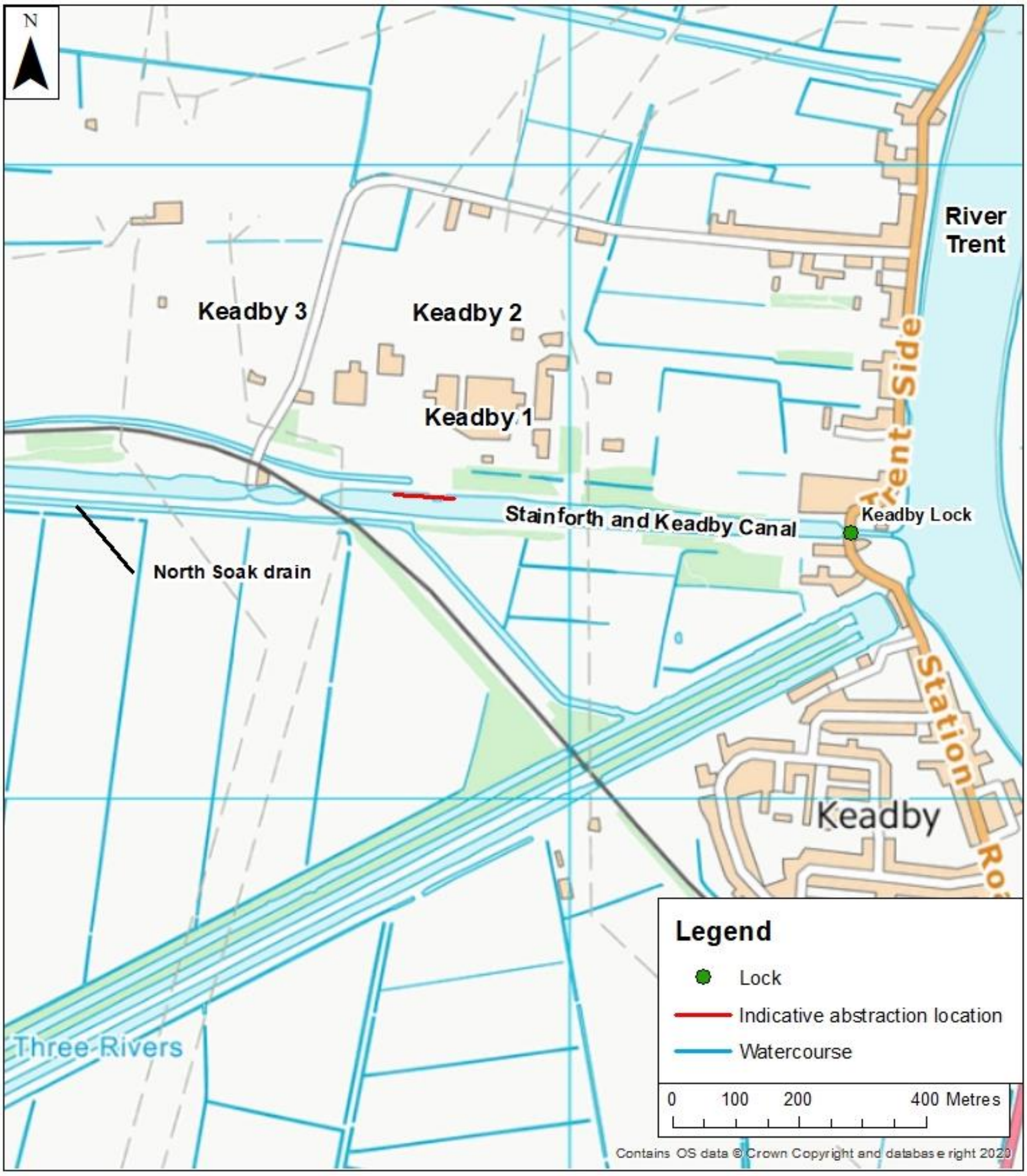


Figure 2: Location of Proposed Abstraction and Keadby Lock

The canal connects the River Don and River Trent and flows around the urbanised residential settlements of Stainforth, Kirk Bramwith, Barnby Dun and Kirk Sandall whilst flowing through Thorne and Doncaster. The canal also traverses the South Humberside Main Line and the M18 motorway.

Local hydrology

The proposed abstraction location lies approximately 750m west of the tidal River Trent which flows in a northerly direction towards the Humber. Approximately 785m to the north of the proposed abstraction location, beyond Keadby Common is Warping Drain, an ordinary watercourse maintained by the Isle of Axholme and North Nottinghamshire Water Level Management Board ('the IDB') that flows east and into the tidal River Trent via sluice gates. Warping Drain includes Paupers Drain; an artificial waterbody influenced by tidal locking with flood embankments on either side.

To the west of the proposed abstraction location is the Keadby Boundary Drain, an ordinary watercourse maintained by the IDB that flows into Warping Drain via a sluice with flood gates. South of the proposed abstraction location there are a number of watercourses running west to east in parallel with each other. These include the North Soak Drain and the South Soak Drain, which flow either side of the Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal. The North and South Soak Drains flow into the Three Rivers a short distance to the south, and then this connects with the River Trent via sluice gates and Keadby Pumping Station, which is a major pump draining the Isle of Axholme. These three watercourses and the River Trent are all main rivers. The Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal is linked to the River Trent via Keadby Lock and managed by the Trust.

Existing System

Canal systems are well maintained watercourses; however, there are still instances where they may present a flood risk due to overtopping or failure. The Canal, like all other canals, is monitored and kept at specific levels to ensure safe passage for canal users. In this case, the process is automated and involves technology known as MEICA SCADA (Mechanical, Electrical, Instrumentation, Control and Automation Supervisory Control And Data Acquisition). This system is set up to automatically operate and control a number of sluices along the Canal to ensure the water in the Canal stays at the appropriate depth for boats to use. These systems are present at a number of locks across the canal of which are shown in Figure 3.

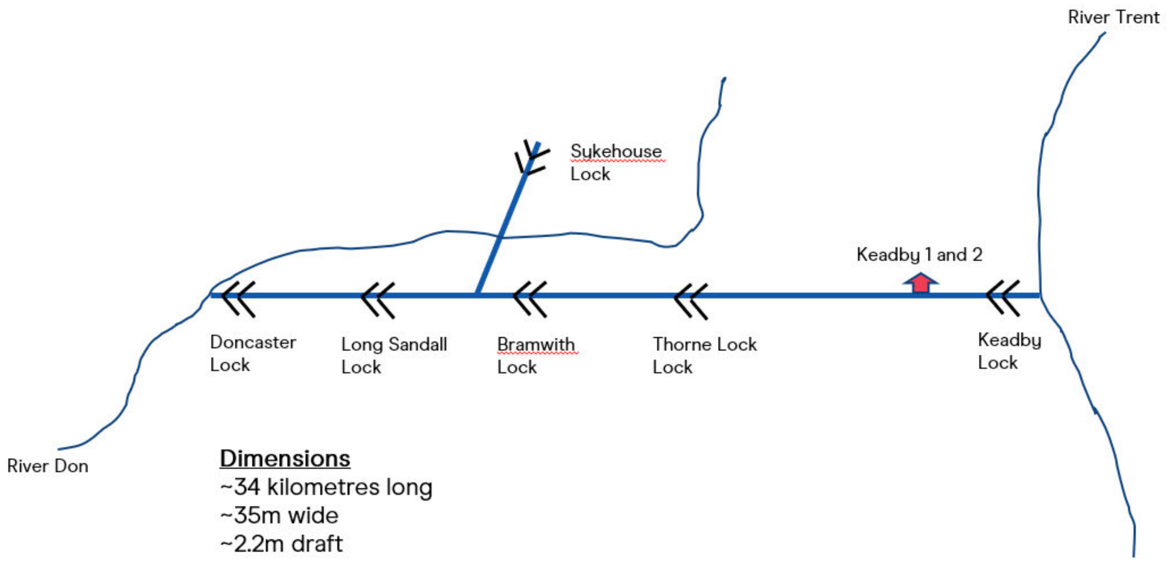


Figure 2 – Canal overview

The normal water level, as confirmed by the Trust, of the Thorne Lock to Keadby Lock pound is set at 4.35 metres Above Ordinance Datum (mAOD) (known as 'Zero Level'). It is within this pound that the abstraction and proposed upgrade works are to take place. The SCADA technology is designed to minimise variation from the normal maintained water level and is set with a 50 mm +/- tolerance, therefore any breach of this tolerance will result in the sluices automatically adjusting in order to maintain the required water level. The existing design level of Keadby Lock is set at 4.12 mAOD which is 230 mm below the maintained water level. As a result of this, in normal operation there is a flow of water out of the Canal of approximately 37 Ml/d through spill over Keadby Lock into the River Trent (see Figure 4).

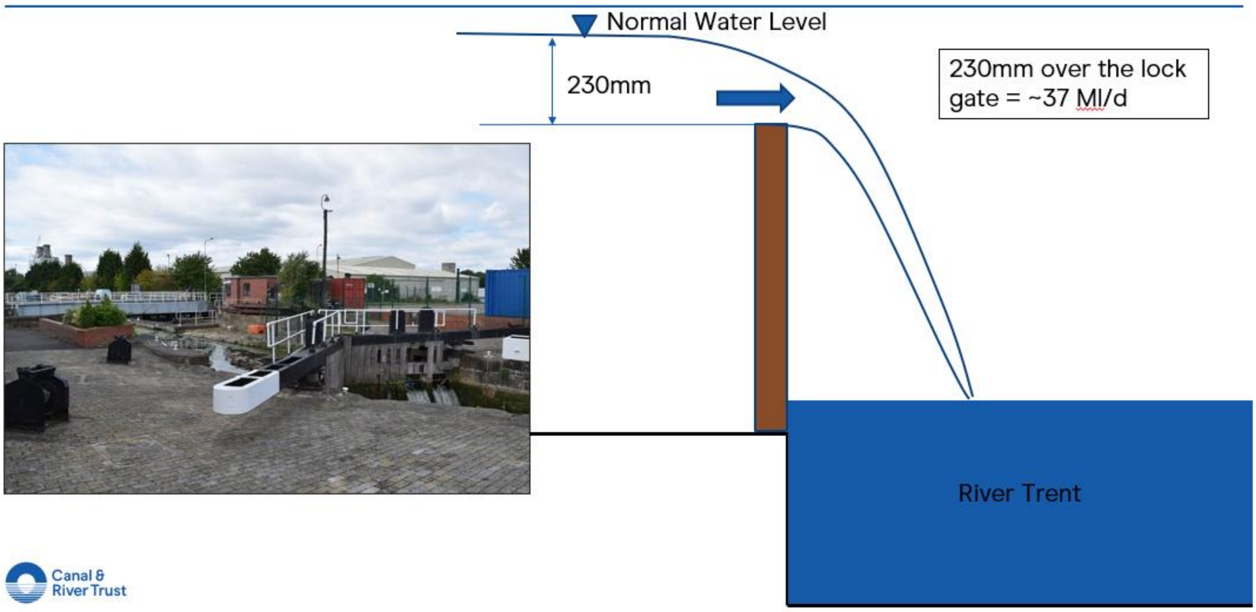


Figure 4: Keadby Lock daily spill volume

Proposed Modification Works at Keadby Lock

In order to make the required volume of water for the Keadby 3 cooling process available for abstraction, efficiency measures are proposed to upgrade Keadby Lock gates. The proposed works are subject to concept design and are understood to involve a modification to the top of the existing Keadby Lock gates to increase the threshold for water spillage. As the final design has not yet been developed, therefore it has been agreed with the Trust to assume a design level similar to the Zero Level for the purpose of this assessment. This would increase the Keady Lock threshold from 4.12 mAOD to 4.35 mAOD and ensure that water which currently is able to discharge into the River Trent is retained in the pound, allowing a sufficient volume of water to be available for abstraction whilst maintaining the Zero Level.

Baseline flood risk

This section discusses potential baseline (as existing) risks in relation to tidal, fluvial, surface water runoff, groundwater and artificial sources (e.g. canals, reservoirs).

Table 1 – Baseline flood risk summary

Source	Baseline flood risk	Risk
Tidal flooding	The proposed abstraction site is located in Flood Zone 3 (>0.5% AEP). The Tidally influenced River Trent is the dominant source of sea flooding, but the area benefits from maintained flood defence embankments and lock gates The Site is at 'low' risk of flooding from tidal sources with the defences in place or flooding resulting from overtopping of the defences during events that exceed 0.5% AEP (1 in 200 chance) of flooding. The Site is at a 'low' residual risk of tidal flooding from the North and South Soak Drains and in the event of a breach in defences.	Low
Fluvial flooding	The proposed abstraction site is located in Flood Zone 3 (>1% AEP). The River Trent is the dominant source of fluvial flooding, particularly as the high embankments allow water levels on the Trent to rise much higher than surrounding watercourses and much of the Isle of Axholme drainage (including the Three Rivers and North and South Soak Drains) is lifted by pumping into the Trent.	Low

	The Site is at 'low' risk of flooding from fluvial sources and ordinary watercourses with the defences in place or resulting from overtopping of the defences during events that exceed 0.5% AEP (1 in 200 chance) of flooding. The Site is at a 'low' residual risk of fluvial flooding in the event of a breach in defences.	
Surface water flooding	The Environment Agency's Risk of Flooding from Surface Water (RoFfSW) online flood map identifies that the majority of land surrounding the abstraction location and along the canal to be at Very Low risk of surface water flooding. The proposed abstraction works are to be situated within and alongside the canal and therefore it is not likely to be impacted by surface water flooding and therefore it is considered to be at 'very low' risk of flooding from surface water.	Very Low
Groundwater flooding	The areas around the proposed abstraction are artificially drained by various land drains and pumping stations, which help to maintain the groundwater level. These are expected to remain operational through the lifetime of the development, contributing to a low risk of groundwater emergence at the proposed abstraction location. The proposed abstraction works are to be situated within the canal and therefore are unlikely to be influenced by groundwater. Based on the information provided, the proposed abstraction is considered to be at low risk of flooding from groundwater sources.	Low
Artificial sources of flooding	The proposed abstraction location is not considered at risk from reservoir flooding. The Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal has a shallow gradient and drains into the River Trent via a sluice. The pound located in between Thorne Lock and Keadby Lock has a maintained water level of 4.35 mAOD (Zero Level). The Trust has confirmed that the section of the canal overtops 250mm above zero level (4.6 mAOD). Over topping is unlikely as the MEICA SCADA technology which automates the sluice gates / locks, ensures the Zero Level is maintained. If any overtopping of the canal were to occur, this would drain into the North and South Soak drains located at a lower elevation on either side of the canal and drain away. The risk of flooding is considered to be 'low'.	Low

Impact of proposed abstraction on flood risk

As the proposed works directly relate to water levels within the Stainforth and Keadby Canal, only canal flood risk has been assessed within this section. The proposed works are not likely to impact any other source.

Impact of the proposed works on canal flooding

The proposed works at Keadby Lock will be designed to provide the required volume of water (27.4 Ml/d for baseload operation) to allow the abstraction from the Canal for Keadby 3 to take place. By retaining and utilising water for a beneficial purpose which would ordinarily discharge into the River Trent, the Zero Level (4.35 mAOD) will be maintained allowing continued safe use of the canal for navigation. This has been confirmed by the Trust with water levels to be controlled by the locks, sluices and abstraction process. Overtopping within the canal occurs 250mm above Zero Level and therefore overtopping is expected at water levels at and above 4.6 mAOD. Overtopping is unlikely to occur as the Keadby Lock gate height will be designed lower than this, which would allow excess water to spill over into the River Trent. With minimal changes to the Zero Level, the proposed works are considered to have a negligible impact on the flood risk of the canal, with the mechanism remaining unchanged from the baseline flood risk.

There is a risk that during a high tide, the River Trent could experience periods of spate and high river levels could restrict the ability of the River Trent receiving water from the canal. At this point, the MEICA SCADA system would recognise a rise in local water levels within their retrospective pounds, which in turn would signal for the locks and sluices to adjust to maintain the Zero Level. This would likely have a knock-on effect up the reach of the canal system as each pound would also experience water level rises. Eventually, this would reach upstream of Bramwith Lock at the Sheffield & South Yorkshire Canal and Stainforth and Keadby Canal confluence. Located within this pound is the Don Aqueduct (NGR: SE 61492 11293) which is located on New Junction Canal and is used to traverse the

River Don. The aqueduct has an overspill mechanism which allows excess water to spill over into the River Don. This mechanism would mitigate any increase in water level within the respective pound. The amount of overspill into the River Don, if any, would likely be negligible and sporadic.

The Don Aqueduct has two large guillotine gates at either end which become operational when the River Don is in flood. These prevent flood waters from the Don flowing along the canal system and protect large amounts of farmland, farmhouses, and key infrastructure from flooding. However, it is possible for flood waters from the Don to enter the canal from Doncaster Lock. If this occurs, the SCADA system initiates and opens the sluices up to Keadby Lock, passing increased flow along the canal. This allows more flood waters to pass down the system into the Keadby Lock pound and into the River Trent. If heavy flooding is forecast, the sluices can be manually operated (if deemed necessary) to allow as much conveyance as possible. Given that this mechanism already operates, and as the normal water level after the proposed changes to Keadby Lock gates will remain similar (or the same as) the levels currently maintained in the system, the impact of the proposed works on canal flooding is considered Low.

Residual canal flood risk

Although the risk of canal flooding is considered Low, there are residual risks which may impact this including blockage, maintenance or reduced or intermittent use of the abstraction operation over time. The Environmental Permit will require maintenance of all infrastructure, including the abstraction, in accordance with Best Available Techniques (BAT). During any maintenance period when the abstraction is not in use, the lower pound will continually receive water from the upper sections of the canal (either from overspill, as a result of a boat utilising a lock or rainfall events). In such instances therefore, there is a risk that the normal water level will be exceeded in the pound. This situation would likely initiate the SCADA technology (works within a 50 mm +/- tolerance of normal water level) which would adjust the relevant sluices to mitigate any further increase in water level. This may reduce the amount of flow entering the pound which would subsequently work its way back upstream resulting in water level rises in each subsequent pound. Eventually, this rise in water level would be mitigated by the overspill mechanism associated with the Don Aqueduct and spill into the River Don. The upgrade works to Keadby Lock gates are to be designed at Zero Level with a 250mm freeboard, therefore any additional flow which enters the pound during either of these residual events would spill into the River Trent. Asa result, residual canal flood risk is considered Low.

In an extreme scenario, the River Trent and River Don may potentially both be in flood through tidal and fluvial influences respectively, potentially resulting in overtopping of Doncaster Lock and Keadby Lock. In this scenario, it is anticipated that all sluices except Keadby Lock would be opened to allow as much flood water as possible through the system. If overtopping is expected, then Keadby Lock is the most favourable pound to overtop as it is close to the river system and has less vulnerable receptors (e.g. residential properties, essential infrastructure) located within close proximity of the lower pound than any others. The probability of this scenario occurring is very low and, in this instance, the mechanism as a result of the proposed works would not change from the existing works, therefore the impact is considered negligible.

Climate change impact on canal flooding

Keadby 3 will have an expected lifespan of circa 25 years and for the purposes of undertaking a worst-case assessment, for flood risk and extended life of35 years has been assessed as agreed with the Environment Agency. It has been assumed that the Proposed Development will become operational between 2026 and 2033, (depending on financial investment decision and construction programming). On this basis, and assuming a 35 year operational life, decommissioning could commence between 2061 and 2068. This will fall within the 2050s' (2040 to 2069) epoch, which is predicted to have a 20% increase in rainfall. This increase will be associated with more extreme weather and is likely to increase the risk of canal breaches. In the event of more extreme weather conditions, the extreme scenario highlighted within the residual risk section may become more probable. Considering the above, the proposed works would have a negligible impact on the impact of climate change on canal flood risk.

Conclusion

The proposed works will retain the required 27.4 Ml/d of water, which would otherwise typically discharge into the River Trent beyond Keadby Lock, for water cooling purposes required by the proposed Keadby 3 low carbon gas fired power station for baseload operations. The retention of water will be achieved by increasing the Keadby Lock threshold from 4.12 mAOD to 4.35 mAOD. The increase aligns with the current normal water level which will also be maintained following the modification works. When Keadby 3 is operational, following cooling duty and subject to evaporative losses, the water will be discharged into the River Trent. It is not anticipated that this would increase the risk of fluvial flooding as in the baseline scenario, water discharges into the River Trent.

The retention of water is unlikely to increase the risk of canal flooding within the Keadby Lock and Thorne Lock pound as the Trust has confirmed that overtopping would occur at levels of 4.6 mAOD or greater. This is 250 mm greater than the proposed Keadby Lock threshold therefore any excess water would likely spill over into the River Trent. Along the canal from Keadby Lock through to Doncaster Lock the water levels are controlled by the MEICA SCADA sluice and lock control technology. Therefore, the flows will be constantly monitored and regulated to ensure the Zero Level is maintained.

If water levels were to increase upstream, the Don Aqueduct would likely act as a form of mitigation. The overspill element of the Don Aqueduct, which is at a similar level to the respective pounds Zero Level, would ensure that any increases in water level would spill into the River Don.

The fluvial flood risk associated with both the River Trent and River Don are not likely to increase as a result of receiving any additional flows from the canal. This is because the current maintained water level is not proposed to change and therefore the volume of any overspill is considered to be similar to that currently received.

The residual risk of blockage or during periods of maintenance could hinder or temporarily pause the abstraction process which would result in the normal water level being exceeded without further controls. However, in this event, the installed SCADA technology would adjust the sluices which could mean water level rises upstream as each pound is likely to reduce the flow received to avoid deviation from the normal water levels. The Don Aqueduct is designed with an overspill which assumed to have been designed to a level similar to the Zero Level for that pound. Any increase in water level would likely spill over into the River Don.

Overall, the proposed works are considered to have minimal impact on canal flood risk with the mechanisms of flooding remaining similar to that of the baseline, therefore both the risk of canal flooding and residual risk remains Low.

APPENDIX B: KEADBY 3 COOLING WATER ABSTRACTION LICENCE APPLICATION WATER FRAMEWORK DIRECTIVE – SCREENING ASSESSMENT MODIFICATION WORKS TO KEADBY LOCK - STAINFORTH AND KEADBY CANAL- TECHNICAL NOTE

AECOM Imagine it. Delivered.

AECOM Infrastructure & Environment UK Limited
11th Floor Colmore Building
Colmore Circus Queensway
Birmingham.
B4 6AT
United Kingdom

T [redacted]

To: SSE

CC:

Project name: The Keadby 3 Low Carbon Gas Power Station Project

Project ref: EN010114

From: Tim Jones, Owen Tucker (AECOM)

Date:
19 November 2021

Technical Note

Keadby 3 Cooling Water Abstraction Licence Application
Water Framework Directive – Screening Assessment
Modification Works to Keadby Lock - Stainforth and Keadby Canal

1. Introduction

AECOM Limited ('AECOM') has been commissioned by Keadby Generation Limited (KGL) to prepare a Water Framework Directive (WFD) Screening Assessment which considers the additional works that are proposed by the Canal and River Trust ('the Trust') to provide cooling water for a proposed low carbon gas fired generating station which will be located on land within the Keady Power Station site at Keadby, Scunthorpe (DN17 3EF) (known herein as 'Keadby 3').

The Trust proposes to secure the necessary water for abstraction by undertaking water efficiency measures which will involve modifying Keadby Lock gate to conserve water which otherwise ordinarily flows from the Stainforth and Keadby Canal directly into the River Trent. The works are being designed with regard to minimising impacts on the normal operating water level of the Stainforth and Keadby Canal, maintained by the Trust for navigation purposes.

For clarity, the scope of this WFD Screening Assessment considers only the additional elements of design that are proposed to be undertaken by the Trust to enable the abstraction to take place without impacting the normal operating water level of the canal. The impacts associated with the proposed water abstraction and its use within the generating station have already been fully assessed within the **Keadby 3 Environmental Statement Volume II Appendix 12B: Water Framework Directive Assessment Report (APP-085),** which can be read alongside this technical note.

This WFD Screening Assessment forms part of an abstraction licence application by the Trust to the Environment Agency.

2. Need for Water Abstraction

To support the operation of Keadby 3, there is a need for water-cooling to take place which will require a maximum flow of 27.4 Ml/d . The preferred option for sourcing cooling water is to abstract from the nearby Stainforth and Keadby Canal. This canal is WFD designated under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. The abstraction is proposed to be located adjacent to the abstraction for Keadby 2 Power Station (under construction) between Keadby Lock and Thorne Lock.

In order to facilitate the proposed water abstraction from the canal without impacting the normal operating water level in the canal, upgrade works to increase the Keadby Lock threshold level are required to increase water retention in the canal. These works are minor in nature. However, given the canal is connected hydrologically to the River Trent (WFD designated as the Humber Upper transitional waterbody), there are also potential impacts to this adjacent water body that require consideration. The potential for impact pathways to the underlying WFD groundwater bodies also requires consideration (i.e. the Lower Trent Erewash - Secondary Combined and Idle Torne - Secondary Mudrocks WFD groundwater bodies).

3. Approach

New developments that have the potential to impact the current or targeted WFD status of a water body are required to assess their compliance against the WFD objectives of the potentially affected water bodies. In accordance with the Planning Inspectorate's Advice Note Eighteen[1] and the Environment Agency guidance for WFD assessments for coastal and transitional waters[2], a three-stage approach may be adopted:

- Stage 1: WFD Screening;
- Stage 2: WFD Scoping; and
- Stage 3: WFD Impact Assessment.

This report presents the findings of Stage 1 (Screening) for the additional design element i.e. modifications to Keadby Lock. Further scoping and WFD Impact Assessment (Stage 2) is not considered necessary at this stage., as outlined below

This assessment is based on the proposed design to raise the height of the bar on the lock gates.

4. Site description

In accordance with Rochdale Envelope principles, the application for Development Consent Order (DCO) includes an area within which the proposed abstraction would need to be sited (Work 4A), see Figure 1.

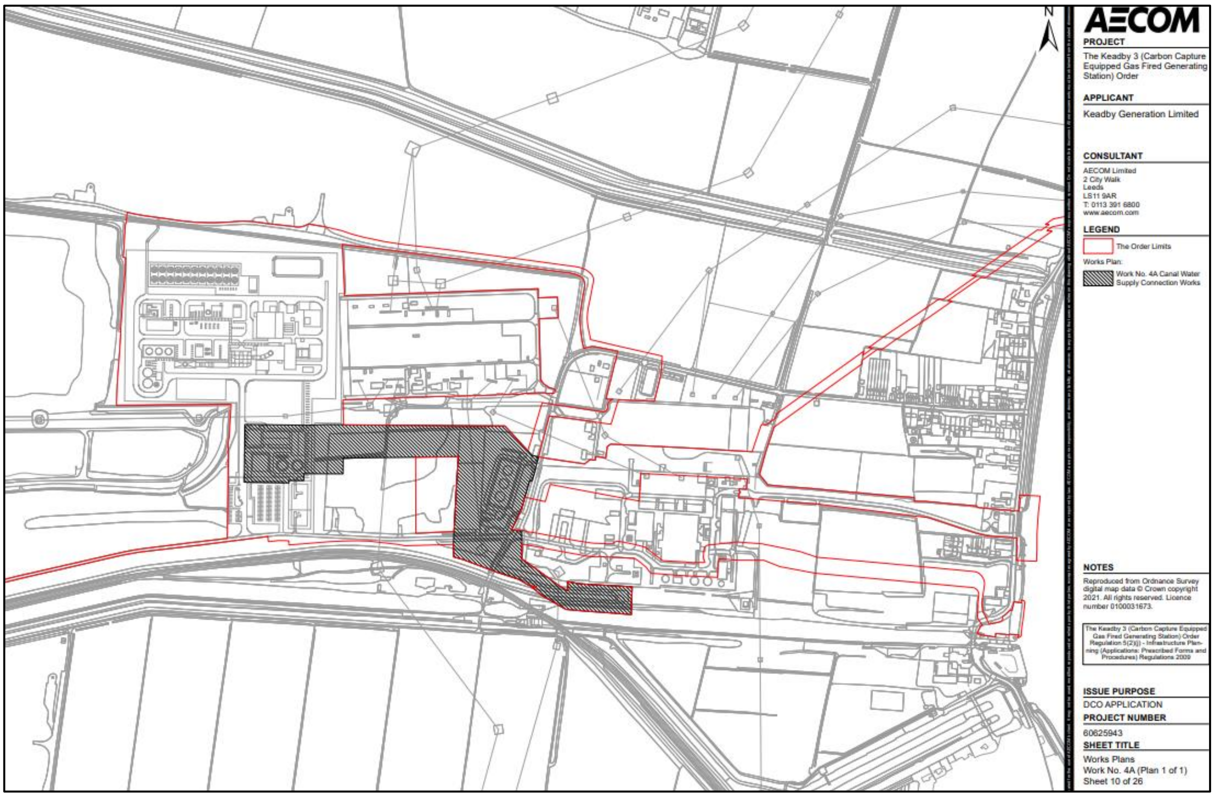


Figure 1: Location of Proposed Canal Water Abstraction (Work 4A, Shaded)

The proposed abstraction would therefore be positioned on the northern bank of the canal located south of the proposed generating station within the proposed Keadby 3 site. The highlighted area on Figure 2 indicates the area within which the abstraction is proposed to be located and the position of Keadby Lock.

[1] PINS (2017) Advice Note 18: The Water Framework Directive
[2] Environment Agency (2016) Water Framework Directive assessment: estuarine and coastal waters (Clearing the Waters for All). Available online: [redacted]

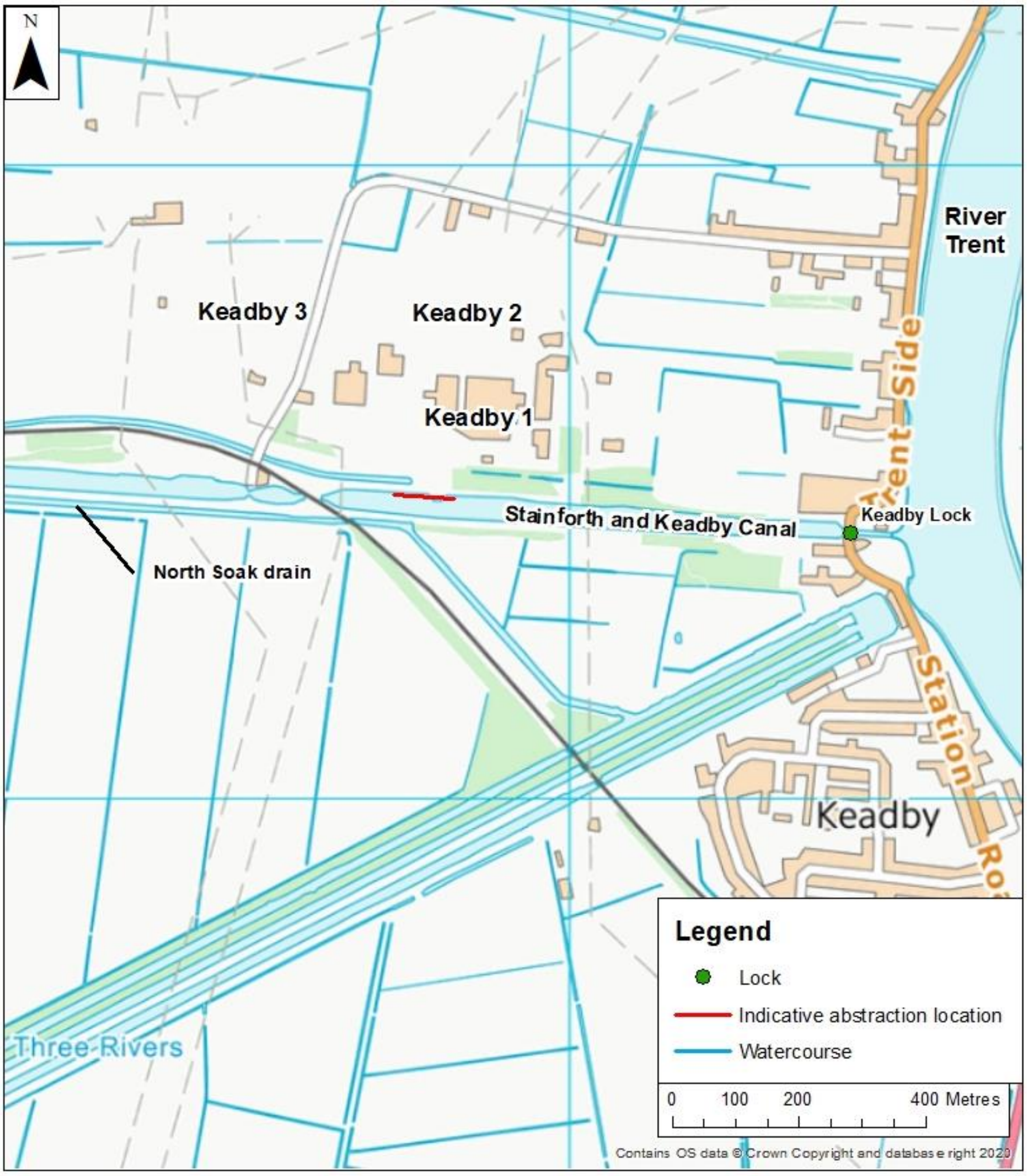


Figure 2: Location of Proposed Abstraction and Keadby Lock

The Stainforth and Keadby Canal is approximately 34 km long and connects the River Don in the west with the River Trent in the east. It flows around the settlements of Stainforth, Kirk Bramwith, Barnby Dun and Kirk Sandall whilst flowing through Thorne and Doncaster. The canal also traverses the South Humberside Main Line and the M18 motorway.

Local hydrology

The locations of local watercourses are shown in **Figure 12-1: Surface Waterbodies and their attributes (ES Volume III)** [redacted]**)** reproduced in Appendix 1**.**

The proposed abstraction location lies approximately 750m west of the tidal River Trent (Humber Upper WFD waterbody) which flows in a northerly direction towards the Humber. Approximately 785m to the north of the proposed abstraction location, beyond Keadby Common is Warping Drain, an ordinary watercourse maintained by the Isle of Axholme and North Nottinghamshire Water Level Management Board ('the IDB') that flows east and into the tidal River Trent via sluice gates. Warping Drain includes Paupers Drain (WFD designated as the Paupers Drain Catchment (trib of Trent)); an artificial waterbody influenced by tidal locking with flood embankments on either side.

To the west of the proposed abstraction location is the Keadby Boundary Drain, an ordinary watercourse maintained by the IDB that flows into Warping Drain via a sluice with flood gates. South of the proposed abstraction location there are a number of watercourses running west to east in parallel with each other. These include the North Soak Drain and the South Soak Drain (WFD designated as North Soak Drain Catchment (trib of Torne/Three Rivers)), which flow either side of the Stainforth and Keadby Canal. The North and South Soak Drains flow into the Three Rivers (WFD designated as

Torne/Three Rivers from Mother Drain to Trent) a short distance to the south, and then this connects with the River Trent via sluice gates and Keadby Pumping Station, which is a major pump draining the Isle of Axholme. These three watercourses and the River Trent are all main rivers. The Sheffield and South Yorkshire Navigation – Stainforth and Keadby Canal is linked to the River Trent via Keadby Lock and managed by the Trust.

Existing Canal System

The Stainforth and Keadby Canal, like all other canals, is monitored and kept at specific levels to ensure safe passage for canal users. In this case, the process is automated and involves technology known as MEICA SCADA (Mechanical, Electrical, Instrumentation, Control and Automation Supervisory Control and Data Acquisition). This system is set up to automatically operate and control a number of sluices along the Canal to ensure the water in the Canal stays at the appropriate depth for boats to use. These systems are present at a number of locks across the canal as shown in Figure 3.

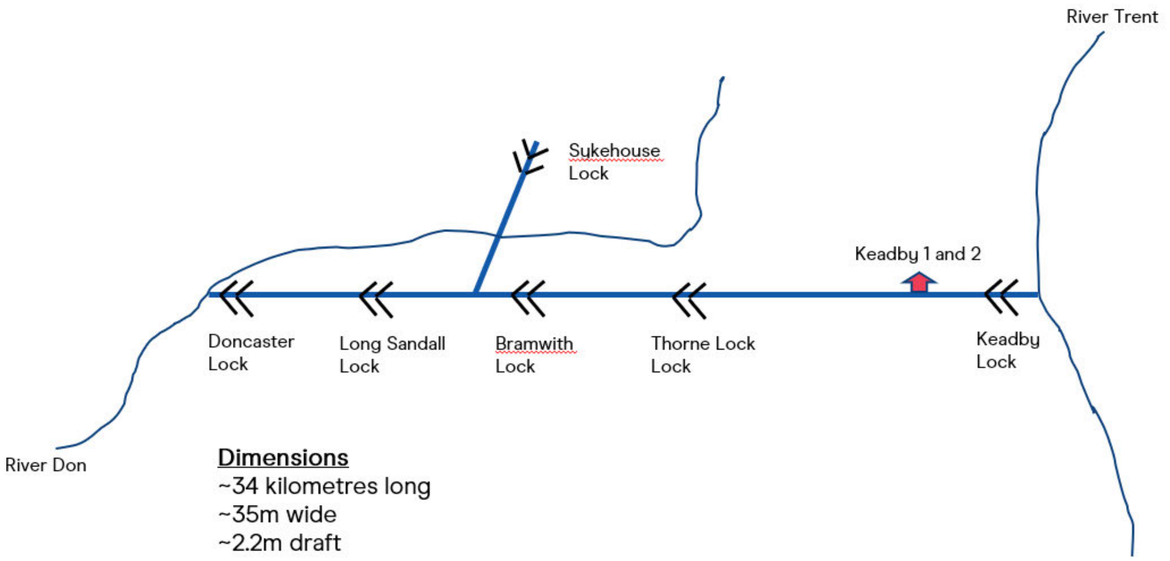


Figure 3 – Canal overview (source: Canal and River Trust)

The normal water level, as confirmed by the Trust, of the Thorne Lock to Keadby Lock pound (i.e. the reach between two sets of locks) is set at 4.35 metres Above Ordinance Datum (mAOD) (and known as 'Zero Level'). It is within this pound that the abstraction and proposed upgrade works are to take place. The SCADA technology is designed to minimise variation from the normal maintained water level and is set with a 50 mm +/- tolerance, therefore any breach of this tolerance will result in the sluices automatically adjusting in order to maintain the required water level. The existing design level of Keadby Lock is set at 4.12 mAOD which is 230 mm below the maintained water level. As a result of this, in normal operation there is a flow of water out of the Canal of approximately 37 Ml/d through spill over Keadby Lock into the River Trent (see Figure 4).

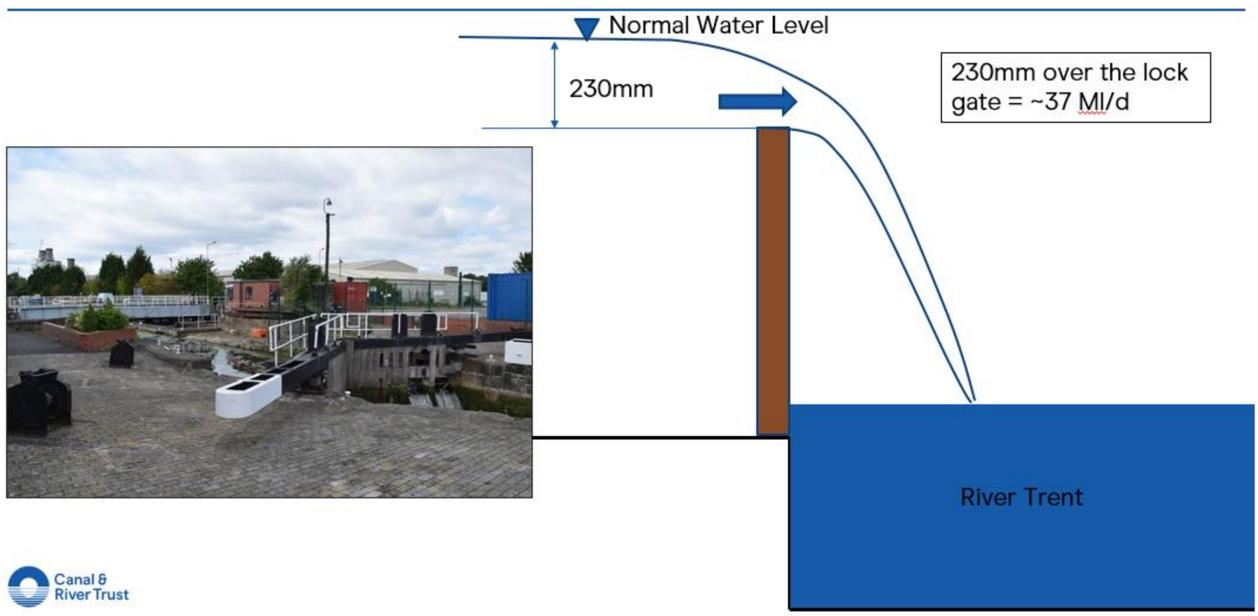


Figure 4: Keadby Lock daily spill volume

Proposed Modification Works at Keadby Lock

In order to make the required volume of water for the Keadby 3 cooling process available for abstraction, changes are required to upgrade Keadby Lock gates. The proposed works are subject to final design but will involve a modification to the top of the existing Keadby Lock gates to increase the threshold level before water overflow into the Trent occurs. As the design has not yet been developed, it has been agreed with the Trust to assume a design level similar to the Zero Level for the purpose of this assessment. This would increase the Keady Lock threshold from 4.12 mAOD to 4.35 mAOD and ensure that water which currently discharges into the River Trent daily is retained in the pound and available for abstraction. This will allow a sufficient volume of water to be available for abstraction whilst maintaining the Zero Level required for navigation. There will be no increased abstraction into the canal system from wider sources, and water that would ultimately drain to the Trent will still do so, but via Keadby 3.

5. Overview of the Water Framework Directive

The WFD, EC Directive 2000/60/EC[3], aims to protect and enhance the quality of the water environment across all European Union (EU) member states. England and Wales have adopted the WFD as national law by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[4]. Following the departure of the United Kingdom from the European Union these regulations continue to apply until they are revoked or superseded by new legislation.

The WFD takes a holistic approach to the sustainable management of water by considering the interactions between surface water, groundwater and water-dependent ecosystems. Ecosystem quality is evaluated according to interactions between biological, physico-chemical and hydromorphological elements (or 'Quality Elements').

Under the WFD, 'Water bodies' are the basic management units and are defined as all or part of a river system or aquifer. Water bodies form part of larger River Basin Districts (RBD), for which River Basin Management Plans (RBMP) are developed and environmental objectives are set. RBMP are produced every six years, in accordance with the river basin management planning cycle. Cycle 2 plans were published in February 2016, and the most recent RBMP data available on the online Catchment Data Explorer is from 2019, which are due to be updated to Cycle 3 plans in 2021 (no updates have yet been published at the time of writing in November 2021).

The WFD requires water bodies to be classified according to their current condition (i.e. the 'Status' or 'Potential,' depending on whether they are heavily modified or artificial water bodies) and to set a series of objectives for maintaining or improving conditions so that water bodies maintain or reach Good Status or Potential.

[3] European Union (2000) Water Framework Directive 2000/60/EC.
[4] HMSO (2017) Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

The Environment Agency is under a duty to exercise its relevant functions so as to best secure that the requirements of WFD for the achievement of environmental objectives are co-ordinated. The Planning Inspectorate's Advice Note 18[5] summarises the overall aims and objectives of the WFD as to:

- Enhance the status and prevent further deterioration of surface water bodies, groundwater bodies and their ecosystems;
- Ensure progressive reduction of groundwater pollution;
- Reduce pollution of water, especially by Priority Substances and Certain Other Pollutants;
- Contribute to mitigating the effects of floods and droughts;
- Promote sustainable water use; and
- Achieve at least good surface water status for all surface water bodies and good chemical status in groundwater bodies by 2015 (or good ecological potential in the case of artificial or heavily modified water bodies).

As a result, new developments that have the potential to impact on current or predicted WFD status are required to assess their compliance against the WFD objectives of the potentially affected water bodies.

In determining whether a development is compliant or non-compliant with the WFD objectives for a water body, the Environment Agency and partnering organisations must also consider the conservation objectives of any Protected Areas (i.e. Natura 2000 sites or water dependent Sites of Special Scientific Interest) and adjacent WFD water bodies, where relevant.

Further details regarding the WFD and how waterbody status/ potential is determined is outlined in **Keadby 3 Environmental Statement Volume II Appendix 12B: Water Framework Directive Assessment Report** – Section 2 [redacted]

Methodology

Guidance on how to undertake WFD assessments can be found in the 'Water Framework Directive risk assessment - How to assess the risk of your activity'[6] and on the You.Gov website. Although the modifications proposed by the Trust are not in their own right a Nationally Significant Infrastructure Project (NSIP), guidance contained in 'The Water Framework Directive - Advice note eighteen: The Water Framework Directive'[5] is also considered relevant best practice. Taken together, these guidance documents have informed the approach taken in this assessment.

A stepwise approach consisting of screening, scoping and impact assessment phases is generally followed in order to: (a) rationalise the levels of WFD assessment and impact mitigation that are required; and (b) verify that proposals meet the requirements of the WFD. The general approach is described by The Planning Inspectorate (2017) and briefly summarised below.

Stage 1 Screening

Screening identifies the zone of influence of a proposed development, and if proposed activities pose a risk to the water environment. It is used to identify if there are activities that do not require further consideration for WFD objectives, for example activities which have been ongoing since before the current RBMP plan cycle and which have thus formed part of the baseline.

Stage 2: Scoping

Scoping is used to identify any potential impacts of the proposed activities to specific WFD receptors and their water quality elements. This involves review of WFD impact pathways, shortlisting which WFD water bodies and quality elements could or could not be affected by proposed activities, and collecting baseline information from the relevant RBMP on the status and objectives for each water body.

Stage 3: Impact Assessment

This involves rationalised assessment of water bodies and quality elements that could be affected by proposed activities, in order to identify any areas of WFD non-compliance. Proposed activities are reviewed in terms of both positive and negative impacts, and the baseline mitigation measures, enhancements, and contributions to the WFD objectives

[5] PINS (2017) Advice Note 18: The Water Framework Directive.
[6] Environment Agency (2016) WFD Risk Assessment: How to Assess the Risk of Your Activity.

described in the RBMP. Any proposed activities with potentially deleterious impacts are reviewed simultaneously with their corresponding mitigation proposals, to determine a net effect on WFD objectives.

Further details regarding the WFD assessment methodology and how waterbody status/ potential is determined can be found in **Keadby 3 Environmental Statement Volume II Appendix 12B: Water Framework Directive Assessment Report** – Section 2. This also includes details on desk study sources and the findings of a site walkover undertaken for the Keadby 3 development on 31 July 2020 which are also considered relevant and applicable in the context of this WFD screening assessment.

The impact assessment is based on a source-pathway-receptor model. For an impact on the water environment to exist the following is required

- an impact source (such as the release of polluting chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or the loss or damage to all or part of a water body);
- a receptor that is sensitive to that impact (i.e. waterbodies and the services they support); and
- a pathway by which the two are linked.

Article 4.7 Derogation

Where the potential for deterioration of water bodies is identified, and it is not possible to mitigate the impacts to a level where deterioration or failure to improve can be avoided, the project would need to be assessed in the context of Article 4.7 of the Directive. For the proposed works considered in this assessment, a derogation under Article 4.7 is not considered necessary.

6. Screening Assessment

The water bodies screened into the assessment have been selected based on the following criteria:

- all surface water and groundwater bodies that may potentially be directly or indirectly impacted by the proposed works; and
- the relevant water bodies have been determined using a Zone of Influence (ZoI) approach, which firstly requires the identification of all potential pathways to an effect on all quality elements, and secondly determination of the extent of the effect (i.e. the ZoI).

Section 2 above provides a brief description of the required works to Keadby Lock to enable the canal water abstraction. All potential pathways to an effect and ZoI have been identified from this understanding of the proposed design. Potential for effects on protected areas associated with the WFD waterbodies has also been considered within the screening assessment.

The proposed works are located within the catchment of the Humber RBMP[7] Table 1 provides a summary of the baseline status/ potential of the WFD waterbodies that have been identified within a 1km ZoI of the proposed works at Keadby Lock. Full WFD status classifications under Cycle 2 (2019) and baseline conditions are presented in **Keadby 3 Environmental Statement Volume II Appendix 12B: Water Framework Directive Assessment Report** – Annex A.

[7] DEFRA (2016) Humber River Basin Management Plan. Available online at [redacted]

Table 1. WFD Surface Water bodies in the Study Area

<table>
<tr><th>Waterbody</th><th>Ecological Status / Potential</th><th>Chemical Status</th><th>Overall Target Objective</th><th>Hydromorphological Designation</th><th>Designated Reach</th></tr>
<tr><td>Humber Upper (GB530402609203)</td><td>Moderate Ecological Potential</td><td>Fail</td><td>Moderate (2015)</td><td>Heavily Modified</td><td>This section of the River Trent is designated from Owston Ferry to the south (approximately 13km upstream of Keadby) to its confluence with the River Ouse approximately 14.5km downstream of Keadby.</td></tr>
<tr><td colspan="6">Site Observations: The Humber Upper waterbody (River Trent) was observed during the site visit from the western bank adjacent to Keadby Power Station, where it flows from the south to the north. Embankments line the river here for flood protection. At this point the waterbody is tidal and has a width of approximately 140m. The river is used for navigation with a wharf at Keadby and the nearest jetty approximately 600m upstream on the east bank near Gunners Wharf. Further details regarding hydrodynamics, tides and sediments are provided in Keadby 3 Environmental Statement Volume II Appendix 12B: Water Framework Directive Assessment Report.
Adjacent to Keadby village there are two existing discharge points into the River Trent from Keadby power station (SE 83536 11647 and SE 83655 12226), with trash screens and bollards to prevent collision from passing boats. The tide was low enough during the site visit to expose intertidal muddy sediments at the channel.
Protected Areas: The river adjacent to Keadby is situated in the Humber Estuary Site of Special Scientific Interest (SSSI), Humber Estuary Special Area of Conservation (SAC) and Humber Estuary Ramsar Site. Nitrates Directive areas S653, S298, S281, S352. Habitats and Species Directive UK0030170 (SAC), Conservation of Wild Birds Directive area UK9006111 (SPA) and Urban Wastewater Treatment Directive area UKENRI130.</td></tr>
<tr><td>Paupers Drain Catchment (trib of Trent) (GB104028064300)</td><td>Moderate Ecological Potential</td><td>Fail</td><td>Moderate (2015)</td><td>Artificial</td><td>Unusually, this waterbody consists of two separate designated watercourses, Warping Drain and Paupers Drain which both flow west to east between Crowle and the River Trent, totalling approximately 13km length and draining an area of around 32.04km^2.</td></tr>
<tr><td colspan="6">Site Observations: Warping drain was observed from the B1392 at SE 83592 12125 where it crosses beneath the road. The watercourse is single thread and approximately 7m wide here and perfectly straight. There was no flow observed due to the tidal lock upstream of the River Trent. The watercourse was extremely turbid and so depth could not be ascertained. There was an algal bloom upstream of the tidal lock indicative of nutrient enrichment. The channel is incised with banks rising relatively steeply away from the channel bed. The banks and riparian zone was densely vegetated as would be expected in summer and provides something of a buffer strip to the arable fields beyond.
Protected Areas: The drain is a designated Local Wildlife Site (LWS) as it supports a population of whorled water-milfoil (Myriophyllum verticillatum). The site is also designated for its wet reed beds with a large population of common reed (Phragmites australis). Nitrates Directive areas S653, S281, S349, S352 and S350. Habitats and Species Directive area UK0030170 (SAC).</td></tr>
<tr><td>North Soak Drain Catchment (trib of Torne/Three Rivers) (GB104028064350)</td><td>Moderate Ecological Potential</td><td>Fail</td><td>Moderate (2015)</td><td>Artificial</td><td>This artificial drain is designated between Thorne and Keadby, where it meets Torne/Three Rivers shortly upstream of the River Trent. It is 26.4km in length and drains a catchment area of 55.641km^2</td></tr>
<tr><td colspan="6">Site Observations: North and South Soak Drains were observed during the site visit at SE 82505 11545 and SE 82487 11450, respectively. Both were approximately 8 m wide and are straight, artificial drainage channels with steep banks, and are located either side of the Stainforth and Keadby Canal. Both were extremely turbid with phytoplankton such that depth could not be ascertained although is expected to a be several metres. There were clumps of algae on the surface and appear nutrient enriched. Fine sediment accumulations were apparent at channel margins in some locations. South Soak Drain is located approximately 3m lower in elevation than the adjacent canal, and the drain supports rich aquatic, emergent and marginal flora.
Protected Areas: The site is a designated LWS for its swamp habitat which is dominated by common reed. Nitrates Directive area S351, S298, S281, S349, S342; Habitats and Species Directive area UK0012915 Thorne Moor.</td></tr>
</table>

<table>
<tr><th>Waterbody</th><th>Ecological Status / Potential</th><th>Chemical Status</th><th>Overall Target Objective</th><th>Hydromorphological Designation</th><th>Designated Reach</th></tr>
<tr><td>Torne/Three Rivers from Mother Drain to Trent (GB104028064340)</td><td>Moderate Ecological Potential</td><td>Fail</td><td>Good (2027)</td><td>Artificial</td><td>This watercourse includes the River Torne, South Engine Drain and Folly Drain. In total, it is designated from the northeast of Rossington and flows generally northwest to meet the River Trent at Keadby. In places the drains move apart and flow parallel to each other. Their combined total length is 50.6km, and they drain a catchment of 85.3km^2.</td></tr>
<tr><td colspan="6">Site Observations: Torne/Three Rivers from Mother Drain to Trent was not visited during the Water Environment walkover.
Protected Areas: Three Rivers is a LWS designated for its three parallel canalised watercourses which support a rich aquatic, emergent and marginal flora. Similarly, the River Torne LWS is designated for supporting a rich aquatic, emergent and marginal flora. It is also designated for its surrounding neutral grassland, purple moor grass and rush pasture and marsh. Nitrates Directive areas S335, S653, S351, S352, S337. Urban Wastewater Treatment Directive area UKENRI99 and Habitats and Species Directive area UK30030166 (SAC).</td></tr>
<tr><td>Sheffield and South Yorkshire Navigation (New Junction and Stainforth and Keadby) (GB70410281)</td><td>Good Ecological Potential</td><td>Fail</td><td>Good (2015)</td><td>Artificial</td><td>The designated reach is 43.8km in length, extending from an offtake from the River Don in the centre of Doncaster to the southwest, to the River Trent immediately southeast of the Keadby 1 power station.</td></tr>
<tr><td colspan="6">Site Observations: This watercourse was visited between the road crossing at SE 82494 11484 and the lock gates between the canal and River Trent at SE 83444 11423. The canal by its nature is artificial and so very straight. At this point it is a wide waterbody at approximately 30m width. There are four sets of lock gates separating the canal from the River Trent, managed by the Canal and River Trust. The canal appeared to be around 1.5m deep with the water being very clear at the time of the site visit. There was an abundance of submerged, floating and emergent macrophytes, and numerous fish were seen in the channel. The canal is used for navigation and water sports, and the towpath is popular for recreation. There is an existing abstraction point from the canal for Keadby 1 at SE 82997 11468, and a new abstraction point for Keadby 2 was being constructed behind a coffer dam during the site visit at SE 82769 11499.
Protected Areas: The Stainforth and Keadby Corridor LWS is designated for a rich aquatic flora throughout its length. The canal is also designated for its mosaic of associated bankside habitats. Nitrates Directive Area S653.</td></tr>
<tr><td>Lower Trent Erewash - Secondary Combined WFD Groundwater Body (GB40402G990300)</td><td>Good Status</td><td>Good Chemical Status</td><td>Good (2027)</td><td>Not applicable</td><td>In relation to the Proposed Development, this waterbody spans the study area to the north of Keadby Common. The overall waterbody is large (1,924km^2) and extends from Ashby-de-la-Zouch to the south to the Humber Estuary to the north.</td></tr>
<tr><td colspan="6">Protected Areas: Nitrate Directive areas Lincolnshire Limestone (G69), Nottinghamshire (G40), Burton (G34); Lower Trent Erewash – Secondary Combined Drinking Water Protected Area (UKGB40402G990300).</td></tr>
<tr><td>Idle Torne - Secondary Mudrocks WFD Groundwater Body (GB40402G992200)</td><td>Good Status</td><td>Good Chemical Status</td><td>Good (2015)</td><td>Not applicable</td><td>In relation to the Proposed Development, this waterbody spans the study area to the south of Keadby Common. The overall waterbody is large (320km^2) and extends from Bilsthorpe to the south to the Swinefleet to the north.</td></tr>
<tr><td colspan="6">Protected Areas: Nitrates Directive area Nottinghamshire (G40); Idle Torn – Secondary Mudrocks Drinking Water Protected Area (UKGB40402G992200)</td></tr>
</table>

WFD water bodies have been screened into this assessment using a ZoI approach and on the basis of whether they are:

- A designated WFD water body within the ZoI (1 km); and
- A designated WFD water body indirectly affected by the ZoI.

WFD Screening of these water bodies in relation to the proposed modification works at Keadby Lock is provided in Table 2. Please note that impacts relating to the proposed water abstraction from Stainforth and Keadby Canal are separately assessed within **Keadby 3 Environmental Statement Volume II Appendix 12B: Water Framework Directive Assessment Report ([redacted]).**

Table 2. Screening of WFD waterbodies potentially impacted by the proposed Keadby Lock modification works

Waterbody ID	Screening Outcome	Justification
Surface Waterbodies:		
Humber Upper (GB530402609203)	In	Given works to the Keadby Lock between Stainforth and Keadby Canal and the River Trent (Humber Upper WFD waterbody) there is potential for direct impacts on the watercourse.
Sheffield and South Yorkshire Navigation (New Junction and Stainforth and Keadby) (GB70410281)	In	Given works to the Keadby Lock between Stainforth and Keadby Canal and the River Trent (Humber Upper WFD waterbody) there is potential for direct impacts on the watercourse.
Paupers Drain Catchment (trib of Trent) (GB104028064300)	Out	There is no identified pathway to impact this waterbody from works to the Keadby Lock
North Soak Drain Catchment (trib of Torne/Three Rivers) (GB104028064350)	Out	There is no identified pathway to impact this waterbody from works to the Keadby Lock
Torne/Three Rivers from Mother Drain to Trent (GB104028064340)	Out	There is no identified pathway to impact this waterbody from works to the Keadby Lock
Groundwater bodies:		
Lower Trent Erewash - Secondary Combined (GB40402G990300)	Out	There is no identified pathway to impact this waterbody from works to the Keadby Lock
Idle Torne - Secondary Mudrocks WFD Groundwater Body (GB40402G992200)	Out	There is no identified pathway to impact this waterbody from works to the Keadby Lock

A screening assessment of the components and activities proposed for the Keadby Lock are considered in Table 3.

Table 3. Screening of the proposed works and activities against WFD quality elements

Activity & Description	Potential Impact	Mitigation	Screening Outcome & Justification
Works to increase the height of Keadby Lock gates - construction workers, vehicles and plant around the Stainforth and Keadby Canal (at Keadby Lock) could be a direct source of fine sediment mobilisation, and this sediment could contain contaminants which are runoff into the canal. Works directly over the watercourse would only consist of modification to the existing lock gate, and no works are proposed within the watercourse itself.	Potential for adverse water quality impacts and subsequent impacts of aquatic ecology from mobilisation of sediments and surface water runoff containing contaminants into Stainforth and Keadby Canal. Could be conveyed downstream to River Trent (Humber Upper WFD waterbody, also a SAC and SSSI). These impacts could impact site designations.	The proposed lock gate modification works are minor in nature and impacts would be very localised and of short duration. They would not require any direct contact with the waterbody, instead being focused on upgrading the existing lock gate above the water level. However, measures to avoid, prevent and reduce adverse effects on the water environment and deal with runoff from surrounding accesses would be included within a Construction and Environmental Management Plan (CEMP) prepared by the Contractor and submitted to the Trust, prior to commencement of construction in line with best practice. The measures included in the Framework CEMP ([redacted]) and in **Keadby 3 Environmental Statement Volume II Appendix 12B: Water Framework Directive Assessment Report –** Section 6 which accompany the DCO Application for Keadby 3 would be used as a reference point by the Contractor, in addition to the measures set out in other guidance by the Trust.	**Screen out impacts to**: - Humber Upper (GB530402609203) - Sheffield and South Yorkshire Navigation (New Junction and Stainforth and Keadby) (GB70410281) Given the small scale and localised nature of the works, and that there is no requirement to physically work within the waterbody, it is anticipated that all residual risk would be adequately mitigated through measures to protect the water environment which will be outlined in the Contractor's CEMP to be approved by the Trust. As such this activity can be screened out of further assessment as it would not have an adverse impact on WFD waterbody status for any element or cause a prevention of future improvement in status. The Stainforth and Keadby Canal LWS comprises a 10km long watercourse and habitat corridor designated for its aquatic and wetland plant interest, and the associated ancillary bank-top scrub and grassland habitats that supplement the biodiversity value of the LWS. The effects on the LWS during construction would be limited to temporary disturbance of a very limited area of channel at Keadby Lock and would therefore not be significant given the large size of the LWS. The minor nature of the proposed modifications mean that any impact would be comparable to or less than that associated with the existing purpose and operation of the lock gate. While the boundary of the Keadby Lock intersects the boundary of the River Trent and therefore the Humber Estuary SSSI, SAC and Ramsar site, these designated areas would not be affected during implementation of the proposed minor modifications to increase the height of the Lock gate. The modifications can be achieved without works within the boundary of these designations, so there would be no loss or disturbance of habitats within the designations, particularly given implementation of measures in the CEMP.
During construction works to increase the height of the Keadby Lock Gate, fuel, hydraulic fluids, solvents, grouts, paints and detergents and other potentially polluting substances may be used on Site. Leaks and spillages of these substances could	Potential for adverse water quality impacts and subsequent impacts of aquatic ecology from accidental spillages into Stainforth and Keadby Canal. Pollutants could be conveyed downstream to River Trent (Humber Upper	The required works would be very localised and short in duration. They would not require any direct contact with the waterbody, instead being focused on the existing lock gate above the water level. However, measures to avoid, prevent and reduce adverse effects on the water environment and deal with spillages (including emergency response plans)	**Screen out impacts to**: - Humber Upper (GB530402609203) - Sheffield and South Yorkshire Navigation (New Junction and Stainforth and Keadby) (GB70410281) Given the small scale and localised nature of the works, and that there is no requirement to physically enter the waterbody, it is anticipated that all residual risk would be adequately mitigated through measures to protect the water environment to be outlined in the Contractor's CEMP.

Activity & Description	Potential Impact	Mitigation	Screening Outcome & Justification
pollute the nearby surface watercourses if their use or removal is not carefully controlled, and spillages could enter existing flow pathways or water bodies directly.	WFD waterbody). These impacts could affect site designations.	would be included within the CEMP prepared by the Contractor, prior to commencement of construction in line with best practice.	As such this activity can be screened out of further assessment as it would not have an adverse impact on WFD waterbody status for any element or cause a prevention of future improvement in status. The effects on the Stainforth and Keadby Canal Corridor LWS during construction would be limited to temporary disturbance of a very limited area of channel at Keadby Lock and would therefore not be significant given the large size of the LWS. The minor nature of the proposed modifications mean that any impact would be comparable to or less than that associated with the existing purpose and operation of the lock gate. The modifications can be achieved without works within the boundary of the Humber Estuary designations, so there would be no loss or disturbance of habitats within the designations, particularly given implementation of measures in the CEMP.
During construction works to Keadby Lock, there is the potential for Invasive Non-Native Species (INNS) to spread to other sites (including WFD waterbodies) via plant and machinery.	Potential for spread of INNS to other location via plant and machinery. This might include the River Trent (Humber Upper waterbody) but may also include off site locations where machinery and plant are next used.	During construction, appropriate controls would be in place to limit the potential for INNS which are known to be present within the Stainforth and Keadby Canal from spreading via plant and machinery onto other sites. Measures will be outlined in an Invasive Species Management Plan (ISMP) which will form part of the Contractor's CEMP. The measures included in the Framework CEMP ([redacted])) and in Keadby 3 Environmental Statement Volume II Appendix 11G: Aquatic Ecology Survey Report ([redacted])– which accompany the DCO Application for Keadby 3 would be used as a reference point by the Contractor in addition to the measures set out in other guidance by the Trust.	**Screen out impacts to**: - Humber Upper (GB530402609203) - Sheffield and South Yorkshire Navigation (New Junction and Stainforth and Keadby) (GB70410281) Given mitigation measures outlined in the ISMP to be produced by the Contractor as part of the CEMP, then risk of spreading INNS would be expected to be negligible and would not adversely impact on WFD classifications or future objectives.
During operation the Keady Lock threshold level will increase from 4.12 mAOD to 4.35 mAOD and ensure that water which currently is able to discharge into the River Trent is retained in the canal, allowing a sufficient volume	Increased level of Stainforth and Keadby Canal leading to reduced flow through to River Trent (Humber Upper WFD waterbody). Potential to change physico-chemical properties (e.g. dissolved	There is no designed mitigation required for this potential impact, given that water will continue to leave the canal but via the abstraction route rather than directly over Keadby Lock.	**Screen out impacts to**: - Humber Upper (GB530402609203) - Sheffield and South Yorkshire Navigation (New Junction and Stainforth and Keadby) (GB70410281) No adverse impacts against WFD classifications or future objectives are anticipated given that the required works are minimal (in order to

Activity & Description	Potential Impact	Mitigation	Screening Outcome & Justification
of water to be available for abstraction whilst maintaining the Zero Level.	oxygen levels) or potential to lead to increased build-up of nutrients or pollutants. However, the current water loss to the River Trent should be regarded as leakage. The established function of the existing lock gate is to retain water within the canal except when the lock is in operation. Furthermore, there will be a new abstraction to Keadby 3 of up to 27.4 Ml/d, as well as the Keadby 2 abstraction which has yet to commence as the scheme is under construction. As such, there will continue to be a significant flow of water out of the canal, albeit via the abstractions rather than directly into the River Trent (Humber Upper WFD waterbody).		prevent leakage of water from the lock), and that water will continue to pass through the canal via the abstraction. The minor nature of the proposed modifications means that any impact on the Stainforth and Keadby Canal LWS would be comparable to or less than that associated with the existing purpose and operation of the lock gate. The banks of the River Trent at this location are heavily modified and would be unchanged by these proposed works, while the channel of the river at the lock gate is already affected by the established use of the lock gate. The proposed modifications would not alter the established use and conditions of the River Trent at this location. No impacts to the designations are therefore anticipated. The water utilised for Keadby 3 will still be discharged into the tidal River Trent on transit from the cooling system (albeit subject to some evaporative losses). The effects of use and discharge of cooling water on habitats within the River Trent have been assessed as part of **Keadby 3 Environmental Statement Volume II Appendix 12B: Water Framework Directive Assessment Report**

7. Conclusion

In conclusion, taking into consideration the minor nature of the works proposed by the Trust to Keadby Lock and the mitigation measures that are also being proposed including a Contractor CEMP, it is considered that no significant adverse impacts will occur to all identified WFD waterbodies (principally the Sheffield and South Yorkshire Navigation (New Junction and Stainforth and Keadby) and Humber Upper WFD waterbodies) meaning that non-compliance with the WFD objectives is unlikely, and no further assessment is required (i.e. it can be screened out).

There are no direct works to other watercourses/ waterbodies to construct the changes to Keadby Lock, and best practice mitigation measures outlined in the CEMP and ISMP would prevent an impact on WFD classifications (for ecological, hydromorphological or physico-chemical quality elements) during construction and would not prevent future objectives being achieved.

Similarly, no operational impacts have been identified that would adversely impact WFD classifications or future objectives.

Furthermore, no impact on the designated ecological sites related to the Stainforth and Keadby Canal or River Trent have been identified, given the mitigation measures.

On the basis of this screening assessment, it is not considered necessary to proceed to Stage 2 (Scoping) or Stage 3 (Impact Assessment) as described in the Planning Inspectorate's Advice Note Eighteen[8].

[8] PINS (2017) Advice Note 18: The Water Framework Directive

Appendix 1. Surface Waterbodies and their Attributes Figure

APPENDIX C: SCHEDULED MONUMENT CONSENT APPLICATION HERITAGE IMPACT ASSESSMENT

Keadby Lock

Scheduled Monument Consent Application
Heritage Impact Assessment

Project number: 60665962

14 January 2022

Delivering a better world

Quality information

Prepared by	Checked by	Verified by	Approved by
[redacted]			
Dr Gillian Scott Principal Heritage Consultant	Mark Service Principal Heritage Consultant	Amy Jones Technical Director – Heritage	Susan Evans Associate– EIA

Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	02-02-22	Amendment following client review	[redacted]	Susan Evans	Associate - EIA

Distribution List

# Hard Copies	PDF Required	Association / Company Name

Prepared for:

Canal & River Trust

Prepared by:

Dr Gillian Scott
Principal Heritage Consultant
E: [redacted]@aecom.com

AECOM Limited
One Trinity Gardens, First Floor
Quayside
Newcastle-upon-Tyne NE1 2HF
United Kingdom

T[redacted]

Table of Contents

Figures

1. Introduction

Background

1.1 This Heritage Impact Assessment accompanies a draft application for Scheduled Monument Consent (SMC) concerning proposed modifications to the lock gates at Keadby Lock Scheduled Monument [NHLE: 1005204] and Grade II listed building [NHLE: 1342734] ('the proposed works'). The proposed works form part of a proposed water management scheme for the Stainforth & Keadby Canal. The Canal & River Trust (hereafter 'the Trust') wish to supply additional water into the pound above Keadby Lock to be abstracted by a third party. The proposed abstraction, by Keadby Generation Limited, would be used to supply cooling water to the proposed Keadby 3 Carbon Capture Power Station. A Development Consent Order (DCO) application for Keadby 3 Carbon Capture Power Station has been submitted to the Secretary of State for Business, Energy and Industrial Strategy, under Section 37 of 'The Planning Act 2008 and is going through Examination at the time of writing. The proposal is to raise the lock gates at the top gates of Keadby Lock by 300mm to prevent water being lost into the River Trent when water levels are high in the canal. This water efficiency proposal would supply sufficient additional water required for abstraction in line with the principles of sustainable development[1].

1.2 This report has been prepared in order to assess the impact of the proposed modifications on the heritage significance and special interest of the Keadby Lock Scheduled Monument [NHLE: 1005204] and Grade II listed building [NHLE: 1342734]. This report conforms to the requirements of the National Planning Policy Framework (2021) and has been prepared in accordance with the guidance published in 2019 by Historic England in Statements of Heritage Significance: Analysing Significance in Heritage Assets.

Objectives

This Heritage Impact Assessment identifies heritage constraints associated with the proposed works and provides relevant and proportional mitigation strategies to reduce the impact where required. The objectives of this document are as follows:

- to place the proposed works within their legislative and policy context;
- to provide an assessment of the significance of Keadby Lock;
- to minimise harm to the heritage significance and special interest of Keadby Lock through sensitive design; and
- to assess the impact of the proposed works on the significance and special interest of Keadby Lock.

Site Location

Keadby Lock is located in the Parish of Keadby with Althorpe, approximately 4km west of the town of Scunthorpe, North Lincolnshire at NGR se 83495 11415. The lock forms the connections between the Stainforth and Keadby Canal and the River Trent and consists of a single lock basin with two alternating pairs of gates.

The proposed works relate to the top lock gates, shown in Figures 1-4. These are furthest upstream of four sets of gates at Keadby. The gates are named in order from west to east as follows: top gates; upstream middle gates; downstream middle gates; and flood gates.

[1] In accordance with National Planning Policy Framework (2021) paragraph 8.c) *'Achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways (so that opportunities can be taken to secure net gains across each of the different objectives) – c) an environment objective – to protect and enhance our natural, built and historic environment; **including making effective use of land**, improving biodiversity, **using natural resources prudently**, minimising wastes and pollution and mitigating and adapting to climate change, including **moving to a low carbon economy**.'*

Figure 1 - Site location (image Arcadis 2022 after Google Earth™).

Figure 2- Map showing the designations at Keadby Lock Scheduled Monument [NHLE: 1005204] and Grade II listed building [NHLE: 1342734] (image Arcadis 2022 after Historic England).

Figure 3 - Downstream face of the top lock gates to be modified at Keadby Lock (image Arcadis 2022)

Figure 4 - Upstream face of the top lock gates to be modified at Keadby Lock (image Arcadis 2022)

2. Legislation and Planning Policy

Legislation

Ancient Monuments and Archaeological Areas Act 1979

2.1 The Ancient Monuments and Archaeological Areas Act (1979) ('the Act') is the central piece of legislation for the protection of the archaeological resource. The first section of the Act requires the Secretary of State for National Heritage to maintain a schedule of nationally important sites. For the purpose of the Act, a monument is defined as:

> *"a) any building, structure or work, whether above or below the surface of the land, and any cave or excavation;*
>
> *b) any site comprising the remains of any such building, structure or work or of any cave or excavation;*
>
> *c) any site comprising, or comprising the remains of, any vehicle, vessel, aircraft or other moveable structure or part thereof which neither constitutes nor forms part of any work which is a monument as defined within paragraph a) above; and*
>
> *d) any machinery attached to a monument shall be regarded as part of the monument if it could not be detached without being dismantled' (Section 61 (7))."*

2.2 The Act further defines an ancient monument as: "*any Scheduled Monument; and any other monument which in the opinion of the Secretary of State is of public interest by reason of the historic, architectural, traditional, artistic or archaeological interest attaching to it' (Section 61 (12)).*"

2.3 A set of criteria, defined as survival/ condition, period, rarity, fragility/ vulnerability, diversity, documentation, group value and potential, assist in the decision-making process as to whether an asset is deemed of national importance and best managed by scheduling.

Planning (Listed Buildings and Conservation Areas) Act 1990

2.4 The Planning (Listed Buildings and Conservation Areas) Act 1990 (as amended) is the principal statutory instrument which must be considered in the determination of any application affecting listed buildings and conservation areas.

2.5 Under this legislation, local planning authorities and the Secretary of State are required to have special regard to the desirability of preserving a listed building, its setting, or any features of special architectural or historic interest that it possesses. It also places a duty on local planning authorities to publish proposals for their conservation areas and exercise their planning functions in a manner that gives regard to the desirability of preserving and enhancing the character or appearance of these areas.

2.6 Section 61 of the Act outlines that where a building is both listed and scheduled, the Ancient Monuments and Archaeological Areas Act 1979 takes precedence and Scheduled Monument Consent, rather than listed building consent is required for any proposed alterations.

National Planning Policy

National Planning Policy Framework (NPPF)

2.7 The NPPF (Ministry of Housing, Communities and Local Government, 2021) sets out the Government's planning policies for England and how these should be applied to contribute to the achievement of sustainable development. While the Environmental Impact Assessment (EIA) methodology forms part of a separate planning regime, the planning decision still takes account of national guidance. As such, it important to understand where the development fits within this. 2.5 Section 16 of the NPPF deals specifically with the historic environment. Where changes are proposed, the NPPF sets out a clear framework to ensure that heritage assets are conserved, and where appropriate enhanced, in a manner that is consistent with their significance.

2.8 The NPPF sets out the importance of being able to assess the significance of heritage assets that may be affected by a development. Significance is defined in Annex 2 as being the, “value of a heritage asset to this and future generations because of its heritage interest. That interest may be archaeological, architectural, artistic or historic”. Significance is not only derived from an asset's physical presence, but also from its setting. The setting of a heritage asset is defined in Annex 2 as, “the surroundings in which a heritage asset is experienced. Its extent is not fixed and may change as the asset and its surroundings evolve”.

2.9 Paragraph 194 of the NPPF states that in determining applications, local planning authorities should require an applicant to describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the assets’ importance and no more than is sufficient to understand the potential impact of the proposal on their significance. Similarly, paragraph 195 includes a requirement on local planning authorities, having assessed the particular significance of any heritage asset that may be affected by a proposal, to take this into account when considering the impact of a proposal on a heritage asset.

2.10 In determining planning applications, local planning authorities should take account of the following points:

- the desirability of sustaining and enhancing the significance of heritage assets and putting them to viable uses consistent with their conservation;
- the positive contribution that conservation of heritage assets can make to sustainable communities including their economic vitality;
- the desirability of new development making a positive contribution to local character and distinctiveness (paragraph 192); and
- opportunities to draw on the contribution made by the historic environment to the character of a place.

2.11 Paragraphs 199 to 203 of the NPPF introduce the concept that heritage assets can be harmed or lost through alteration, destruction or development within their setting. This harm ranges from less than substantial through to substantial. With regard to designated assets, paragraph 199 states that great weight should be placed on its conservation, irrespective of whether any potential harm is considered to be substantial or less than substantial. The paragraph goes further to say that the more important the asset, the greater the weight should be on its conservation. In paragraph 200, a distinction is made in respect of those assets of the highest significance (e.g. scheduled monuments, Grade I and Grade II* listed buildings) where substantial harm to or loss should be wholly exceptional.

2.12 Paragraph 201 states that in instances where development would cause substantial harm to or total loss of significance of a designated asset, consent should be refused unless it can be demonstrated that it is necessary to achieve substantial public benefits that outweigh that harm or loss. Paragraph 202 says in instances where development would cause less than substantial harm to the significance of a designated asset, the harm should be weighed against the public benefits of the proposal to provide a balanced judgement.

Local Planning Policy

2.13 The Proposed Development Site lies entirely within the administrative area of North Lincolnshire Council. The statutory development plan for the area currently comprises the following documents:

- North Lincolnshire Core Strategy (NLC, 2011a) - adopted June 2011;
- Housing and Employment Land Allocations (NLC, 2017) - adopted March 2016; and
- Saved Policies of the North Lincolnshire Local Plan (North Lincolnshire Council, 2007) - adopted May 2003, saved September 2007.

2.14 North Lincolnshire historic environment planning policies relevant to the current application include the following saved policies from the 2003 Local Plan.

- Policy HE5: Development affecting Listed Buildings. The policy states that ‘proposals which damage the setting of a listed building will be resisted’ (North Lincolnshire Council 2003, 204).

- Policy HE8: Ancient Monuments. The policy states that proposals that would result in an adverse effect on the setting of a 'scheduled ancient monument' will not be permitted (North Lincolnshire Council 2003, 206).

2.15 The North Lincolnshire Core Strategy (adopted June 2011) includes Policy CS6 Historic Environment stating the following [extract]:

> *"The council will promote the effective management of North Lincolnshire's historic assets through…preserving and enhancing the rich archaeological heritage of North Lincolnshire.*
>
> *The council will seek to protect, conserve and enhance North Lincolnshire's historic environment, as well as the character and setting of areas of acknowledged importance including historic buildings, conservation areas, listed buildings (both statutory and locally listed), registered parks and gardens, scheduled ancient monuments and archaeological remains.*
>
> *All new development must respect and enhance the local character and distinctiveness of the area in which it would be situated, particularly in areas with high heritage value".*

2.16 North Lincolnshire Council is currently preparing a new single Local Plan for North Lincolnshire. Once formally adopted, this will replace the existing North Lincolnshire Local Plan and Core Strategy. Policy HE1p will apply to all scheduled monuments in the plan area. Policy HE1p states the following:

> *"Development proposals affecting archaeological remains, whether known or potential, designated or undesignated, should take every practical and reasonable step to protect and, where possible, enhance their significance.*
>
> *Planning applications for such development must be accompanied by an appropriate and proportionate desk based assessment to understand the potential for and significance of remains, and the impact of development upon them.*
>
> *If desk based assessment does not provide sufficient information, developers will be required to undertake field evaluation in advance of determination of the application. This may include a range of techniques for both intrusive and non-intrusive evaluation, as appropriate to the site. All archaeological work should be undertaken by a suitably qualified party in accordance with professional standards and guidance published by Historic England and the Chartered Institute for Archaeology.*
>
> *Wherever possible and appropriate, mitigation strategies should ensure the preservation of archaeological remains in-situ. Where this is either not possible or not desirable, the developer will be required to make adequate provision for preservation by record according to a written scheme of investigation submitted by the developer and approved by the planning authority.*
>
> *Any work undertaken as part of the planning process must be appropriately archived in a way agreed with the local planning authority. The written scheme of investigation should be submitted in advance of determination of the application and its implementation will be secured by condition' (North Lincolnshire Council 2020, Policy HE1p)".*

3. Guidance

Planning Practice Guidance (PPG)

3.1 The PPG (Ministry of Housing, Communities and Local Government, 2019) provides further advice and expands on the guidance and policy outlined in the NPPF.

3.2 Significance of heritage assets and its importance in decision taking is explored in Paragraph 009 of the PPG which states that heritage assets may be affected by direct physical change or by change in their setting. Being able to properly assess the nature, extent and importance of the significance of a heritage asset, and the contribution of its setting, is very important to understanding the potential impact and acceptability of development proposals (ID 18a-009-20140306 Last updated 23 07 2019).

3.3 The PPG discusses how to assess if there is substantial harm. It states that what matters in assessing if a proposal causes substantial harm is the impact on the significance of the heritage asset. Ultimately, whether a proposal causes substantial harm will be a judgement for the decision taker. However, it acknowledges that substantial harm is a high test so may not arise in many cases. A key consideration when assessing whether there is an adverse impact on a listed building is whether the adverse impact seriously affects a key element of its special architectural or historic interest. It is the degree of harm to the asset's significance rather than the scale of the development that is to be assessed (Paragraph: 017 Reference ID: 18a-017-20140306).

Historic England Guidance

3.4 Historic England has published a series of Good Practice Advice (GPA), of which those of most relevance to this appraisal are GPA2 - *Managing Significance in Decision-taking* (March 2015), GPA3 - *The Setting of Heritage Assets* (2nd Edition) (December 2017a) and Advice Note 12 *Statements of Heritage Significance* (2019).

3.5 GPA2 emphasises the importance of having a knowledge and understanding of the significance of heritage assets likely to be affected by the development and that the *"first step for all applicants is to understand the significance of any affected heritage asset and, if relevant the contribution of its setting to its significance"* (paragraph 4). Early knowledge of this information is also useful to a local planning authority in pre-application engagement with an applicant and ultimately in decision making (paragraph 7).

3.6 GPA3 provides advice on the setting of heritage assets. Setting is as defined in the NPPF and comprises the surroundings in which a heritage asset is experienced. Elements of a setting can make positive or negative contributions to the significance of an asset and affect the ways in which it is experienced. Historic England state that setting does not have a boundary and what comprises an asset's setting may change as the asset and its surroundings evolve. Setting can be extensive and, particularly in urban areas or extensive landscapes, can overlap with other assets. The contribution of setting to the significance of an asset is often expressed by reference to views and the GPA in paragraph 11 identifies those views, such as those that were designed, or those that were intended, that contribute to understanding the significance of assets.

3.7 Historic England published Advice Note 12 (HE 2019) which outlines a recommended approach to assessing the significance of heritage assets in line with the requirements of NPPF. It includes a suggested reporting structure for a 'Statement of Heritage Significance,' as well as guidance on creating a statement that is proportionate to the asset's significance (heritage value) and the potential degree of impact of a proposed scheme.

Chartered Institute for Archaeologists

3.8 The baseline study has been undertaken in accordance with guidance published by the Chartered Institute for Archaeologists (CIfA), with specific regard to the Standard and Guidance for Historic Environment Desk-based Assessment (CIfA 2020) and the Code of Conduct (CIfA 2019).

IEMA Principles of Cultural Heritage Impact Assessment in the UK

3.9 Principles of Cultural Heritage Impact Assessment in the UK (IEMA 2021) is a guide to good practice in cultural heritage impact assessment published jointly by the Institute of Environmental Management and Assessment (IEMA), the Institute of Historic Building Conservation (IHBC) and the Chartered Institute for Archaeologists (CIfA). The document provides guidance on understanding cultural heritage assets and evaluating the consequences of change.

3.10 Understanding cultural heritage assets is split into three stages: Description, Significance and Importance. The description arrives at a factual statement that establishes the nature of the asset. The heritage values of the asset are then analysed (the guidance stresses that these include but are not limited to aesthetic, historic, scientific, social or spiritual values) and a statement of cultural significance given. Finally, the importance of the asset is assessed, and a conclusion drawn as to the level of protection that the asset merits in planning policy and cultural heritage legislation. The guidance notes that, unlike cultural significance, importance is scaled and can be described as high, medium or low.

3.11 The process of evaluating the consequences of change is split into three stages: Understanding change, Assessing impact and Weighting the effect. All aspects of a proposal that have the ability to change a cultural heritage asset or its setting are first explained. If these changes affect the cultural significance of the asset the resulting impact, which could be positive or negative, and its magnitude is then assessed. The effect is a combination of the magnitude of the impact and the cultural heritage asset's importance, and the scale of the effect will determine by how much the issue should influence the design of the proposal and whether the proposal is acceptable and will be permitted.

4. Methodology

Defining Significance

4.1 A methodology for the assessment of significance of heritage assets is outlined in Historic England's Advice Note 12 (Historic England 2019) whilst Historic England GPA3 (2017a) provides the basis of a methodology for the assessment of setting and how it contributes to significance. The NPPF defines significance as *"The value of a heritage asset to this and future generations because of its heritage interest. That interest may be archaeological, architectural, artistic or historic. Significance derives not only from a heritage asset's physical presence, but also from its setting"*.

4.2 Significance is often established by statutory designations such as listed buildings, scheduled monuments and conservation areas. More particular advice as to what makes up significance is set out in Historic England's Advice Note 12 (Historic England 2019), which provides a methodology for thinking consistently about the heritage values that can be ascribed to a place and defines those heritage interests as follows:

- Archaeological interest: there will be archaeological interest in a heritage asset if it holds, or potentially holds, evidence of past human activity worthy of expert investigation at some point.
- Architectural interest: these are interests in the design and general aesthetics of a place. They can arise from conscious design or fortuitously from the way the heritage asset has evolved. More specifically, architectural interest is an interest in the art or science of the design, construction, craftsmanship and decoration of buildings and structures of all types.
- Artistic interest: this is an interest in other human creative skills, like sculpture.
- Historic Interest: An interest in past lives and events (including pre-historic). Heritage assets can illustrate or be associated with them. Heritage assets with historic interest not only provide a material record of our nation's history but can also provide meaning for communities derived from their collective experience of a place and can symbolise wider values such as faith and cultural identity.

4.3 This impact assessment is focused on Keadby Lock. To define the significance of the asset, research into the history of the canal and lock has been undertaken using historic maps, photographs and primary and secondary documents. A discussion of the lock's historic background is provided in Section 5, together with information on its development over time including historic and recent alterations. This information is used to define the asset's significance using the terminology provided above in Section 6. By defining significance in this way, modifications can be designed sensitively to conserve and enhance the significance of heritage places.

Consultation

4.4 Consultation was undertaken with Historic England via a virtual meeting platform on 9th December 2020. This focused on the purpose of the scheme, a discussion of design options, and agreement of the documentation that would be required to accompany an application for Scheduled Monument Consent.

4.5 All options considered for the proposed development are presented in the Options Appraisal Report (Arcadis 2022). Consultation identified Option 1 as Historic England's preferred option for this modification to the gates, but Option 2 was also identified as the preferred option for the gates if they are to be replaced in their entirety in the future.

4.6 It was agreed that the following documentation would be submitted as part of the Scheduled Monument Consent application:

- Cover letter outlining the need for the scheme;
- Options Appraisal showing the design development and selection, as well as providing information on control measures in place for dealing with overflow, should abstraction cease;
- Heritage Impact Assessment (this document); and
- Completed Application form with signed Certificate 2(1)(a) to comply with Paragraph 2(1) of Schedule 1 of the Ancient Monuments and Archaeological Act 1979.

5. Heritage Baseline

Listing Description

5.1 The Lock is a scheduled monument [NHLE: 1005204] however no formal description of the monument is currently available on Historic England's online NHLE. The lock is also a Grade II listed building [NHLE: 1342734], and the listing description for the asset is as follows:

"Tidal canal lock and abutments for former swing bridge. 1793-1802 for the Stainforth and Keadby Canal; new lock gates and sills fitted 1932; concrete platform, lock-keeper's hut and sheet steel pilings to river front of 1970s- 80s. Ashlar-faced lock basin and bridge abutments. Timber lock gates with iron railings. Aligned east-west, with River Trent to east. Single lock basin with 2 alternating pairs of gates; the outer flood gates nearly 8 metres high. Lock wall has depth gauge in Roman numerals inscribed on north side beside outer flood gates, and inscription to centre of north side recording fitting of new gates and sills in August 1932. To west of lock are abutments for former swing road bridge with curved recessed retaining walls to north and south, and coped stone wall to southern entrance with wooden and iron barred gate. C20 swing road bridge to west, and brick walls around lock are not included in the listing. The Stainforth and Keadby Canal, built to by-pass the lower reaches of the River Don, was purchased by the South Yorkshire Railway Co which opened a line along the north canal bank in 1859. Its terminus beside Keadby Lock was superseded in 1864 when the line was diverted to Keady Bridge a mile to the south."
([redacted]

Historical Background

5.2 Throughout the medieval period, the Keadby area is likely to have been marshland, used as summer pasture and exploited for the rich fishing and hunting resources that such an environment provides. In the post-medieval period however, a systematic drainage programme was initiated, converting areas of marshland and moorland into organised, drained and fertile enclosures to create an entirely new landscape. The work comprised the cutting of new drains, construction of dykes, and re-directing the flow of the island's bounding rivers, and warping systems. The ambitious programme, begun in the 1620s, was designed by Cornelius Vermuyden, who had been commissioned by Charles I to drain the land. Vermuyden redirected the flow of the Rivers Idle, Torne and Don, by channelling them in large straight dykes into the River Trent. A later addition consisted of the creation of the 'New Idle River' or Keadby Drain', running south-west to north-east to a new sluice gate south of Keadby village.

5.3 In 1792 the Stainforth and Keadby Canal Navigation Company obtained an Act of Parliament to cut the non-tidal Stainforth and Keadby Canal. It was engineered by John Thompson (Surveyed 1772, engineer 1792-95) and Daniel Servant (Historic England 2017c) and opened in 1802. It bypassed the lower reaches of the River Don and linking the River Don at Bramwith with the River Trent via Stainforth, Thorne and Ealand. This enabled a waterway navigation for the industries of South Yorkshire and Nottinghamshire (Van de Noort and Ellis 1998). Drains were cut either side of the canal (the North and South Soak Drain) due to its disrupting the existing drainage system, and the runoff was carried to Keadby outfall (ibid). A bridge was constructed over the canal, at the western end of Chapel Lane, and a swing bridge operated at its eastern end, at its confluence with the River Trent (Le Quesne 2015). It had three locks; one at the beginning of the canal at Bramwith; one at Thorne; and the other at Keadby, the eastern terminus of the canal at its junction with the River Trent. Keadby Lock comprised a single, pound-type lock basin, constructed in stone ashlar, with two opposing sets of timber gates meaning that the lock could be used whether the level of the river was higher or lower than in the canal. The lock could take vessels with keels up to 81 by 22.5 feet, although longer vessels could pass through if the river was level with the canal and both sets of gates could be opened. This was an important facility for the boatbuilding industry on the canal, which was otherwise limited in its vessel size by the limit of the lock. To the immediate west of the lock there was originally a swing bridge, but only the bridge abutments now remain.

5.4 The Don Navigation Company bought the canal in 1836 after a series of aborted attempts to construct new navigations to by-pass it. In 1850 the Don Navigation Company was merged with the Doncaster and Goole Railway company to become the South Yorkshire Railway Company. In 1859 they opened a railway line along its north bank, but the canal was still a busy navigation during this time. Initially the railway terminus was at the lock, but in 1864 it was diverted south across the canal to the original Keadby Swing Bridge (later replaced with the existing Keadby Bridge. As the 19th century progressed, however, there was growing dissatisfaction with the canal and its use began to decline. In an effort to save the canals and make them competitive with the railways, the Sheffield and South Yorkshire Canal Company Ltd. was formed in 1888 with a view to buying back the canals from the railway company and upgrading them. Plans were drawn up to upgrade the Don Navigation and the Stainforth and Keadby Canal to take 300- or 400-ton barges and to build a new port facility at Keadby, where coal could be trans-shipped to seagoing vessels. These plans never came to fruition however due to protracted dealings with the railway companies, whilst ownership of the waterways had been transferred to the Sheffield and South Yorkshire Canal Company, the railway company still nominated five of the ten directors, and thus retained significant control. Instead, a jointly funded project to build a canal from Bramwith to the Aire and Calder was progressed and in 1905 the New Junction Canal was opened. It was completely straight, and was the last canal built in England for commercial purposes (Historic England 2017c, 49). This removed the need to build a new port at Keadby.

5.5 The 20th century history of the canal is a story of slow decline, although the lock gates and sills at Keadby were replaced in 1932 according to an inscription on the lock. The current road swing bridge was also added in the 1930s. Nationalisation of the Stainforth and Keadby Canal took place in 1948 in common with most other canals in Britain. The Transport Acts of 1968 and 1983 divided British canals into commercial waterways, which were still carrying commercial traffic, cruising waterways, which had potential for leisure use, and remainder waterways, for which no economic use could be seen at the time. The Stainforth and Keadby Canal was designated as a commercial waterway, and traffic was restricted to working boats carrying freight. The area around Keadby Lock was developed in the 1970s and 1980s with the addition of a lockkeeper's hut. Steel sheet pilings were added to the river front. As the 20th century progressed this gradually changed with all use of the canal now being predominately leisure boats. In 2012 the Canal & River Trust were created, and they took over all of the assets of British Waterways including the Stainforth and Keadby Canal and Keadby Lock.

5.6 The lock was designated as a listed building in 1987, when the description presented in Section 5.1 of this report was written. The date of its designation as a scheduled monument is not available on Historic England's online record. The Historic England Archive holds one photographic image of the lock dated to 1999 [redacted] This shows the westernmost set of gates that are the focus of this assessment and the gates shown are not the same gates as those now present at the site. A review of main works and maintenance works undertaken at the lock between 1997 and 2021 is provided in Appendix A of this report. This demonstrates a process of continued maintenance and evolution at the lock to ensure it continues to meet the needs of its present uses. An application for scheduled monument consent was made in the 2003 for full mechanisation of the lock and in 2005 for stabilisation and strengthening works. These works included replacement of the lock gates, which was carried out in 2005/6. A building recording of the lock was undertaken by Mercian Archaeology in 2003, as part of the conditions of consent, but it has not been possible to find an archived copy of the resulting report. It therefore appears that the present lock gates are likely to have been installed in the early 2005/6 as part of this work and they are not the surviving gates from 1932 described in the 1987 listing description. This is borne out in examination of the present lock gates (see Figures 3-4). The ironwork may be a survival from 1932, but the timber gates themselves appear much newer, fitting with a date in the early 2000s. The original timber balance beams have also been replaced in steel across the majority of the gates. The only remaining timber balance beam is on the downstream middle gates (cabin side). That timber beam was original until 2017, when it was replaced with a new oak beam in accordance with the Section 12 Scheduled Monument Management Agreement (SMMA).

5.7 There are four sets of matching lock gates at Keadby, all of the same design, except for the downstream middle gates where there is a replacement timber balance beam instead of the steel replacement beams seen on the other gates). They comprise perforated timber gates with steel balance beams and gate paddles. A timber walkway is fitted with a metal guard rail to the topside. The gates are constructed of timber upright posts that are linked on the rear sides by horizontal timber rails. The rails are jointed to the uprights with a dado joints and heavy-gauge square-section iron nails and straps. Spaces between the upright posts create the perforation. At the top of the gate these are called fenders and they prevent boats from getting stuck between the top bar of the gate and the balance beam. The fenders are a modification to the original gate design. The lower sections of the gates and sill were not visible at the time of inspection, but it is assumed that gate paddles are still present in the lower third of the gates. As can be seen in Figure 3, water currently overtops the mid-rail of the top gates at Keadby and flows through the perforation when the gates are closed. This is not the correct operation of the gates and it will lead to more rapid deterioration of the gates over time and can also create flooding problems for full length boats attempting to use the lock. As well as allowing for a greater capacity of water in the canal behind the gates, the proposed development will also assist with this overtopping issue.

6. Statement of Significance

6.1 The designation of the Lock as a scheduled monument and Grade II listed building demonstrates that it has been previously assessed by the Secretary of State as being of special interest. The specific reasons for this designation are not provided in the online listing description. The Lock draws its significance from its architectural and illustrative historical interests as a well-preserved section of the British canal network, demonstrating late-18th century engineering and technical innovation. The Stainforth and Keadby Canal, whilst quite late in the date range of British canal construction (1745-1835), was built during the peak period of canal construction in the 1790s. By this time the success of the canals, both in supporting trade and industry, and as a financial investment for their creators, had been proven by the earlier canal systems. By the 1790s they were seen as a safe investment, but this tailed off in the 1820s as the threat of the railways became more apparent. Many of the canals built in the 1790s suffered from financial difficulty almost as soon as they were built. The fact that Keadby lock, together with the wider Stainforth and Keadby canal, has remained in continuous use from the early-19th century to the present therefore contributes to its significance. The double lock gates ensured for efficient operation of the lock dependent upon water levels in the Trent and the facility to allow for longer vessels to pass through the lock when the lock and river were at the same level was an important mechanism that supported the boat building industry on the canal until 1984. The canal and lock have adapted to changes in use throughout this time, from industrial traffic, to freight cargo, to leisure and continues to perform the function for which it was originally built.

6.2 The lock also has a degree of archaeological interest in the evidence it contains of previous structures, such as the former swing bridge abutments and the phases of development of the lock over the course of the 19th, 20th and 21st centuries. The lock has remained in continuous use from the early-19th century to the present and it, together with the wider canal network, has adapted to changes in use throughout this time, from industrial traffic, to freight cargo, to leisure.

6.3 The proposed works are focused on modifying the lock gates. The listing description for the lock records that the lock gates were installed in 1932, however this assessment has found that the existing lock gates were installed in 2005/ 6. Historic England's Designation Listing Selection Guide for Transport Infrastructure (2017b) states that most locks predating the 1830s are worthy contenders for designation, and that "*locks, usually of the pound type, are listable if appreciable parts of the original stone pound walls (and associated surfaces) survive"* (Historic England 2017b, 8). This is the case at Keadby, so its designation as a scheduled monument and listed building relates in part to the degree of survival of original fabric. The Listing Selection Guide proceeds to state that *"lock gates will rarely be early as they require regular renewal, and appropriate allowance must be made"* (Historic England 2017b, 8). This statement acknowledges that it is much less common for the original lock gates to survive and that the lack of survival of original fabric of the gates should not be a barrier to designation. It acknowledges that in order for the lock to continue to function for its original purpose, which is usually a structure's optimum viable use, frequent renewal of the gates is a necessity. The lack of survival of the original gates, together with the loss of the replacement gates of the 1930s at Keadby does not therefore diminish the significance of the lock. The presence of two sets of functioning gates at Keadby is a key part of the lock's significance. The design and materials used in the present gates, installed in 2005/ 6, are appropriate to the lock's architectural and illustrative historic values and they therefore contribute to the significance of the lock and assist in maintaining it in active use.

7. Development Description

Options Appraisal

7.1 An Options Appraisal report has been prepared by Arcadis to accompany the draft application of Scheduled Monument Consent (Arcadis 2022). This presents the background to the proposed changes, before discussing six design options that were initially considered for the proposed modification to the lock gates. All options aim to lessen the volume of water that currently overtops the mid-rail of the lock gate and flows through the perforated face of the of the gate. Options considered included:

- Option 1. Fit a plank horizontally to the upstream face of the top gates, with a height of 300mm.
- Option 2. Install planks in gaps between existing timbers to a height of 300mm.
- Option 3. Fit a baulk to the existing bar.
- Option 4. Fit planks in gaps between existing vertical timbers up to the top bar of the gate.
- Option 5. Remove planking between intermediate and top bars and install a mechanised tipping weir.
- Option 6. Install a demountable stop plank system.

7.2 A shortlist of two options, namely Option 1 and Option 2, was presented to Historic England during a formal pre-application consultation on 9th December 2021 and Option 1 was selected as the preferred option for the scheme due to its minimal intervention and sensitive design that retains the character and special interest of the gates and lock. It was noted that the Option 2 design would be the preferred option if the lock gates were to be entirely replaced in the future.

7.3 This application therefore assesses Option 1 as the proposed scheme.

Design and Materials

7.4 The proposed modification is to fit an additional plank, of 300mm width, to the upstream face of the top lock gates, sitting directly above the mid-rail and resting against the existing vertical planks of the gates. Figure 5 shows a proposed elevation and cross section. The plank would be green oak, to match as closely as possible to the existing gates once weathered, and the fixings would be heavy-gauge square-section nails to match the existing fixings. The additional plank would heighten the retained water level in the canal upstream of the lock, allowing the additional capacity required for third-party abstraction as outlined below

- 1,253 cubic metres per hour
- 27,400 cubic metres per day
- 7,250,000 cubic metres per year

7.5 A Flood Risk Technical Note has been prepared for the proposed works (AECOM 2021) which details how the canal's automated MEICA SCADA (Mechanical, Electrical, Instrumentation, Control and Automation Supervisory Control And Data Acquisition) system is set up to automatically operate and control a number of sluices along the canal to ensure the water level stays at the appropriate depth for boats to use. The operating level of the canal (the 'Zero' level) is currently set at 4.35mAOD. The height of the mid-rail on the present gates at Keadby Lock is 4.12mAOD, meaning that the additional head of water currently overtops the mid-rail of the canal and discharges through the lock into the River Trent. The proposed works would increase the threshold height at Keadby Lock from 4.12 mAOD to c.4.35 mAOD and ensure that water which currently is able to discharge into the River Trent is retained upstream, allowing a sufficient volume of water to be available for abstraction whilst maintaining the Zero Level. Because the canal will still be operating at the Zero level, for which it has capacity, no additional alterations are required to contain the additional volume of water in the canal. It also means that abstraction can take place whilst still allowing sufficient water level for boats using the canal. The Flood Risk Technical Note finds only a negligible impact on the flood risk of the canal as a result of the proposed work.

7.6 The canal's MEICA SCADA will control the water level in the canal and maintain it at the Zero level. The SCADA technology is designed to minimise variation from the normal maintained water level and is set with a 50 mm +/- tolerance, therefore any breach of this tolerance will result in the sluices automatically adjusting in order to maintain the required water level. Therefore, should abstraction at Keadby III Power

Station cease, firstly the canal would remain at the Zero level, but in the unlikely event that an increase of 50 mm above the Zero level is observed, the SCADA automated system will operate to reduce the volume of water entering the canal and mitigate flood risk. Only in extreme events would there be the risk of flooding, a stoppage on abstraction would not cause such an event in the day to day operation of the canal.

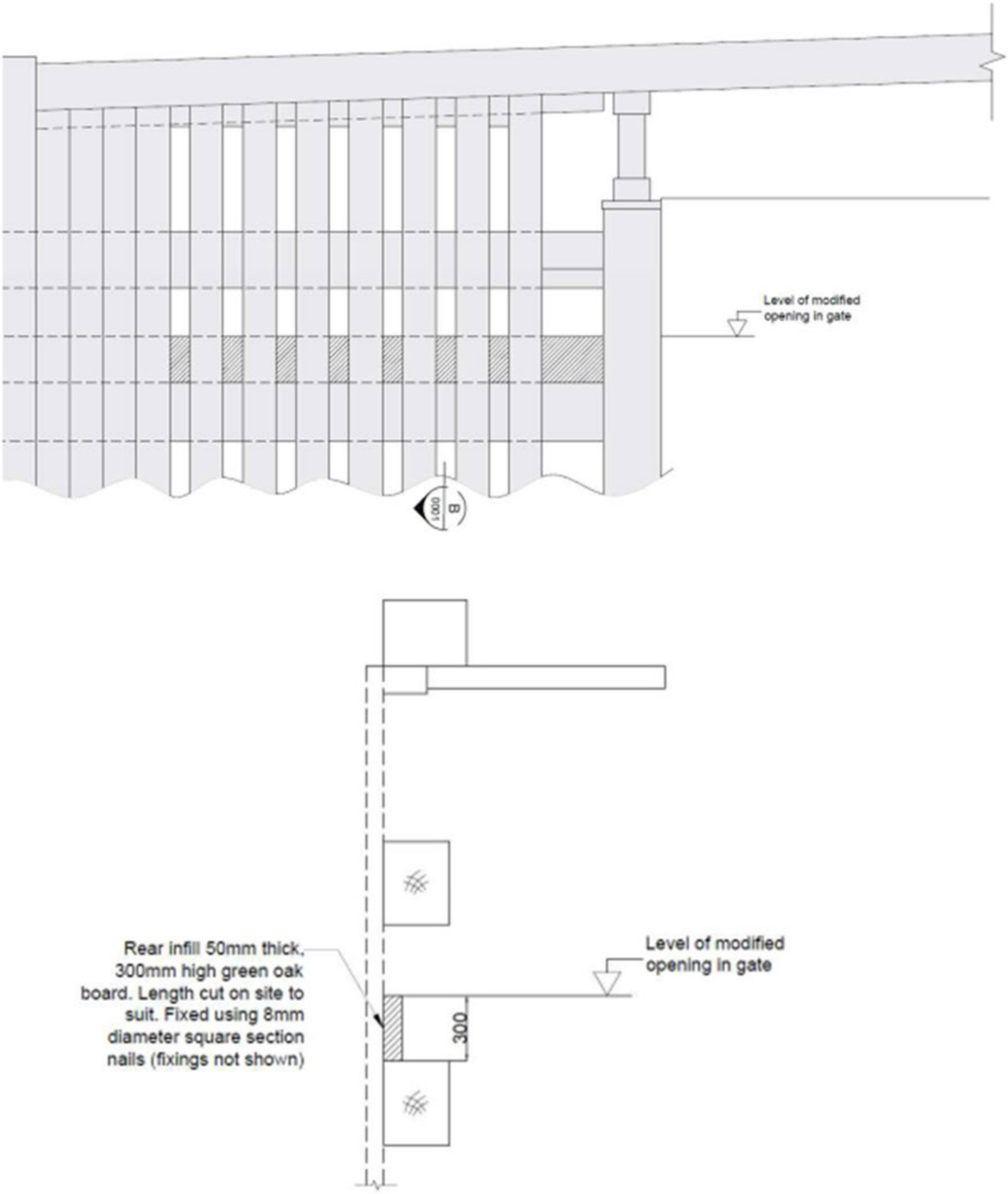


Figure 5 - Elevation and cross section of the proposed modification to the top lock gates (Arcadis 2022).

8. Assessment of Impact

8.1 This assessment has confirmed that the present lock gates at Keadby were installed in 2005/ 6, rather than being a survival of the 1930s as stated in the listed building description. The Listing Selection Guide for Transport Infrastructure acknowledges that lock gates require frequent renewal and that allowances need to be made with regard to the survival of historic fabric when defining the significance of a lock for this reason. The present lock gates, although not historic, therefore make a positive contribution to the significance of the lock through maintaining it in operation and through their design and materials which are sensitive and appropriate to the age of the lock and its heritage significance.

8.2 The proposed works involve the addition of one plank to the mid-rail of the upstream side of the top lock gates. The addition is a minimal visual alteration to this set of lock gates. Whilst the lock gates are not historic, their function and appearance make a contribution to the heritage significance of the lock and they form part of the designated asset. The gates are one pair of four pairs of matching gates present at the lock. Whilst the visual alteration to the gates is minimal, and will be largely imperceptible when weathered, the addition will alter one set of four sets of gates making one set slightly different to the other three. This very minor change will not alter the perception and understanding of the lock's architectural and historic interests. It is also a reversable detail. The proposal can therefore be achieved without impacting upon the significance and special interest of the lock.

8.3 The proposal will allow for the scheme objective of retaining water in the canal behind the lock for proposed abstraction. It will also improve the current situation at the lock where presently water overtops the mid-rail of the lock gate and flows into the lock when the gates are closed. This is not the correct operation of the gates and it will lead to more rapid deterioration of the gates over time. It can also create problems for full length boats attempting to use the lock. The improvement to this situation will increase the longevity of the present lock gates and therefore delay further necessary changes and larger interventions to the heritage asset.

8.4 The canal's MEICA SCADA will control the water level in the canal and maintain it at the Zero Level of 4.35mAOD. Because the canal will still be operating at the Zero Level, no additional alterations are required to contain the additional volume of water in the canal, and abstraction can take place whilst still allowing sufficient water levels for boats using the canal. The Flood Risk Technical Note (AECOM 2021) finds only a negligible impact on the flood risk of the canal as a result of the proposed work, with the mechanism remaining unchanged from the baseline flood risk. The SCADA technology is designed to minimise variation from the normal maintained water level and is set with a 50 mm +/- tolerance, therefore any breach of this tolerance will result in the sluices automatically adjusting in order to maintain the required water level. Therefore, should abstraction at Keadby 3 Carbon Capture Power Station temporarily cease, firstly the canal would remain at the Zero Level, but in the unlikely event that an increase of 50 mm above the Zero Level is observed, the SCADA automated system will operate to reduce the volume of water entering the canal and mitigate flood risk.

9. Conclusion

9.1 This Heritage Impact Assessment has presented the legislative and policy background pertaining to the proposed works and has provided background information and a statement of significance for Keadby Lock Scheduled Monument and Grade II listed building.

9.2 The assessment of the impact of the scheme, presented in Section 8 found that there will be no impact to the significance or special interest of the lock as a result of the proposed works. The proposal would require a minimal alteration to the lock gates, which are not themselves historic. The proposed works will also assist in improving the longevity of the current gates by reducing a current overtopping problem that will, if left unchecked, accelerate the natural deterioration of the gates. The improvement to this situation will increase the longevity of the present lock gates and therefore delay further necessary changes and larger interventions to the heritage asset.

9.3 The proposed development therefore passes the tests of the Scheduled Monument and Archaeological Areas Act 1979 by ensuring for the 'benefit of the monument' as per Schedule 1 Part 1 (2). It also passes the tests of the Planning (Listed Buildings and Conservation Areas) Act 1990, firstly by seeking scheduled monument consent in advance of the works and by placing great weight on the conservation of designated heritage assets. The development is in accordance with paragraph 199 of the NPPF (2021). It is also in accordance with saved Policies HE5 and HE8 of the North Lincolnshire Local Plan (2003) and Policy CS6 of the North Lincolnshire Core Strategy (2011).

9.4 This heritage impact assessment forms part of the formal pre-application, accompanying a full draft application for scheduled monument consent, on which the advice of Historic England is sought.

10. References

AECOM (2021) *Flood Risk Technical Note.* Unpublished Report (submitted with application)

Ancient Monuments and Archaeological Areas Act (1979) (as amended) The Stationery Office, London. Available online at: [redacted]

Arcadis (2022) *Keadby Lock Gate Modification Options Appraisal.* Unpublished report (submitted with application).

CIfA (2019) *Code of Conduct.* Chartered Institute for Archaeologists, Reading, October 2019. Available online at: [redacted]

CIfA (2020) *Standard and guidance. Historic environment desk-based assessment.* Chartered Institute for Archaeologists, Reading. Available online at: [redacted]

Historic England (2015) *Managing Significance in Decision-taking. Historic Environment Good Practice Advice in Planning: 2.* Available online at: [redacted]

Historic England (2017a) *Historic Environment Good Practice Advice in Planning Note 3. The Setting of Heritage Assets.* Available online at: [redacted]

Historic England (2017b) *Infrastructure: Transport. Listing Section Guide*. Available online at: [redacted]

Historic England (2017c) *Canal and River Navigations National Overview: An appraisal of the heritage and archaeology of England's present and former inland navigable waterways. Historic England Research Report Series 28-2017.* Available online here: [redacted]

Historic England (2019) *Statements of Heritage Significance: Analysing Significance in Heritage Assets Historic England Advice Note 12.* Available online at: [redacted]

IEMA (2021) *Principles of Cultural Heritage Impact Assessment in the UK.* Available online at: [redacted]

Le Quesne, C (2015) *Keadby II Power Station: Historic Environment Desk-Based Assessment*. Unpublished report: Environmental Resources Management.

Ministry of Housing, Communities and Local Government (2019). *Planning Practice Guidance: Historic environment.* Available online at: [redacted].

Ministry of Housing, Communities and Local Government (2021) *National Planning Policy Framework*. Available online at: [redacted]

North Lincolnshire Council. (2003) *Adopted Local Plan.* Available online: [redacted]

North Lincolnshire Council (2007) *Saved Policies of the North Lincolnshire Local Plan*. Available online: [redacted]

North Lincolnshire Council (2011) *The North Lincolnshire Local Development Framework*. Available online: [redacted]

Planning (Listed Buildings and Conservation Areas) Act 1990. (1990) c. 9. Available online at: [redacted]

Van der Noort, R and Ellis, S (1998) *Wetland heritage of the Ancholme and lower Trent valleys: An archaeological survey*.

Websites:

Historic England National Heritage List for England [redacted] [last accessed 21-12-2021]

Historic England Archive: [redacted] [last accessed 10-01-2022]

National Library of Scotland Online. Available: [redacted] [last accessed 10-01-2022]

Appendix A Summary of Works to Keadby Lock 1997-2021

A.1 Summary of Main Works

Year	Proposal	Details	Implemented
Pre-1997	Works to lock invert	Sections of the timber floor beyond the main lock chamber removed and replaced in concrete.	
1997		Extensive work including re-pointing, pressure grouting, excavation and reconsolidation of the ground beside the lock walls, re-concreting the surface there, removal of parts of the timber planking from the lock floor near the east gates and its replacement there in concrete. Works recorded that some stone setts had been located beneath the concrete surface and suggested that these be retained as a feature. Not implemented.	
1999	Gate replacement & Minor associated works	Proposal for replacement of two pairs of lock gates in ekke hardwood, fitting steel quoins, removal of timber plank floor to the main lock chamber and its replacement in concrete. The provision of new flood gates and downstream middle lock gates and localised work to the quoins sealing surfaces. At that time a photographic record was made of the lock chamber for the owners British Waterways. Works limited to gate replacement and minor associated works (due to take place in Feb-March 1999). Proposals for steel quoins were dropped and the stonework will instead be repaired with mortar. The timber planking floor or lock 'invert' to be further investigated during de-watering, and the case for its restoration or replacement re-examined. Previous survey in 1998 indicated that the surface of the planking had softened, and that there was localised damage by mechanical	New flood gates and downstream middle lock gates. Lock had previously undergone a series of partial refitting's of winding gear and gates. Programme of archaeological recording undertaken as part of works.

Year	Proposal	Details	Implemented
		dredging; no evidence submitted to show that the floor was still heaving, although there was some suggestion that one of the lock walls was sinking, perhaps due to failure of the timbers beneath. Proposals for mechanisation were also put on hold.	
2002	Intrusive Ground Investigation Works (outside scheduled area)	Initial site investigation works into the ground alongside the lock outside the scheduled area	English Heritage Notified
2003	Mechanisation (P/00556)		SMc granted Programme of archaeological recording was condition of consent.
2005	Stabilisation/ Strengthening (P/00561)		SMc granted
2006	Stone setts & lighting	Material and design details as part of wider lock landscaping post stabilisation project	English Heritage approved
	FAS: Envt Agency Modifications	?	?
2011	FAS: access step Modifications	Alter the existing (modern) steel steps due to safety concerns (late 2011).	SMc granted
2014	Balance beam repairs	?	?
2016	Disposal of land (Estates)	Disposal of various parcels of land SAP Numbers Part 1356,1357,1360 and lease in area to Crown Estate at Keadby to PD Ports Properties Limited. The land is leased to AWS which is a company owned by PD Ports and we are selling subject to the existing leases which are contained within the registered Title.	
2017	Balance beam replacement & missing riser chains replaced	The balance beam of the downstream middle gate (cabin side) rotten and requires replacing. Historic England advise that the beam must be replaced like-for-like in oak, rather than in steel as the other balance beams at this location. Lock chamber riser chain at upstream middle gate (far side) is missing and requires replacing. Bottom fixings are broken	Clearance from Historic England under terms of s.17 management agreement

Year	Proposal	Details	Implemented
		on chains at the downstream and upstream middle gates and the **top gates**. Remove rotten timber balance beam and replace like-for-like. Repair/replace missing/damaged riser chains and fixings.	
2018	Septic tank replacement to control cabin (Estates)	Current metal above ground waste storage tank is beyond repair and requires replacement. Project is to remove the metal tank in situ and replace with an above ground bunded polyurethane tank system	
2019	dredging	Silt build-up in the lock chamber – dredging required	Clearance issued from Historic England under terms of s.17 management agreement
2021	dredging	Silt build-up to lock approach (Trent side) – dredging required	Clearance issued from Historic England under terms of s.17 management agreement

Notifications identified in CRT's database for works 2012-2021

Notification	Functional Location	PG	Description	Created On	Req End	Completion	Description of functional location
12188024	FK-025-006	2	CRT - Sluice sticking at keadby	08.11.2012	28.02.2013	18.02.2013	Keadby Lock
12213724	FK-025-006	3	M&E Replace Pull Starters on Gennies	20.11.2012	30.03.2026	01.04.2016	Keadby Lock
12215790	FK-025-006	2	CRT - Keadby lock fuse needs resetting	21.11.2012	22.11.2012	14.01.2013	Keadby Lock
12315463	FK-025-006	2	R3 BW - Increase tred depth on step	04.02.2013	31.03.2014	31.03.2014	Keadby Lock
12326074	FK-025-006	2	PCS PCH	11.02.2013	10.01.2027		Keadby Lock
12326075	FK-025-006	2	ladder 8 runs broken	11.02.2013	31.03.2015	30.07.2014	Keadby Lock
12326072	FK-025-006	2	balance beam rotten	11.02.2013	11.02.2015	13.02.2013	Keadby Lock
12326073	FK-025-006	2	B22 Insufficient tread depth of 80mm	11.02.2013	23.09.2022		Keadby Lock
12372680	FK-025-006	2	slippery surface around lock	11.03.2013	31.03.2013	19.03.2013	Keadby Lock
12420482	FK-025-006	2	holding chains missing	15.04.2013	31.03.2015	05.08.2014	Keadby Lock
12423901	FK-025-006	2	keadby dredging	17.04.2013	31.03.2015	26.06.2014	Keadby Lock
12429630	FK-025-006	2	Repairs to Lock - Keadby	22.04.2013	31.03.2015	21.05.2015	Keadby Lock
12429625	FK-025-006	2	Repairs to Lock - Keadby	22.04.2013	31.03.2014	17.03.2014	Keadby Lock
12450873	FK-025-006	2	R1 replace rotten walkboard	09.05.2013	31.08.2014	30.07.2014	Keadby Lock
12491633	FK-025-006	2	hydraulic pump leaking at keadby	07.06.2013	31.07.2013	15.07.2013	Keadby Lock
12536940	FK-025-006	2	FK-Sluice switches open	11.07.2013	31.08.2013	09.08.2013	Keadby Lock
12542944	FK-025-006	2	ELECTRICAL FAULT AT KEADBY LOCK	15.07.2013	16.07.2013	09.08.2013	Keadby Lock
12557641	FK-025-006	2	FK-Main control fuse blown	25.07.2013	26.07.2013	09.08.2013	Keadby Lock
12564251	FK-025-006	2	FK-mains power fault	30.07.2013	31.07.2013	09.08.2013	Keadby Lock
12599095	FK-025-006	2	FK-faulty power pack oil filter pump	21.08.2013	22.08.2013	22.08.2013	Keadby Lock
12605051	FK-025-006	2	FK-main power supply Keadby Lock	28.08.2013	31.03.2014	01.04.2014	Keadby Lock
12605052	FK-025-006	2	FK- Keadby Lock Paddle Gear	28.08.2013	31.12.2013	14.01.2014	Keadby Lock
12608732	FK-025-006	2	R3 Repairs to CCTV system	30.08.2013	31.03.2015	27.11.2013	Keadby Lock
12608740	FK-025-006	2	FK - Filtration Pump	30.08.2013	31.12.2013	18.11.2013	Keadby Lock

Notification	Functional Location	PG	Description	Created On	Req End	Completion	Description of functional location
12633514	FK-025-006	2	Paint balance beam	16.09.2013	16.09.2014	14.07.2014	Keadby Lock
12660093	FK-025-006	2	FK-Keadby Lock - 240v socket	01.10.2013	31.12.2013	14.01.2014	Keadby Lock
12704282	FK-025-006	2	mains power failure at keadby	31.10.2013	01.11.2013	13.11.2013	Keadby Lock
12745313	FK-025-006	2	Spindle survey	29.11.2013	31.03.2030	06.11.2014	Keadby Lock
12781640	FK-025-006	2	Metal Stalk bent	06.01.2014	31.03.2015	30.07.2014	Keadby Lock
12781639	FK-025-006	2	B17 - Balance beam rotten	06.01.2014	31.03.2018	30.01.2018	Keadby Lock
12827924	FK-025-006	2	Refixs green fencing	10.02.2014	31.03.2014	31.03.2014	Keadby Lock
12836436	FK-025-006	2	Keadby Lock - Anti-slip	17.02.2014	31.03.2015	17.06.2014	Keadby Lock
12900070	FK-025-006	2	Metal stalk bent	31.03.2014	31.03.2015	30.07.2014	Keadby Lock
12900068	FK-025-006	2	Corrosion on bottom of balance beam.	31.03.2014	31.03.2019	30.06.2016	Keadby Lock
12900069	FK-025-006	2	Boil on gate cill	31.03.2014	30.04.2014	29.04.2014	Keadby Lock
12978759	FK-025-006	2	M&E Repairs to Gate Proximity Switches	29.05.2014	31.03.2015	03.06.2014	Keadby Lock
12986064	FK-025-006	2	Replace back planking on upstream middle gate (far side).	03.06.2014	31.03.2025		Keadby Lock
13002934	FK-025-006	2	FK-Keadby Lock **top gate (far side)** sluice	12.06.2014	19.06.2014	30.07.2014	Keadby Lock
13122822	FK-025-006	2	Holding Chain missing	29.08.2014	31.03.2019	05.07.2016	Keadby Lock
13122824	FK-025-006	2	Bent stalk on paddle gearing downstream middle gate (far side)	29.08.2014	31.03.2016	16.10.2015	Keadby Lock
13144208	FK-025-006	2	Holding Chain missing	11.09.2014	11.09.2015	16.09.2014	Keadby Lock
13144210	FK-025-006	2	Bent stalk on paddle gearing downstream middle gate (far side)	11.09.2014	11.09.2015	16.09.2014	Keadby Lock
13164526	FK-025-006	2	Pointing to Blockwork Required	20.09.2014	31.03.2026		Keadby Lock
13400132	FK-025-006	3	M&E Repairs to HPU Cover	10.03.2015	28.07.2017	12.05.2017	Keadby Lock
13423333	FK-025-006	2	Balance beam corrosion in two places	24.03.2015	31.03.2025		Keadby Lock
13441570	FK-025-006	2	Keadby - lock area needs power washing	08.04.2015	19.06.2015	16.06.2015	Keadby Lock
13674787	FK-025-006	2	Concrete crack next to steps.	02.09.2015	31.03.2025		Keadby Lock

Notification	Functional Location	PG	Description	Created On	Req End	Completion	Description of functional location
13674788	FK-025-006	2	Broken backboard downstream middle gate (cabin side).	02.09.2015	31.03.2025	21.04.2021	Keadby Lock
13685264	FK-025-006	2	Keadby Lock downstream middle gate (far side) manual Sluice defect	08.09.2015	01.11.2016	02.10.2016	Keadby Lock
13719571	FK-025-006	14	Non-slip missing on walkway.	28.09.2015	27.09.2016	18.10.2016	Keadby Lock
13719532	FK-025-006	3	Clean CCTV lens	28.09.2015	05.10.2015	22.04.2016	Keadby Lock
13742338	FK-025-006	2	Manual sluice downstream middle gate (far side) bolt on stalk	09.10.2015	01.11.2016	02.10.2016	Keadby Lock
13742335	FK-025-006	2	B16R Lock riser chains broken	09.10.2015	17.09.2017	30.01.2018	Keadby Lock
13802125	FK-025-006	2	keadby lock storage cabin	13.11.2015	16.12.2015	15.12.2015	Keadby Lock
13810198	FK-025-006	12	Generator door keadby lock	19.11.2015	26.11.2015	20.09.2016	Keadby Lock
13890312	FK-025-006	3	CON - Ram bolts to tighten.	17.01.2016	16.02.2016	21.09.2018	Keadby Lock
13942619	FK-025-006	3	Hydraulic leak from power pack	19.02.2016		11.03.2016	Keadby Lock
14100791	FK-025-006	3	M&E Generator not working	20.05.2016	21.05.2016	06.02.2017	Keadby Lock
14168924	FK-025-006	2	Broken fender **top gate (cabin side)**	29.06.2016	29.08.2016	02.10.2016	Keadby Lock
14202545	FK-025-006	3	hydraulic leak u/s gates keadby lock	14.07.2016		02.10.2016	Keadby Lock
14234228	FK-025-006	2	Keadby Sluice No3 stalk detat from door	01.08.2016	02.09.2016	02.10.2016	Keadby Lock
14245308	FK-025-006	3	M&E - Keadby Lock Sluice Fault	05.08.2016		06.02.2017	Keadby Lock
14272314	FK-025-006	2	**Top gate (cabin side)** Missing back planking	19.08.2016	26.08.2016	06.12.2016	Keadby Lock
14272318	FK-025-006	2	3 x riser chains within lock are missing	19.08.2016	26.08.2016	19.08.2016	Keadby Lock
14310016	FK-025-006	14	CCTV camera obscured	09.09.2016	16.09.2016	08.11.2016	Keadby Lock
14343191	FK-025-006	3	Horse shoe around heel post loose **top gate (cabin side)**	29.09.2016	29.09.2017	26.10.2018	Keadby Lock
14391035	FK-025-006	2	Fender missing on balance beam downstream middle gate (far side)	27.10.2016	31.03.2026		Keadby Lock
14421463	FK-025-006	2	Slider chains within Lock are missing	16.11.2016	15.02.2017	25.11.2016	Keadby Lock
14421470	FK-025-006	14	Re align safety fence to prevent injury	16.11.2016	14.02.2017	29.03.2017	Keadby Lock

Notification	Functional Location	PG	Description	Created On	Req End	Completion	Description of functional location
14469781	FK-025-006	3	M&E - Defective green traffic light.	16.12.2016	23.12.2016	06.02.2017	Keadby Lock
14510374	FK-025-006	3	M&E Keadby Lock: Faulty Navigation Light	19.01.2017	26.01.2017	06.02.2017	Keadby Lock
14517124	FK-025-006	14	replace worn signage	24.01.2017	24.04.2017	30.03.2017	Keadby Lock
14525808	FK-025-006	3	M&E Keadby Lock traffic light ent fault	30.01.2017	06.02.2017	12.05.2017	Keadby Lock
14558677	FK-025-006	3	M&E - Keadby Lock: Change Power Pack AC	16.02.2017		12.05.2017	Keadby Lock
14558675	FK-025-006	3	Keadby Lock: Change Power Pack Oil Filter	16.02.2017		12.05.2017	Keadby Lock
14917719	FK-025-006	3	Hydraulic Leak power pack Keadby Lock	14.09.2017	21.09.2017	14.02.2018	Keadby Lock
14987043	FK-025-006	3	M&E - river light indicator light	24.10.2017	31.10.2017	05.10.2018	Keadby Lock
15061544	FK-025-006	3	Repair to Control Desk Panel Keadby Lk	08.12.2017	15.12.2017	09.04.2019	Keadby Lock
15126080	FK-025-006	14	Lifebuoy box fallen off fence	29.01.2018	28.02.2018	27.02.2018	Keadby Lock
15284497	FK-025-006	3	green traffic light out at keadby	09.05.2018	16.05.2018	05.10.2018	Keadby Lock
15325563	FK-025-006	14	Footpath to Lock entrance	05.06.2018	05.07.2018	01.08.2018	Keadby Lock
15516886	FK-025-006	3	M&E replacing lights	26.09.2018	27.09.2018	05.10.2018	Keadby Lock
15555676	FK-025-006	3	One cross head slider seized	18.10.2018	25.10.2018	26.10.2018	Keadby Lock
15555597	FK-025-006	3	M&E no 8 Sluice actuator loose	18.10.2018	25.10.2018	26.10.2018	Keadby Lock
15555595	FK-025-006	3	M&E no 3 Sluice actuator loose	18.10.2018	25.10.2018	26.10.2018	Keadby Lock
15555599	FK-025-006	3	M&E no 1 Ram Bed Loose	18.10.2018	25.10.2018	26.10.2018	Keadby Lock
15580870	FK-025-006	1	Fenders loose/missing on wingwall	06.11.2018	31.03.2025		Keadby Lock
15650419	FK-025-006	3	M&E Sluice No 4 actuator leaking oil	18.12.2018	25.12.2018	18.09.2020	Keadby Lock
15650401	FK-025-006	3	M&E Low oil levels on power pack	18.12.2018	25.12.2018	10.01.2019	Keadby Lock
15819123	FK-025-006	2	Leak in o/s wall	03.04.2019	31.03.2029		Keadby Lock
16002478	FK-025-006	5	MEICA In Lock Level Transducer Failed	22.07.2019	23.07.2019	03.04.2020	Keadby Lock
16051590	FK-025-006	14	ASSA key snapped in the lock	19.08.2019	18.08.2021	31.12.2019	Keadby Lock
16132027	FK-025-006	3	M&E Tidy & Secure Hydraulic Pipes	08.10.2019	15.10.2019	18.09.2020	Keadby Lock
16132028	FK-025-006	3	M&E Label Isolator Correctly	08.10.2019	15.10.2019	14.12.2020	Keadby Lock
16458129	FK-025-006	3	M&E **top gate (cabin side)** weld strides	29.07.2020	05.08.2020	18.09.2020	Keadby Lock

Notification	Functional Location	PG	Description	Created On	Req End	Completion	Description of functional location
16458127	FK-025-006	3	M&E downstream middle gate (cabin side) pipe re-route	29.07.2020	30.07.2020	18.09.2020	Keadby Lock
16464597	FK-025-006	2	Lock ladders missing runs/steps	04.08.2020	03.09.2020		Keadby Lock
16464596	FK-025-006	2	Lock entrance river side to be dredged	04.08.2020	03.09.2020	26.08.2020	Keadby Lock
16484660	FK-025-006	3	M&E Inv leaks on filter on powerpack	18.08.2020	25.08.2020	18.09.2020	Keadby Lock
16490143	FK-025-006	3	M&E Power pack failure	21.08.2020	28.08.2020	16.11.2020	Keadby Lock
16490155	FK-025-006	14	Keadby lock chains loose	21.08.2020	22.08.2020	24.08.2020	Keadby Lock
16524305	FK-025-006	12	Septic Tank needs emptying urgently	11.09.2020	31.03.2021	30.09.2020	Keadby Lock
16529289	FK-025-006	2	VRA - Ladders not compliant	15.09.2020	31.03.2031		Keadby Lock
16602497	FK-025-006	15	Silt build up River entrance to lock	27.10.2020	27.10.2022		Keadby Lock
16682394	FK-025-006	14	Ladder hoop bent req straightening	12.01.2021	12.01.2023		Keadby Lock
16730482	FK-025-006	3	M&E Desk panel lights blown	10.03.2021	17.03.2021	13.05.2021	Keadby Lock
16739862	FK-025-006	3	M&E Repair & reinstall system on lock	23.03.2021	21.06.2021	20.09.2021	Keadby Lock
16777724	FK-025-006	14	Boat chains 1 missing, 1 not attached	20.04.2021	20.03.2022	28.09.2021	Keadby Lock
16807203	FK-025-006	12	CCTV at Keadby Lock not working	10.05.2021	31.03.2022	22.06.2021	Keadby Lock
16855296	FK-025-006	2	Pot holes to be filled	08.06.2021	08.07.2021	22.06.2021	Keadby Lock
16893015	FK-025-006	3	M&E Number 2 ram bed loose	30.06.2021	07.07.2021	12.07.2021	Keadby Lock
16892968	FK-025-006	3	M&E **top gate (cabin side)** Gate bracket	30.06.2021	07.07.2021	12.07.2021	Keadby Lock
16892970	FK-025-006	3	M&E No 3 ram bed loose	30.06.2021	07.07.2021	12.07.2021	Keadby Lock
16895351	FK-025-006	3	M&E Replace all pressure gauges on HPU2	01.07.2021	08.07.2021	12.07.2021	Keadby Lock
16895350	FK-025-006	3	M&E Replace all pressure gauges on HPU1	01.07.2021	08.07.2021	12.07.2021	Keadby Lock
16895346	FK-025-006	3	M&E Replace 2 Sluice sensors on **top gate (far side)**	01.07.2021	08.07.2021	12.07.2021	Keadby Lock
16895348	FK-025-006	3	M&E Replace 2 sluice sensors on **top gate (cabin side)**	01.07.2021	08.07.2021	12.07.2021	Keadby Lock
16895347	FK-025-006	3	M&E Replace 2 gate sensors on **top gate (far side)**	01.07.2021	08.07.2021	12.07.2021	Keadby Lock

Notification	Functional Location	PG	Description	Created On	Req End	Completion	Description of functional location
16895349	FK-025-006	3	M&E Replace 2 gate sensors on **top gate (cabin side)**	01.07.2021	08.07.2021	12.07.2021	Keadby Lock
16910908	FK-025-006	3	M&E Upgrade upstream middle gate (far side) and sluice 6 sensors	09.07.2021	16.07.2021	16.11.2021	Keadby Lock
16910906	FK-025-006	3	M&E Upgrade upstream middle gate (cabin side) and sluice 5 sensors	09.07.2021	16.07.2021	01.11.2021	Keadby Lock
16910905	FK-025-006	3	M&E Upgrade downstream middle gate (far side)and sluice 4 sensors	09.07.2021	16.07.2021	01.11.2021	Keadby Lock
16910903	FK-025-006	3	M&E Upgrade downstream middle gate (cabin side) and sluice 3 sensors	09.07.2021	16.07.2021	01.11.2021	Keadby Lock
16949123	FK-025-006	2	Masonry joints cracking O/S chamber	04.08.2021	03.08.2026		Keadby Lock
16972287	FK-025-006	3	M&E D/S N/S Sluice fault	18.08.2021	25.08.2021	13.09.2021	Keadby Lock
17067470	FK-025-006	14	Lifebuoy ring Lanyard missing	18.10.2021	31.03.2022	29.11.2021	Keadby Lock
17089873	FK-025-006	3	M&E HPU2 replace oil and filters	03.11.2021	03.12.2021		Keadby Lock
17089872	FK-025-006	3	M&E HPU1 replace oil and filters	03.11.2021	03.12.2021	20.12.2021	Keadby Lock
17123876	FK-025-006	3	M&E Repair floodlights	25.11.2021	02.12.2021	29.11.2021	Keadby Lock
17162610	FK-025-006	3	M&E upstream middle gate (far side) and sluice 6 not working	22.12.2021	29.12.2021		Keadby Lock
15529097	FK-025-006-04	2	Boil on cill on upstream middle gates	03.10.2018	31.03.2025		Keadby Lock D/S Middle Gate
15819124	FK-025-006-04	2	Lobby side plank broken	03.04.2019	01.04.2024		Keadby Lock D/S Middle Gate
16877665	FK-025-006-04	3	Stalk on gate paddle bent both side	21.06.2021	20.06.2026		Keadby Lock D/S Middle Gate
16949124	FK-025-006-04	14	DONE Nonslip boards loose lobby side	04.08.2021	04.08.2022		Keadby Lock D/S Middle Gate
15316043	FK-025-006-02	14	0325m Fenders Missing/Broken DONE	30.05.2018	30.09.2020	28.08.2020	**Keadby Lock Top Gate**
15580869	FK-025-006-02	14	Walkboard starting to rot	06.11.2018	26.08.2022		**Keadby Lock Top Gate**
16148652	FK-025-006-02	14	Loose no-slip boards on walkway	18.10.2019	17.10.2020	31.12.2019	**Keadby Lock Top Gate**
16148653	FK-025-006-02	14	Collar req repacking on heel post DONE	18.10.2019	30.03.2021	28.08.2020	**Keadby Lock Top Gate**
16738731	FK-025-006-02	14	Refixs non-slips walkboards	22.03.2021	22.03.2022	30.07.2021	**Keadby Lock Top Gate**

Notification	Functional Location	PG	Description	Created On	Req End	Completion	Description of functional location
16949125	FK-025-006-02	2	Boil on cill possibly silt on downstream middle gate (cabin side)	04.08.2021	24.08.2026		Keadby Lock
15580871	FK-025-006-03	14	Outside walkway board starting to rot	06.11.2018	26.08.2022		Keadby Lock U/S Middle Gate
15936832	FK-025-006-03	3	Gate paddle motor on working downstream middle gate (far side)	12.06.2019	13.09.2019	26.08.2020	Keadby Lock U/S Middle Gate

[redacted]

[redacted]