DOGGER BANK D WIND FARM

Preliminary Environmental Information Report

Volume 2
Appendix 21.2 Fluvial Geomorphology Baseline Survey

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Prepared For:	**Dogger Bank D Offshore Wind Farm**

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V1	01/05/2025	Final	IO	AG	AT

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Glossary

Term	Definition
Additional Mitigation	Measures identified through the EIA process that are required as further action to avoid, prevent, reduce or, if possible, offset likely significant adverse effects to acceptable levels (also known as secondary (foreseeable) mitigation) All additional mitigation measures adopted by the Project are provided in the Commitments Register.
Design	All of the decisions that shape a development throughout its design and pre-construction, construction / commissioning, operation and, where relevant, decommissioning phases.
Development Consent Order (DCO)	A consent required under Section 37 of the Planning Act 2008 to authorise the development of a Nationally Significant Infrastructure Project, which is granted by the relevant Secretary of State following an application to the Planning Inspectorate.
Effect	An effect is the consequence of an impact when considered in combination with the receptor's sensitivity / value / importance, defined in terms of significance.
Environmental Impact Assessment (EIA)	A process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information and includes the publication of an Environmental Statement.
Environmental Statement (ES)	A document reporting the findings of the EIA which describes the measures proposed to mitigate any likely significant effects.
Evidence Plan Process (EPP)	A voluntary consultation process with technical stakeholders which includes a Steering Group and Expert Topic Group (ETG) meetings to encourage upfront agreement on the nature, volume and range of supporting evidence required to inform the EIA and HRA process.
Expert Topic Group (ETG)	A forum for targeted technical engagement with relevant stakeholders through the EPP.
Impact	A change resulting from an activity associated with the Project, defined in terms of magnitude.
Mitigation	Any action or process designed to avoid, prevent, reduce or, if possible, offset potentially significant adverse effects of a development. All mitigation measures adopted by the Project are provided in the Commitments Register.
Onshore Converter Station (OCS)	A compound containing electrical equipment required to stabilise and convert electricity generated by the wind turbines and transmitted by the export cables into a more suitable voltage for grid connection into Birkhill Wood Substation.

Term	Definition
Onshore Converter Station (OCS) Zone	The area within which the Onshore Converter Station and Energy Storage and Balancing Infrastructure will be located in vicinity of Birkhill Wood Substation.
Onshore Development Area	The area in which all onshore infrastructure associated with the Project will be located, including any temporary works area required during construction and permanent land required for mitigation and enhancement areas, which extends landward of Mean Low Water Springs. There is an overlap with the Offshore Development Area in the intertidal zone.
Onshore Export Cable Corridor (ECC)	The area within which the onshore export cables will be located, extending from the landfall to the Onshore Converter Station zone and onwards to Birkhill Wood Substation.
Onshore Export Cables	Cables which bring electricity from the transition joint bay at landfall to the Onshore Converter Station zone (HVDC cables) and from the Onshore Converter Station zone onwards to Birkhill Wood Substation (HVAC cables).
Project Design Envelope	A range of design parameters defined where appropriate to enable the identification and assessment of likely significant effects arising from a project's worst-case scenario. The Project Design Envelope incorporates flexibility and addresses uncertainty in the DCO application and will be further refined during the EIA process.
Pool	A distinct natural feature of deeper water.
Reach	Section of a stream or river along which similar hydrologic conditions exist, such as discharge, depth, area, and slope.
Riffle	Shallow, fast-flowing water with a distinctly disturbed surface.
Scoping Opinion	A written opinion issued by the Planning Inspectorate on behalf of the Secretary of State regarding the scope and level of detail of the information to be provided in the Applicant's Environmental Statement. The Scoping Opinion for the Project was adopted by the Secretary of State on 02 August 2024.
Scoping Report	A request by the Applicant made to the Planning Inspectorate for a Scoping Opinion on behalf of the Secretary of State. The Scoping Report for the Project was submitted to the Secretary of State on 24 June 2024.
Study Areas	A geographical area and / or temporal limit defined for each EIA topic to identify sensitive receptors and assess the relevant likely significant effects.
The Applicant	SSE Renewables and Equinor acting through 'Doggerbank Offshore Wind Farm Project 4 Projco Limited'.
The Project	Dogger Bank D (DBD) Offshore Wind Farm Project, also referred to as DBD in this PEIR.

21.2 Fluvial Geomorphology Baseline Survey

21.2.1 Introduction

1. The aim of the fluvial geomorphology baseline survey is to characterise the geomorphological conditions of major watercourses that will be crossed by the Dogger Bank D Offshore Wind Farm project (hereafter 'the Project' or DBD). Baseline information gathered during the survey has been used to inform the assessment presented in **Volume 1, Chapter 21 Water Resources and Flood Risk** of the Preliminary Environmental Information Report (PEIR). Results have also been used in the assessment of likely significant effects on hydromorphological quality elements supported by river water bodies presented in **Appendix 21.4 Water Environment Regulations Compliance Assessment**.

2. Characterising the geomorphology of watercourses provides baseline information on their physical form and the processes (such as sediment transport and deposition) that may influence this form. The baseline information of surveyed watercourses presented in this appendix has been used to determine how watercourses are likely to respond to the construction, operation and maintenance (O&M) and decommissioning of the Project. The baseline condition will also be used to inform the detailed design, construction and monitoring phases of the Project. This will ensure the geomorphological and ecological integrity of these watercourses is maintained and will also inform any potential Biodiversity Net Gain (BNG) opportunities.

21.2.2 Survey Method

3. This section presents details of the study area and methodology used to undertake the geomorphological baseline survey. The methodology was consulted on at Expert Topic Group Meeting 10 (see **Appendix 21.1 Consultation Responses on Water Resources and Flood Risk**).

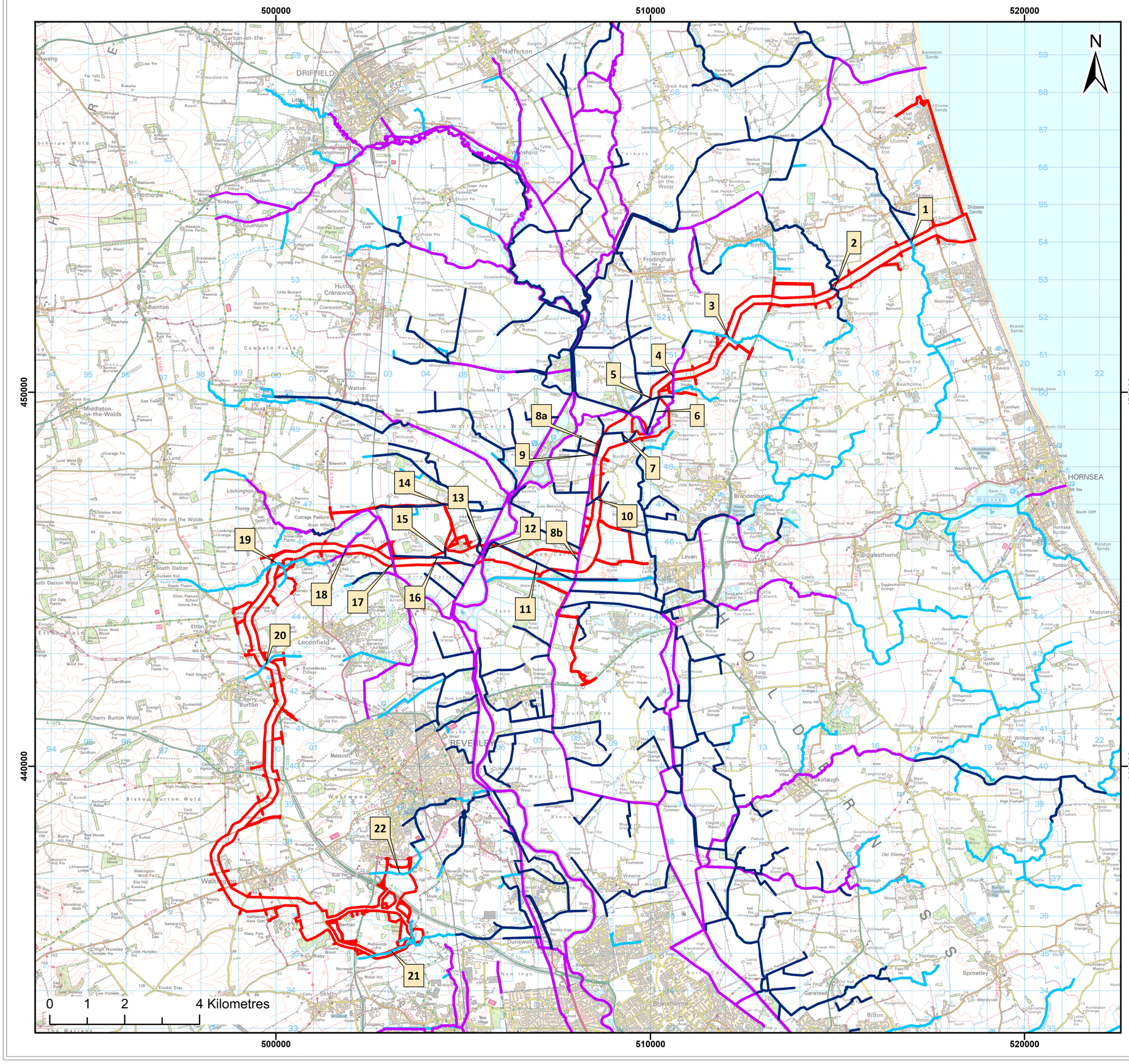
21.2.2.1 Survey Area

4. A total of 23 reaches which are located within the Onshore Development Area were identified for the targeted geomorphological baseline survey. The surveyed reaches consisted of all Main Rivers and major ordinary watercourse crossed by the Onshore Development Area. Details of the surveyed reaches are presented in **Table 21.2-1** and **Figure 21.2-1**.

Table 21.2-1 Surveyed Watercourses

Reach No.	Watercourse Type	Watercourse Name	Water Framework Directive Water body catchment
1	Ordinary Watercourse	Stream Dike	Barmston Sea Drain / Skipsea Drain to Conf

Reach No.	Watercourse Type	Watercourse Name	Water Framework Directive Water body catchment
2	Internal Drainage Board (IDB) Drain	Dunnington Sewer	Old Howe / Frodingham Beck to R Hull
3	Ordinary Watercourse	Towns Drain	Mickley Dike Catchment
4	Main River	Mickley Dike	
5	IDB Drain	Holts Drain	
6	IDB Drain	Halls Drain	
7	IDB Drain	Hallytreeholme Farm	
8a	IDB Drain	Holderness Drain	Holderness Drain Source to Foredyke Stream
8b	Main River	Holderness Drain	
9	IDB Drain	Burshill Park Drain	
10	IDB Drain	Heigholme Drain	
11	IDB Drain	Leven South Carr Drain	
12	Main River	River Hull	Hull from Arram Beck to Humber
13	Main River	Beverley and Barmston Drain	Beverley and Barmston Drain
14	IDB Drain	Coal Dike	
15	IDB Drain	Watson Drain	
16	IDB Drain	Boundary Drain	
17	Main River	Bryan Mills Beck	Bryan Mills Beck Source to Bryan Mills Farm
18	Main River	Scorborough Beck	Scorborough Beck
19	Ordinary Watercourse	Bealey's Beck	
20	Ordinary Watercourse	North Drain	High Hunsley to Arram Area
21	Ordinary Watercourse	South of Birkhill Wood	Beverley and Barmston Drain
22	Ordinary Watercourse	Autherd Drain	High Hunsley to Woodmansey Area



Legend:

- Onshore Development Area
- Watercourse
- Main River
- Beverley and North Holderness IDB Drains

Project:

Dogger Bank D Offshore Wind Farm

DOGGER BANK WIND FARM

Title:

Geomorphological Walkover Survey Extent

Figure: 21.2-1

Drawing No: PC6250-RHD-XX-ON-DR-GS-0039

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
03	23/05/2025	JH	GC	A3	1:100,000
02	11/11/2024	JH	GC	A3	1:100,000

Co-ordinate system: British National Grid

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21.2.2.2 Methodology

5. A targeted geomorphology walkover survey was undertaken to characterise the surface water conditions of the watercourses. The survey was undertaken between 21st and 24th October 2024, by two experienced fluvial geomorphologists using best-practice guidance for geomorphological characterisation and monitoring, including:

   - Environment Agency (2003): River Habitat Survey in Britain and Ireland: Field Survey Guidance Manual.
   - Environment Agency (2007): Geomorphological Monitoring Guidelines for River Restoration Schemes.
   - European Committee for Standardization (CEN, 2018): Water Quality – Guidance standard for assessing the hydromorphological features of rivers.

6. Visual inspections were undertaken in the survey area for each watercourse. The main characteristics of each watercourse were carefully recorded from the bank top. Photographs and locations of key features of interest were captured and recorded. The following parameters were recorded in order to characterise the baseline geomorphology of each watercourse:

   - Flow conditions, including dominant flow types and the degree of variability within each reach.
   - Channel form, including planform, width and depth variation, bank form and condition, substrate and bank materials.
   - Floodplain characteristics, including connectivity to the floodplain, and structure of the riparian zone.
   - Evidence of channel modification, including enlargement and re-sectioning, artificial bank protection, embankments and in-channel structures.
   - Any visual contamination of the watercourse (e.g. excessive sedimentation / smothering, hydrocarbons, sewage fungus, discoloration, etc.) as well as any operating discharges / pipes e.g. septic tank outflows etc. in order to identify any evidence of contamination or local sources of pollution.

7. At the crossing points, the survey encompassed the onshore export cable corridor (ECC) width. In areas where the spatial extent of the works is greater (e.g. the grid connection, Onshore Converter Station (OCS) zones and temporary construction compounds), the targeted walkover survey encompassed the entire length of any watercourse within the footprint of the Onshore Development Area. All terminology used for the survey was consistent with the latest standard for hydromorphology (CEN, 2018).

21.2.2.3 Survey Limitations

8. Channel flow and water levels on survey days were low, particularly in the IDB drains. Several watercourses showed evidence of recent vegetation clearance and dredging, and these maintenance activities served to remove potential erosional and depositional features in the affected water courses. It is considered unlikely any natural geomorphological features would have been present in most of these drains due to the baseline management strategy of regular sediment removal.

9. Access to watercourse channels was variable, with difficulty in some areas due to dense vegetation and fencing. However, sufficient areas were accessible to fully describe water course crossings, meaning the results discussed in the subsequent sections are representative of the dominant conditions at each crossing.

21.2.3 Results

10. Results of the walkover survey have been grouped and reported by their respective Water Framework Directive (WFD) water body catchment to allow easy cross reference to **Volume 1, Chapter 21 Water Resources and Flood Risk** of the PEIR and **Appendix 21.4 Water Environment Regulations Compliance Assessment**.

21.2.3.1 Barmston Sea Drain / Skipsea Drain to Conf (GB104026077770)

21.2.3.1.1 Stream Dike

11. The results of the Stream Dike walkover survey are presented in **Table 21.2-2**.

Table 21.2-2 Geomorphological Walkover Survey of Stream Dike

Parameter	Description
Grid Reference	**TA 17003 53924**
Overview	Stream Dike is a deep, uniform width channel that has been artificially incised. It is adjacent to arable farmland. Signs of recent vegetation clearing and dredging were observed and there was good access to the channel.

Parameter	Description
Grid Reference	**TA 17003 53924**
	
Flow Conditions	There is no diversity in flow type; stagnant water was observed in the channel.
Channel Form, Soils and Substrates	The watercourse has a straight, uniform width channel. Banks are steep and vegetated, however recent vegetation clearance and dredging have led to unprotected bank toes. Also, any evidence of erosion and deposition would have been removed by dredging activities. The banks are made of silt while substrate materials were obscured by turbid water. The watercourse has a bankfull width and depth of 4 m respectively, and a wetted width of 1.5 m. The wetted depth was obscured by turbid water. 
Floodplain Connectivity	There is no connectivity with the floodplain.

Parameter	Description
Grid Reference	**TA 17003 53924**
In Channel / Riparian Vegetation	In-channel vegetation was not observed. The banks were vegetated with grass on the left bank and herbaceous vegetation on the right bank. There is no diversity in riparian vegetation on the floodplains due to arable land use.
Modifications / Structures / Pollution	The watercourse is an artificial straight channel with uniform width. There were no in-channel structures in the surveyed section.

21.2.3.2 Old Howe / Frodingham Beck to R Hull (GB104026067021)

21.2.3.2.1 Dunnington Sewer

12. The results of the Dunnington Sewer walkover survey are presented in **Table 21.2-3**.

Table 21.2-3 Geomorphological Walkover Survey of Dunninton Sewer

Parameter	Description
Grid Reference	**TA 14989 52718**
Overview	Dunnington Sewer is an artificial, straight and deep channel of uniform width. Access to the channel was good. Woodland and arable land characterise the left and right banks, respectively. Right bank vegetation is maintained by mowing. 

Parameter	Description
Grid Reference	**TA 14989 52718**
	
Flow Conditions	There is no diversity in flow type; stagnant water was observed in the channel.
Channel Form, Soils and Substrates	The watercourse has a straight, uniform width channel. The banks are steep and vegetated. There were no signs of dredging, but the right bank grass cover is regularly mowed. Bank toes are vegetated, and no signs of erosion or deposition were observed. Bank and substrate materials were obscured by vegetation and turbid water respectively. The watercourse has a bankfull width and depth of 2.5 m and 2 m respectively, and a wetted width of 1.5 m. The wetted depth was obscured by turbid water.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	In-channel vegetation was observed, while grass and herbaceous vegetation covered the right and left banks respectively. There is no diversity in riparian vegetation on the right floodplain (due to arable land use), but a mixture of herbaceous flora and trees was observed on the left bank.
Modifications / Structures/ Pollution	The watercourse is an artificial straight channel with uniform width. There were no in-channel structures in the surveyed section.

21.2.3.3 Mickley Dike Catchment (GB104026066990)

21.2.3.3.1 Towns Drain

13. The results of the Town Drain walkover survey are presented in **Table 21.2-4**.

Table 21.2-4 Geomorphological Walkover Survey of Towns Drain

Parameter	Description
Grid Reference	**TA 12065 51476**
Overview	Towns drain is an artificial straight and deep channel of uniform width. Access to the channel was poor due to a thick hedge; observations were made from one access point. Adjacent land use on both banks was arable, although the Orange Road is on the left bank of the drain. There were no signs of vegetation clearance or dredging. 

Parameter	Description
Grid Reference	**TA 12065 51476**
	
Flow Conditions	Observations were obscured due to vegetation cover.
Channel Form, Soils and Substrates	The watercourse has a straight and uniform width channel. Banks were vegetated by a mixture of grass and herbaceous vegetation. At the point of access, bank toe protection was not observed. Bank materials were obscured while gravel substrate was observed in places. Signs of erosion and deposition were obscured, and channel dimensions could not be accurately estimated.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	The right bank floodplain was covered by grass and herbaceous flora, while a hedge covered the left bank floodplain.
Modifications / Structures / Pollution	Two pipe inlets were observed on the left bank, and the Orange Road is on the left bank of the water course.

Parameter	Description
Grid Reference	**TA 12065 51476**
	

21.2.3.3.2 Mickley Dike

14. The results of the Mickley Dike walkover survey are presented in **Table 21.2-5**.

Table 21.2-5 Geomorphological Walkover Survey of Mickley Dike

Parameter	Description
Grid Reference	**TA 10487 49661**
Overview	Mickley Dike is a straight channel with a uniform width. Land use on the left bank floodplain is tourism (caravan park), and arable land on the right bank floodplain. Access to the channel was good and there were signs of recent vegetation clearance and dredging.
Flow Conditions	No perceptible flow was observed.
Channel Form, Soils and Substrates	The watercourse has a straight and uniform width channel. Recent dredging activities have removed potential signs of erosion or deposition from the channel. Both bank and substrate materials were silt. While bank toe was vegetated in some sections, in others vegetation had recently been removed by dredging. The watercourse has a bankfull width and depth of 4 m respectively, and a wetted width and depth of 1 m and 0.3 m.
Floodplain Connectivity	There is no connectivity with the floodplain.

Parameter	Description
Grid Reference	**TA 10487 49661**
In Channel / Riparian Vegetation	There was limited in-channel vegetation and both banks were grassed. There is no diversity in riparian vegetation as adjacent lands are arable.
Modifications / Structures/ Pollution	Embankments were observed on both sides of the channel. A trash screen, culvert and bridge crossings were also observed. 

21.2.3.3.3 Holts Drain

15. The results of the Holts Drain walkover survey are presented in **Table 21.2-6**.

Table 21.2-6 Geomorphological Walkover Survey of Holts Drain

Parameter	Description
Grid Reference	**TA 09973 49797**
Overview	Holts Drain is an artificial straight channel of uniform width. Access to the channel was good. The adjacent land use is rough pasture. There were no signs of recent dredging and vegetation clearance.

Parameter	Description
Grid Reference	**TA 09973 49797**
	
Flow Conditions	There is no diversity in flow type, stagnant water was observed in the channel.
Channel Form, Soils and Substrates	The watercourse has a straight and uniform width channel. Both banks were vegetated, and thus, bank materials were obscured. Also, due to in-channel vegetation, substrate materials were not observed. There were no visible signs of erosion or deposition. The watercourse has a bankfull width and depth of 3 m and 1.5 m respectively, and a wetted width of 1.5 m and wetted depth of 0.4 m.
Floodplain Connectivity	There is limited connectivity with the floodplain due to the incised nature of the channel.

Parameter	Description
Grid Reference	**TA 09973 49797**
	
In Channel / Riparian Vegetation	The left bank floodplain was characterised by grass, herbaceous flora and a deciduous tree; grasses covered the right bank floodplain.
Modifications / Structures / Pollution	The channel is straight and has a unform width, but there were no in-channel modifications / structures observed.

21.2.3.3.4 Halls Drain

16. The results of the Halls Drain walkover survey are presented in **Table 21.2-7**.

Table 21.2-7 Geomorphological Walkover Survey of Halls Drain

Parameter	Description
Grid Reference	**TA 10224 49839**
Overview	Halls Drain is an artificial, straight channel of uniform width. Adjacent land use was arable and access to channel was good. There were no signs of recent vegetation clearance or dredging.

Parameter	Description
Grid Reference	**TA 10224 49839**
	
Flow Conditions	There is no diversity in flow type; stagnant water was observed in the channel.
Channel Form, Soils and Substrates	The watercourse has a straight and uniform width channel. Both banks were vegetated by grass and characterised by silts. Due to in-channel vegetation, substrate materials were not observed. There were no visible signs of erosion or deposition. The watercourse has a bankfull width and depth of 3 m and 1.5 m respectively, and a wetted width of 1.5 m. The wetted depth was obscured by in-channel vegetation.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	The floodplain was covered by improved grass and herbaceous flora.
Modifications / Structures / Pollution	The channel is straight and has a unform width, but there were no in-channel modifications / structures.

21.2.3.3.5 Hallytreeholme Farm

17. The channel at Hallytreeholme could not be surveyed due to dense vegetation on the banks of the watercourse.

21.2.3.4 Holderness Drain Source to Foredyke Stream (GB104026066950)

21.2.3.4.1 Holderness Drain

18. The results of the Holderness Drain walkover survey are presented in **Table 21.2-8**.

Table 21.2-8 Geomorphological Walkover Survey of Holderness Drain (IDB Drain)

Parameter	Description
Grid Reference	**TA 08713 48836**
Overview	Holderness Drain (IDB Drain) is an artificial, straight and deep channel of uniform width. The surrounding land use was arable. 

Parameter	Description
Grid Reference	**TA 08713 48836**
	
Flow Conditions	The flow type could not be observed due vegetation obscuring the channel.
Channel Form, Soils and Substrates	The channel is an artificial drainage channel of uniform width. The substrate and bank materials could not be observed as the channel was obscured by herbaceous vegetation and grass cover. The watercourse has a bankfull width and depth of 4 m. No wetted observations were made due to dense in-channel vegetation cover.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	The watercourse had extensive in-channel vegetation. Both banks were vegetated with the left bank dominated by grasses and the right bank dominated by herbaceous vegetation. There is no diversity in riparian vegetation on the floodplains due to arable land use.
Modifications / Structures / Pollution	The channel is artificial and there were no in-channel modifications / structures observed.

21.2.3.4.2 Holderness Drain

19. The results of the Holderness Drain (Main River) walkover survey are presented in **Table 21.2-9.**

Table 21.2-9 Geomorphological Walkover Survey of Holderness Drain (Main River)

Parameter	Description
Grid Reference	**TA 08098 45670**
Overview	Holderness Drain is an artificial drainage channel of uniform width surrounded by arable land on both banks. There was good channel access during site visit. 

Parameter	Description
Grid Reference	**TA 08098 45670**
	
Flow Conditions	Holderness Drain displayed little variation in flow type as stagnant water was observed in-channel.
Channel Form, Soils and Substrates	The drain is a deep, artificial drainage channel of uniform width. The substrate material was obscured due to turbid water. The bank material was silt, and the watercourse has a bankfull width and depth of 5 m and 1.5 m, respectively. The wetted width was obscured by vegetation growth while turbid water obscured the wetted depth.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	There was no in-channel vegetation observed. Both banks were vegetated with grasses and herbaceous vegetation. Land use on both floodplains was arable with no diversity in riparian vegetation.
Modifications / Structures / Pollution	The channel is artificial and there were no in-channel modifications / structures observed.

21.2.3.4.3 Burshill Park Drain

20. The results of the Burshill Park Drain walkover survey are presented in **Table 21.2-10**.

Table 21.2-10 Geomorphological Walkover Survey of Burshill Park Drain

Parameter	Description
Grid Reference	**TA 08555 48276**
Overview	Burshill Park Drain is an artificial, straight channel of uniform width. Adjacent land use was arable on both banks. In channel vegetation was present; herbaceous plants covered the left bank and grass was present on the right bank. 

Parameter	Description
Grid Reference	**TA 08555 48276**
	
Flow Conditions	There is no diversity in flow type, stagnant water was observed in the channel.
Channel Form, Soils and Substrates	The watercourse has a straight and uniform width channel. Both banks were vegetated with grasses on the right banks and herbaceous plants on the left bank. Due to in-channel vegetation, substrate materials were not observed. There were no visible signs of erosion or deposition. The watercourse has a bankfull width and depth of 5 m respectively and a wetted width and depth of 1 m and 0.3 m respectively.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	Channel banks were vegetated with grass and brush with brush growth in the channel. There is no diversity in riparian vegetation on the floodplains due to arable land use.
Modifications / Structures / Pollution	The channel is straight and has a unform width, but there were no in-channel modifications / structures observed.

21.2.3.4.4 Heighholme Drain

21. The results of the Heigholme Drain walkover survey are presented in **Table 21.2-11**.

Table 21.2-11 Geomorphological Walkover Survey of Heighholme Drain

Parameter	Description
Grid Reference	**TA 08550 47148**
Overview	Heighholme Drain is an artificial, straight channel of uniform width. Adjacent land was arable on both banks. Significant in-channel vegetation was present and both banks were grassed. 

Parameter	Description
Grid Reference	**TA 08550 47148**
	
Flow Conditions	There is no diversity in flow type, stagnant water was observed in the channel.
Channel Form, Soils and Substrates	The watercourse has a straight, uniform width channel. Both banks were vegetated and there were no signs of recent vegetation clearance or dredging. Due to in-channel vegetation, substrate materials were not observed. There were no visible signs of erosion or deposition. The watercourse has a bankfull width and depth of 4 m and 2.5 m respectively, and a wetted width of 1 m. The wetted depth was obscured by in-channel vegetation.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	There was significant in-channel vegetation (rushes) and grass was present on both banks. There is no diversity in riparian vegetation on the floodplains due to arable land use.
Modifications / Structures/ Pollution	The channel is straight and has a unform width, but there were no in-channel modifications / structures observed.

21.2.3.4.5 Leven South Carr Drain

22. At the time of the visit, no access was granted by landowners and therefore the watercourse not observed.

21.2.3.5 Hull from Arram Beck to Humber (GB104026067212)

21.2.3.5.1 River Hull

23. The results of the River Hull walkover survey are presented in **Table 21.2-12**.

Table 21.2-12 Geomorphological Walkover Survey of the River Hull

Parameter	Description
Grid Reference	**TA 05493 45475**
Overview	The River Hull is bounded by embankments on both sides with arable land use on the right-hand bank and woodland on the left-hand bank. Access to the river was poor due to vegetation and boggy floodplain soils. 

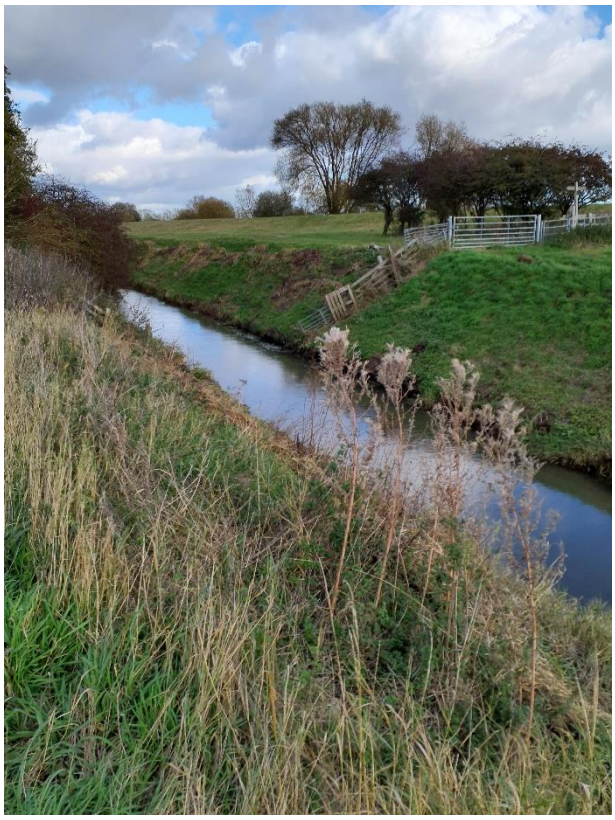
Parameter	Description
Grid Reference	**TA 05493 45475**
	
Flow Conditions	The River Hull displays little variation in flow conditions, which are characterised by glide flows.
Channel Form, Soils and Substrates	The river channel is embanked on both sides. Substrates could not be observed due to dense vegetation. The watercourse has a bankfull width of 25 m and a wetted width of 10 m. The bankfull depth and wetted depth were obscured due to inaccessible banks.
Floodplain Connectivity	There is connectivity with the immediate floodplain, although embankments on both banks constrain the potential for wider connectivity.
In Channel / Riparian Vegetation	No in-channel vegetation is present in the River Hull. Both banks are vegetated with grasses and trees, however canopy cover is low (<30%).
Modifications / Structures / Pollution	There is an embankment on both banks of the River Hull, but no other modifications / structures are present.

21.2.3.6 Beverley and Barmston Drain (GB104026067211)

21.2.3.6.1 Beverley and Barmston Drain

24. The results of the Beverley and Barmston Drain walkover survey are presented in **Table 21.2-13.**

Table 21.2-13 Geomorphological Walkover Survey of Beverley and Barmston Drain

Parameter	Description
Grid Reference	**TA 05428 45589**
Overview	The Beverley and Barmston Drain is an artificial drainage channel of uniform width with arable land use on both banks. There was good access to the channel and signs of recent dredging were observed. 
Flow Conditions	There is no variation in flow type. Stagnant water was observed in the channel.
Channel Form, Soils and Substrates	The watercourse is an artificial drainage channel of uniform width. There were no signs of erosion or deposition observed, but the channel had been recently desilted/dredged. The substrate material was obscured by turbid water. The watercourse has a bankfull width and depth of 10 m and 5 m respectively, and a wetted width of 3 m. The wetted depth was obscured by turbid water.
Floodplain Connectivity	There is no connectivity with the floodplain.

Parameter	Description
Grid Reference	**TA 05428 45589**
In Channel / Riparian Vegetation	There was no in-channel vegetation observed and both banks of the Beverley and Barmston Drain were vegetated with grasses. There is no diversity in riparian vegetation on the floodplains due to arable land use.
Modifications / Structures / Pollution	The channel is artificial and there were no in-channel structures observed. The channel had recently been desilted.

21.2.3.6.2 Coal Dike

25. The results of the Coal Dike walkover survey are presented in **Table 21.2-14**.

Table 21.2-14 Geomorphological Walkover Survey of Coal Dike

Parameter	Description
Grid Reference	**TA 04497 46994**
Overview	Coal Dike is a straight, deep incised channel of uniform width. The adjacent land use is arable and access to the channel was good. No signs of recent dredging were observed, but weed removal had been carried out prior to site visit. 

Parameter	Description
Grid Reference	TA 04497 46994
	
	

Parameter	Description
Grid Reference	**TA 04497 46994**
Flow Conditions	Coal Dike displayed riffles in some places but a well-defined pool-riffle sequence was not observed. In most areas there was no receptible signs of flow.
Channel Form, Soils and Substrates	The watercourse is a straight, deep incised channel of uniform width. There were no signs of erosion or deposition observed. Gravel bed was observed in one location (immediately downstream of the bridge) but there appeared to be no transfer of gravel from upstream. A silt bed was observed along the rest of the reach. The observed bank material was silt. The watercourse has a bankfull width and depth of 3 m and a wetted width and depth of 0.8 m and 0.1 m, respectively.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	No in-channel vegetation was observed. Grasses and herbaceous vegetation were observed on the right and left banks respectively. Signs of recent weed removal from the channel were observed.
Modifications / Structures / Pollution	There were no in-channel modifications / structures observed. A bridge crossing was noted along the survey reach.

21.2.3.6.3 Watson Drain

26. The results of the Watson Drain walkover survey are presented in **Table 21.2-15**.

Table 21.2-15 Geomorphological Walkover Survey of Watson Drain

Parameter	Description
Grid Reference	**TA 04525 45603**
Overview	Watson Drain is an artificial drainage channel of uniform width. There is good access to the channel and adjacent land use is arable. Signs of recent dredging and vegetation clearance were not observed.

Parameter	Description
Grid Reference	**TA 04525 45603**
	
Flow Conditions	Glide flows characterise the reach.
Channel Form, Soils and Substrates	The watercourse is a straight, artificial channel of uniform width. There were no signs of erosion or deposition observed. The substrate was obscured by turbid water and bank materials were also obscured by vegetation. The watercourse has bankfull and wetted widths of 3 m and 1 m, respectively. Bankfull and wetted depths were obscured.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	No in-channel vegetation was observed. Both bank face and bank top were vegetated with grasses. There is no diversity in riparian vegetation on the floodplains due to arable land use.
Modifications / Structures / Pollution	The channel is artificial and there were no in-channel modifications / structures observed.

21.2.3.6.4 Boundary Drain A

27. The results of the Boundary Drain A walkover survey are presented in **Table 21.2-16**.

Table 21.2-16 Geomorphological Walkover Survey of Boundary Drain

Parameter	Description
Grid Reference	**TA 04407 45587**
Overview	Boundary Drain A is a deep, artificial drainage channel with uniform width. Access was good and arable land use was adjacent to both banks. Signs of recent dredging and weed removal were not observed. 
Flow Conditions	Flow conditions at Boundary Drain A showed no variation; stagnant water was observed in the channel.
Channel Form, Soils and Substrates	The watercourse is a straight, artificial channel of uniform width. There were no signs of erosion or deposition observed. Substrates were obscured by turbid water. The watercourse has a bankfull width and depth of 4 m and 2 m respectively, and a wetted width of 1 m. The wetted depth was obscured by turbid water.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	There was no in-channel vegetation observed. The right bank is vegetated with grasses and the left bank is vegetated with herbaceous vegetation.

Parameter	Description
Grid Reference	**TA 04407 45587**
Modifications / Structures / Pollution	The channel is artificial and there were no in-channel modifications / structures observed.

21.1.3.6.4.1 Boundary Drain B

28. The results of the Boundary Drain B walkover survey are presented in **Table 21.2-17**.

Table 21.2-17 Geomorphological Walkover Survey of Boundary Drain B

Parameter	Description
Grid Reference	**TA 03214 45620**
Overview	A second reach along Boundary Drain was observed approximately 1.2 km upstream of the location recorded in **Table 21.2-16**. Here, Boundary Drain is a deep, artificial drainage channel of uniform width. The geomorphic features observed at this second crossing were the same as those described for Boundary Drain in **Table 21.2-16** and are not described further. 

Parameter	Description
	

21.2.3.6.5 Ordinary Watercourse South of Birkhill Wood A

29. The results of the survey of the ordinary watercourse south of Birkhill Wood A are presented in **Table 21.2-18**.

Table 21.2-18 Geomorphological Walkover Survey of South of Birkhill Wood A

Parameter	Description
Grid Reference	**TA 03618 35590**
Overview	The ordinary watercourse south of Birkhill Wood A is an artificial drainage channel with dense vegetation on both banks. Due to dense vegetation, it was only possible to access the channel at one location along this reach.

Parameter	Description
Grid Reference	TA 03618 35590
	
	

Parameter	Description
Grid Reference	**TA 03618 35590**
Flow Conditions	Flow appeared to be stagnant, although the reach was heavily obscured by vegetation.
Channel Form, Soils and Substrates	The watercourse is an artificial drainage channel. The surrounding land use on both banks is characterised by scrubby riparian woodland. The observed substrate material was silt, and the bank material was sandy. The watercourse has a bankfull width and depth of 1.5 m and 0.5 m respectively, and a wetted width and depth of 0.8 m and 0.05 m.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	There was extensive in-channel vegetation observed. Dense herbaceous vegetation and shrubs were observed on both banks, and there was high canopy cover of >70%.
Modifications / Structures / Pollution	There were no in-channel modifications / structures observed.

21.1.3.6.5.1 Ordinary Watercourse South of Birkhill Wood B

30. The results of the survey of the ordinary watercourse south of Birkhill Wood B are presented in **Table 21.2-19.**

Table 21.2-19 Geomorphological Walkover Survey of South of Birkhill Wood B

Parameter	Description
Grid Reference	**TA 03687 35340**
Overview	The reach at South of Birkhill Wood B is located approximately 0.3 km downstream of South of Birkhill Wood A (**Table 21.2-18**). The watercourse was obscured by dense vegetation and access to the channel was not possible.

Parameter	Description
	

21.1.3.6.5.2 Ordinary Watercourse South of Birkhill Wood C

31. The results of the survey of the ordinary watercourse south of Birkhill Wood C are presented in **Table 21.2- 20.**

Table 21.2-20 Geomorphological Walkover Survey of South of Birkhill Wood C

Parameter	Description
Grid Reference	**TA 03634 35319**
Overview	A third reach south of Birkhill Wood (C) was recorded on an adjacent tributary approximately 0.1 km upstream of the confluence with the watercourse recorded in **Table 21.2-18.** The features observed at South of Birkhill Wood C were similar to that described in **Table 21.2-18** and are not discussed further.

Parameter	Description
Grid Reference	TA 03634 35319
	
	

21.1.3.6.5.3 Ordinary Watercourse South of Birkhill Wood D

32. The results of the survey of the ordinary watercourse south of Birkhill Wood D are presented in **Table 21.2-21.**

Table 21.2-21 Geomorphological Walkover Survey of South of Birkhill Wood D

Parameter	Description
Grid Reference	**TA 03572 35356**
Overview	A fourth location south of Birkhill Wood (D) was recorded approximately 0.2 km upstream of South of Birkhill Wood C. The features observed at South of Birkhill Wood D were similar to that described in **Table 21.2-18** and are not described further. 

21.1.3.6.5.4 Ordinary Watercourse South of Birkhill Wood E

33. The results of the survey of the ordinary watercourse south of Birkhill Wood E are presented in **Table 21.2-22.**

Table 21.2-22 Geomorphological Walkover Survey of South of Birkhill Wood E

Parameter	Description
Grid Reference	**TA 03603 35270**

Parameter	Description
Overview	A fifth location south of Birkhill Wood (E) was recorded on a second adjacent tributary approximately 0.1 km upstream of the confluence with the watercourse recorded in **Table 21.2-18.** The features observed at South of Birkhill Wood E were similar to that described in **Table 21.2-18** and are not described further.

21.1.3.6.5.5 Ordinary Watercourse South of Birkhill Wood F (TA 02560 34923)

34. Access to another reach of ordinary watercourse south of Birkhill Wood F was not possible, therefore no observations were made.

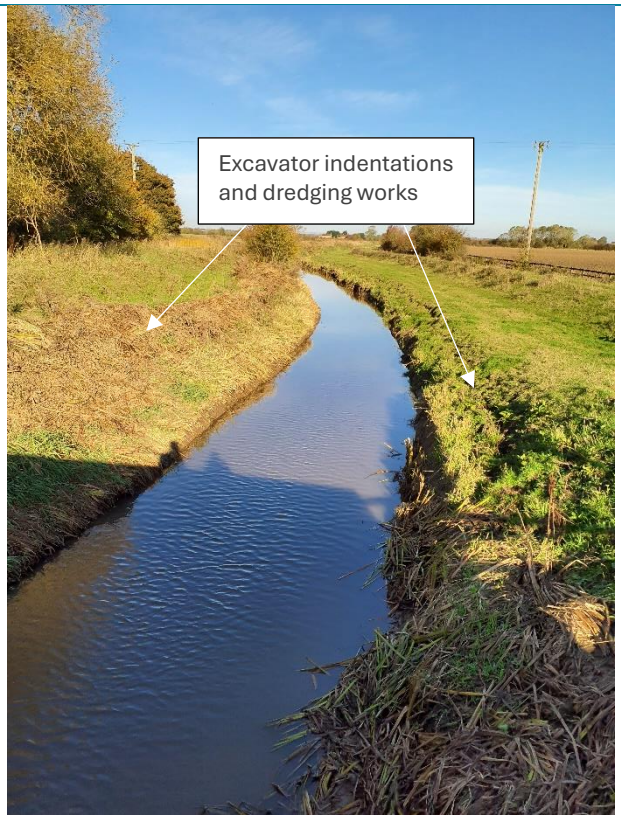
21.2.3.7 Bryan Mills Beck Source to Bryan Mills Farm (GB104026066960)

21.2.3.7.1 Bryan Mills Beck A

35. The results of the Bryan Mills Beck A walkover survey are presented in **Table 21.2-23.**

Table 21.2-23 Geomorphological Walkover Survey of Bryan Mills Beck A

Parameter	Description
Grid Reference	**TA 03032 45985**
Overview	Bryan Mills Beck has a channel of uniform width with embankments on either side. Signs of recent activities included mowing, excavator indentations and dredging. The land use adjacent to Bryan Mills Beck is arable on the left bank and rough pasture on the right bank.

Parameter	Description
Grid Reference	TA 03032 45985
	 

Parameter	Description
Grid Reference	**TA 03032 45985**
Flow Conditions	The dominant flow type was glide.
Channel Form, Soils and Substrates	The watercourse flows in a channel of uniform width with embankments on either bank. The channel had recently been de-silted, removing any potential signs of erosion or deposition. The bank material was silt and recent de-silting of the channel was the likely cause of the turbid water which obscured the substrate. The watercourse has a bankfull width and depth of 6 m and 1.5 m respectively, and a wetted width of 3.5 m. The wetted depth was obscured by turbid water.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	There was no in-channel vegetation or canopy cover observed. There was no vegetation on either bank face, but the right bank top was vegetated with shrub and the left bank top was vegetated with grasses.
Modifications / Structures / Pollution	The channel is bounded by embankments on either side to protect the railway on the right bank and arable farmland on the left bank.

21.1.3.7.1.1 Bryan Mills Beck B

36. The results of the Bryan Mills Beck B walkover survey are presented in **Table 21.2-24**.

Table 21.2-24 Geomorphological Walkover Survey of Bryan Mills Beck B

Parameter	Description
Grid Reference	**TA 03122 45521**
Overview	A second reach along Bryan Mills Beck was observed approximately 0.5 km downstream of the location recorded in **Table 21.2-23.** Here, Bryan Mills Beck is a straight, deep, artificial drainage channel of uniform width. The geomorphic features observed were similar to those described in **Table 21.2-23.** and are not described further.

Parameter	Description
	
	

21.2.3.8 Scorborough Beck (GB104026066901)

21.2.3.8.1 Scorborough Beck

37. The results of the Scorborough Beck walkover survey are presented in **Table 21.2-25**.

Table 21.2-25 Geomorphological Walkover Survey of Scorborough Beck

Parameter	Description
Grid Reference	**TA 01836 45714**
Overview	Scoroborough Beck flows in a deep, incised channel. The adjacent land use on both banks was arable. Due to thick vegetation obscuring the channel at all but one location, observations were made at this single accessible point. 

Parameter	Description
Grid Reference	TA 01836 45714
	
	

Parameter	Description
Grid Reference	**TA 01836 45714**
Flow Conditions	There was little perceptible flow in the reach.
Channel Form, Soils and Substrates	Fine gravel substrate material was observed in one location and the bank material was silt. There were some signs of fluvial erosion observed on the left bank. The watercourse has a bankfull width and depth of 4.5 m and 3 m respectively, and a wetted width and depth of 2 m and 0.2 m.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	Extensive in-channel grasses and herbaceous vegetation were observed. Both banks were vegetated with dense herbaceous / scrubby vegetation.
Modifications / Structures / Pollution	There were no in-channel modifications / structures observed at Scorborough Beck.

21.2.3.8.2 Bealey's Beck A

38. The results of the Bealey's Beck A walkover survey are presented in **Table 21.2-26**.

Table 21.2-26 Geomorphological Walkover Survey of Bealey's Beck A

Parameter	Description
Grid Reference	**TA 00210 45324**
Overview	Bealey's Beck A is a gravel-bed watercourse with a pool-riffle flow sequence. At the observed reach, bank protection was in place for a bridge crossing.

Parameter	Description
Grid Reference	TA 00210 45324
	
	

Parameter	Description
Grid Reference	**TA 00210 45324**
	
Flow Conditions	Riffles and pool were observed at Bealey's Beck.
Channel Form, Soils and Substrates	The watercourse is narrow with a mixture of woodland and herbaceous vegetation on the banks. The substrate and bank materials are fine gravels and sand, respectively. Erosion in the form of toe undercutting was observed at one location near a bridge. The watercourse has a bankfull width and depth of 5 m and 2.5 m respectively, and a wetted width and depth of 3 m and 0.15 m.
Floodplain Connectivity	There is limited connectivity to the floodplain.
In Channel / Riparian Vegetation	In-channel herbaceous vegetation was present at Bealey's Beck A. Herbaceous vegetation and woodland were also observed on the banks. Due to the wooded surroundings, canopy cover was high (>70%).
Modifications / Structures / Pollution	Sheet pile bank protection and bridge were observed.

21.1.3.8.2.1 Bealey's Beck B

39. The results of the Bealey's Beck B walkover survey are presented in **Table 21.2-27**.

Table 21.2-27 Geomorphological Walkover Survey of Bealey's Beck B

Parameter	Description
Grid Reference	**TA 00395 45435**
Overview	A second reach along Bealey's Beck was visited approximately 0.3 km downstream of the location recorded in **Table 21.2-26.** Here, Bealey's Beck was obscured by thick vegetation and no observations of the channel were made. 

21.1.3.8.2.2 Bealey's Beck C

40. The results of the Bealey's Beck C walkover survey are presented in **Table 21.2-28**.

Table 21.2-28 Geomorphological Walkover Survey of Bealey's Beck C

Parameter	Description
Grid Reference	**TA 00141 45376**
Overview	A third reach along Bealey's Beck was recorded approximately 0.1 km upstream of the location recorded in **Table 21.2-26**. Here, Bealey's Beck was observed as a fine gravel bed reach, with pool-riffle flow types and some in-channel large woody material present. There was also a small tributary that joined the channel 0.01 km upstream. Bank scour was observed at one location along the left bank and a small pipe outlet of the left bank. Overall, the reach is very similar to that described in **Table 21.2-26** and is not discussed further. 

Parameter	Description
Grid Reference	TA 00141 45376
	 

21.1.3.8.2.3 Bealey's Beck D

41. The results of the Bealey's Beck D walkover survey are presented in **Table 21.2-29**.

Table 21.2-29 Geomorphological Walkover Survey of Bealey's Beck D

Parameter	Description
Grid Reference	**SE 99927 45395**
Overview	A fourth reach along Bealey's Beck was observed approximately 0.4 km upstream of the location recorded in **Table 21.2-26.** Here, Bealey's Beck was observed as a fine gravel and sand bed reach, dominated by riffle and pool flow types. A tributary joined the channel at this observed reach. Overall, the reach is very similar to that described in **Table 21.2-26** and is not discussed further. 

21.2.3.9 High Hunsley to Arram Area (GB104026066841)

21.2.3.9.1 North Drain A

42. The results of the North Drain A walkover survey are presented in **Table 21.2-30**.

Table 21.2-30 Geomorphological Walkover Survey of North Drain A

Parameter	Description
Grid Reference	**TA 00190 42948**
Overview	North Drain A is an artificial drainage channel with a culvert running below Miles Lane Road. Land use is rough pasture on the right bank and arable on the left bank. The channel showed signs of recent excavation / dredging works. 

Parameter	Description
Grid Reference	TA 00190 42948
	 

Parameter	Description
Grid Reference	**TA 00190 42948**
Flow Conditions	Natural flow types were not observed due to recent channel works.
Channel Form, Soils and Substrates	The watercourse is an artificial drainage channel of uniform width. The substrate and bank materials are silt and the bank toe was bare from recent dredging. The watercourse has a bankfull width and depth of 1.5 m and 1 m respectively, and a wetted width and depth of 0.8 m and 0.02 m.
Floodplain Connectivity	There is no connectivity with the floodplain.
In Channel / Riparian Vegetation	There was no in-channel vegetation observed due to the recent dredging / excavation activity. Both banks were vegetated by grasses. There is no diversity in riparian vegetation on the floodplains due to arable land use.
Modifications / Structures / Pollution	One culvert was observed at the North Drain where the channel passes beneath the Miles Lane Road. The channel showed signs of recent dredging / excavation.

21.1.3.9.1.1 North Drain B

43. The results of the North Drain B walkover survey are presented in **Table 21.2-31**.

Table 21.2-31 Geomorphological Walkover Survey of North Drain B

Parameter	Description
Grid Reference	**SE 99723 42715**
Overview	A second reach along North Drain was observed approximately 0.5 km upstream of the location recorded in **Table 21.2-30**. Here, North Drain was observed as a dry and artificial drainage channel. The channel was completely vegetated with grasses and one culvert was observed. Adjacent land use was arable and access to the channel was good. Signs of dredging were observed in places. Overall, the reach has dimensions similar to that described in **Table 21.2-30**. and is not described further.

Parameter	Description
	
	

Parameter	Description
	

21.2.3.10 High Hunsley to Woodmansey Area (GB104026066820)

21.2.3.10.1 Autherd Drain

44. The results of the Autherd Drain walkover survey are presented in **Table 21.2-32**.

Table 21.2-32 Geomorphological Walkover Survey of Autherd Drain

Parameter	Description
Grid Reference	**TA 03607 37208**
Overview	Autherd Drain is an artificial drainage channel. The channel was dry during the site visit and one culvert was observed. There was good access to the channel, arable land use was observed on both banks.

Parameter	Description
Grid Reference	TA 03607 37208
	
	

Parameter	Description
Grid Reference	**TA 03607 37208**
Flow Conditions	The observed channel was dry; therefore, no flow type could be determined.
Channel Form, Soils and Substrates	The watercourse is an artificial drainage channel and the substrate was obscured by vegetation. The watercourse has a bankfull width and depth of 1 m and 0.5 m respectively. There were no wetted observations due to dry channel.
Floodplain Connectivity	The watercourse has limited connectivity with the floodplain.
In Channel / Riparian Vegetation	The dry channel contained extensive vegetation and both banks were vegetated with grasses. The land use surrounding the channel was arable and therefore, there is no diversity in riparian vegetation.
Modifications / Structures / Pollution	The channel is artificial, and one culvert was observed.

21.2.4 Survey Summary and Conclusions

45. A fluvial geomorphology baseline survey has been undertaken across 23 watercourses that intersect with the Onshore Development Area of the Project. The aim of the survey was to characterise the baseline geomorphological conditions of these watercourses. Some of the water bodies have more than one interaction point with the Onshore Development Area (e.g. ordinary watercourse south of Birkhill Wood). The survey coincided with vegetation clearance and dredging activities of some of the drains. These maintenance works therefore removed any potential signs of erosion or deposition in the affected drains, and also led to turbid water condition. This subsequently obscured observation of the substrate materials.

46. The following conclusions are made:

- There is limited connectivity with the floodplain (and in most cases, none exists) due to the incised nature of most channels, associated with dredging activities. Except for River Hull, Ordinary Watercourse South of Birkhill Wood, Scorborough Beck and Bealey's Beck (where woodland, herbaceous vegetation and grasses interact side by side), there is no diversity in riparian vegetation on the floodplains due to arable land use.
- The substrate and bank materials were primarily sand and silt, although fine gravel beds were observed at some locations (e.g. Bryan Mills Beck). In-channel and bank-face vegetation obscured observations in many water courses.
- In terms of flow type, little variation was observed as most watercourses had stagnant water in-channel. There was clear evidence of more natural forms and processes along Bealey's Beck, where a well-defined pool-riffle sequence was observed.

- Most of the surveyed watercourses are artificial and are designed to drain adjoining arable lands. These watercourses are deep (typically 1.5 – 5 m), straight and have uniform widths.
- In most cases, the bank toes were either bare or vegetated, but at two locations (Boundary drain and Autherd drain), artificial toe protection was observed.
- Except for very few cases of bank scour (e.g. Bealey's Beck), signs of erosion and deposition were not observed in most of the watercourses.
- Embankment, bridges and culverts were the near and across channel modifications. One trash screen was the only in-channel feature observed.
- Overall, watercourses in the survey area are set within sediment deposition zones, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments / silts by low energy glide flows. Many channels are characterised by in-channel vegetation, which will help to increase channel roughness and reduce flow velocities.
- A key finding of the survey is that, given the low energy nature of watercourses in the study area, there is limited potential for significant vertical channel incision of sufficient magnitude to expose the buried onshore export cables.

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List of Acronyms

Acronym	Definition
BNG	Biodiversity Net Gain
DBD	Dogger Bank D Offshore Wind Farm Project
DCO	Development Consent Order
ECC	Export Cable Corridor
GPS	Global Positioning System
IDB	Internal Drainage Board
OCS	Onshore Converter Station
PEIR	Preliminary Environmental Information Report
WFD	Water Framework Directive