RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Preliminary Environmental Information Report

Chapter 20 – Appendix 20.1 Geomorphological Baseline Survey Technical Report

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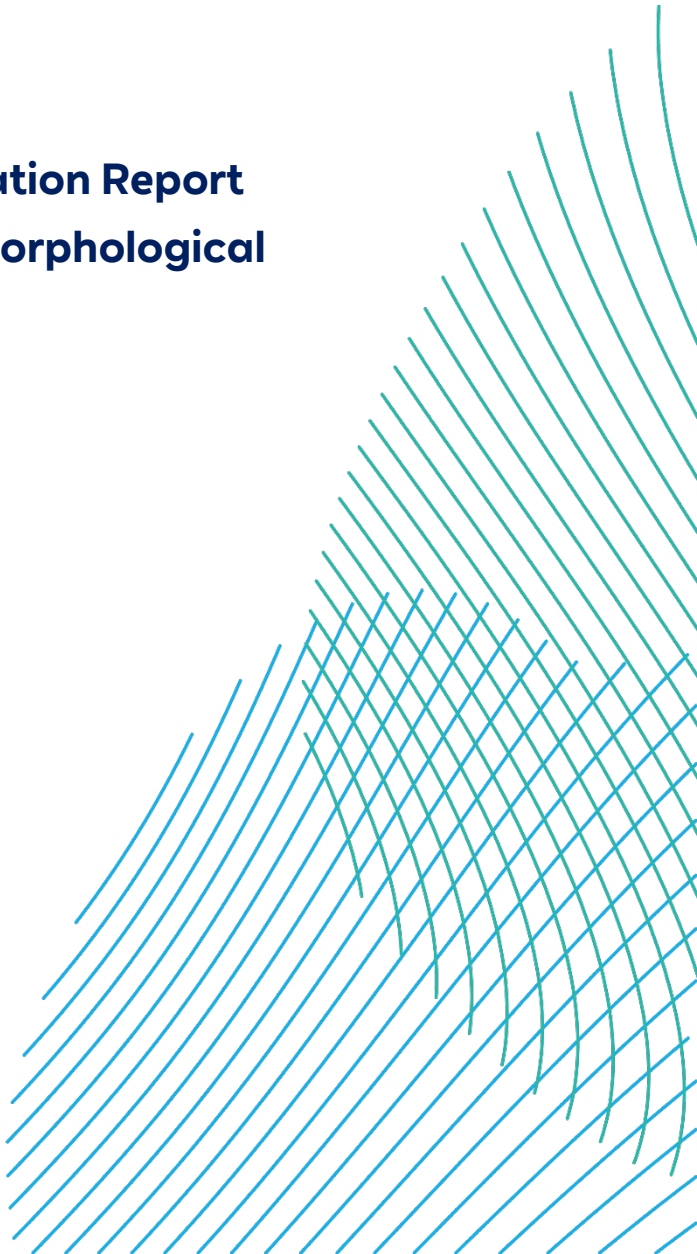

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Glossary

Term	Definition
Armouring	Armouring occurs when the bed surface of gravel-bed rivers is coarsened relative to the sub-surface.
Aggradation	A progressive build up or raising of the channel bed and floodplain due to sediment deposition. The geological process by which streambeds are raised in elevation and flood plains are formed. Aggradation indicates that stream discharge and/or bed-load characteristics are changing.
Bankfull Discharge	Bankfull discharge is the flow that reaches the transition between the channel and its flood plain and is thus morphologically significant.
Bar	An accumulation of alluvium (usually gravel or sand) caused by a decrease in sediment transport capacity on the inside of meander bends or in the centre of an overwide channel.
Bed	The bottom of a channel.
Bed Slope	The inclination of the channel bottom, measured as the elevation drop per unit length of channel.
Catchment	The total area of land that drains into any given watercourse.
Coarse Sediment	Sediment of grain diameter greater than 2 mm.
Cobbles	Substrate particles that are smaller than boulders and larger than gravels and are generally 64 - 256 mm in diameter. Can be further classified as small and large cobble.
Erosion	Process that wears away the river bed and banks. Erosion also breaks up the rocks that are carried by the river.

Term	Definition
Equilibrium	Rivers seek a state of dynamic equilibrium between the imposed conditions of valley slope, discharge, and sediment supply, and channel adjustments that can include width, depth, velocity, reach slope, roughness, and sediment size. Over time, the channel adjusts to changes in discharge and sediment supply due to human activities, climate change, and extreme events.
Gravel	Gravel or other shallow sediment deposition on the inside of bends.
Glide	A section of smooth or rippled flow, deeper flow than run.
Horizontal Directional Drilling (HDD)	HDD is a trenchless technique to bring the offshore cables ashore at the landfall and can be used for crossing other obstacles such as roads, railways and watercourses onshore.
Introductory Consultation Boundary	The area of search presented to the public as part of an initial consultation exercise in September 2021.
Main River	A statutory type of watercourse in England and Wales, maintained by the Environment Agency (EA). These watercourses are usually larger streams and rivers, but also include some smaller watercourses.
Ordinary Watercourse	Includes every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river.
Onshore Development Area	The Onshore Development Area for PEIR is the boundary within which all onshore infrastructure required for the Projects will be located including landfall, onshore export cable route, accesses, construction compounds and onshore substations. The Onshore Development Area is to be refined through the consultation and engineering review process.
Onshore Export Cables	Onshore export cables take the electricity from the Transition Joint Bay to the onshore substations.

Term	Definition
Landfall Locations	The location where the offshore cables come ashore.
Planform	The planform evolution of meandering rivers occurs as a result of mutual adjustments between meandering form and processes.
Pool	Discrete areas of deep water typically formed on the outside of meanders.
Point Bar	Gravel or other shallow sediment deposition on the inside of bends.
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South offshore wind farms).
Reach	A section of watercourse between two defined points and/or a length of an individual river which shows broadly similar physical characteristics.
Riparian	The area of land alongside a river, often planted with trees.
Riffle	A reach of stream that is characterised by shallow, fast-moving water broken by the presence of rocks and boulders.
Run	Shallow, fast flowing section, similar in character to a riffle but not a discrete feature.
Sinuosity	Sinuosity, as applied to stream-channel pattern, is a non-dimensional ratio of the length of the channel thalweg to the length of the stream valley, measured between the same points.
Silt	As fluvial sediment, silt is sediment with a particle diameter between 0.002 & 0.062 mm. Some classification systems define the lower size limit to be 0.004 mm.

Term	Definition
Scour	The erosive action of running water in streams, which excavates and carries away material from the bed and banks. Scour may occur in both earth and solid rock material and can be classed as general, contraction, or local scour.
Wetland Scrape	Shallow ponds of less than 1 m depth which hold rain or flood water seasonally and which remain damp for much of the year. They are shallow depressions with gently sloping edges which create obvious water features in fields. They can make a significant difference to wildlife and can be created in areas of damp or floodplain.
Sedimentation (Siltation)	The process by which sediment is mechanically deposited from suspension within a fluid, generally water, or ice, thereby accumulating as layers of sediment that are segregated owing to differences in size, shape, and composition of the sediment particles.
Scour	Removal of sediment such as sand and gravel.
Substrate	Sediment material that rests at the bottom of a river.
Thalweg	A line connecting the lowest points of successive cross-sections along the course of a valley or river.
The Applicant	RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited as the owners of DBS West and DBS East respectively are the named undertakers that will have the benefit of the Development Consent Order. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited.

Term	Definition
Water Environment Regulations	The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017, which implement Directive of the European Parliament and of the Council 2000/60/EC establishing a framework for community action in the field of water policy (generally known as the Water Framework Directive (WFD) under the terms of the Floods and Water (Amendment etc.) (EU Exit) Regulations 2019.
Wetland	Wetland is a low-lying area, including ephemeral-lake floors, in which water either is shallowly ponded on the surface or has a persistent (weeks or longer) near-surface condition of ground-water saturation adequate to support hydrophytic vegetation.

Acronyms

Term	Definition
AEP	Annual Exceedance Probability
AMSL	Above Mean Sea Level
DBS	Dogger Bank South
EIA	Environmental Impact Assessment
FRA	Flood Risk Assessment
GIS	Geographical Information Systems
MHWS	Mean High Water Spring
MLWS	Mean Low Water Spring
OS	Ordnance Survey
PEIR	Preliminary Environmental Information Report
PRoW	Public Rights of Way
SAC	Special Area of Conservation
SPA	Special Protected Area
SSSI	Site of Special Scientific Interest
UK	United Kingdom
WFD	Water Framework Directive

20.1. Introduction

20.1.1. Introduction

1. Royal HaskoningDHV was commissioned by RWE Renewables UK Dogger Bank South (West) and RWE Renewables Dogger Bank South (East) (hereafter the Applicant) to undertake a geomorphological baseline survey of the major watercourses proposed to be crossed by the onshore elements of the Dogger Bank South (DBS) East and DBS West offshore wind farms (the Projects). The baseline survey involved a walkover of thirteen major watercourses to establish and characterise the baseline conditions at those sites (see **Figure 20-1-1**).

20.1.2. Aims

2. The aim of the geomorphological walkover survey was to characterise the geomorphological baseline conditions of the major watercourses that are proposed to be crossed by the Projects.

3. 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. This baseline information has been used to determine how the watercourses are likely to respond to the construction, operation and decommissioning of the Projects. This baseline environment will then be used to inform the detailed design, construction and monitoring phases of the Projects , to ensure the geomorphological and ecological integrity of these watercourses is maintained.

4. The purpose of this report is to present the baseline characteristics of the surveyed watercourses, and to provide an overall understanding of their existing condition against which potential impacts can be assessed. The baseline information gathered during this geomorphological walkover survey has been used to inform the assessments presented in **Chapter 20 Hydrology and Flood Risk** and **Appendix 20.2 Water Environment Regulations Compliance Assessment**.

20.1.3. Methodology

5. This section presents the study area and methodology used to undertake the geomorphological walkover survey.

20.1.3.1. Study Area

6. Thirteen major watercourses which are located within the Projects Introductory Consultation Boundary were identified for the targeted geomorphological walkover survey. These consisted of all the Main Rivers and/or river water bodies identified under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 in the Humber River Basin District Management Plan. The thirteen identified watercourses are presented in **Table 20-1** and **Figure 20-1-1**.

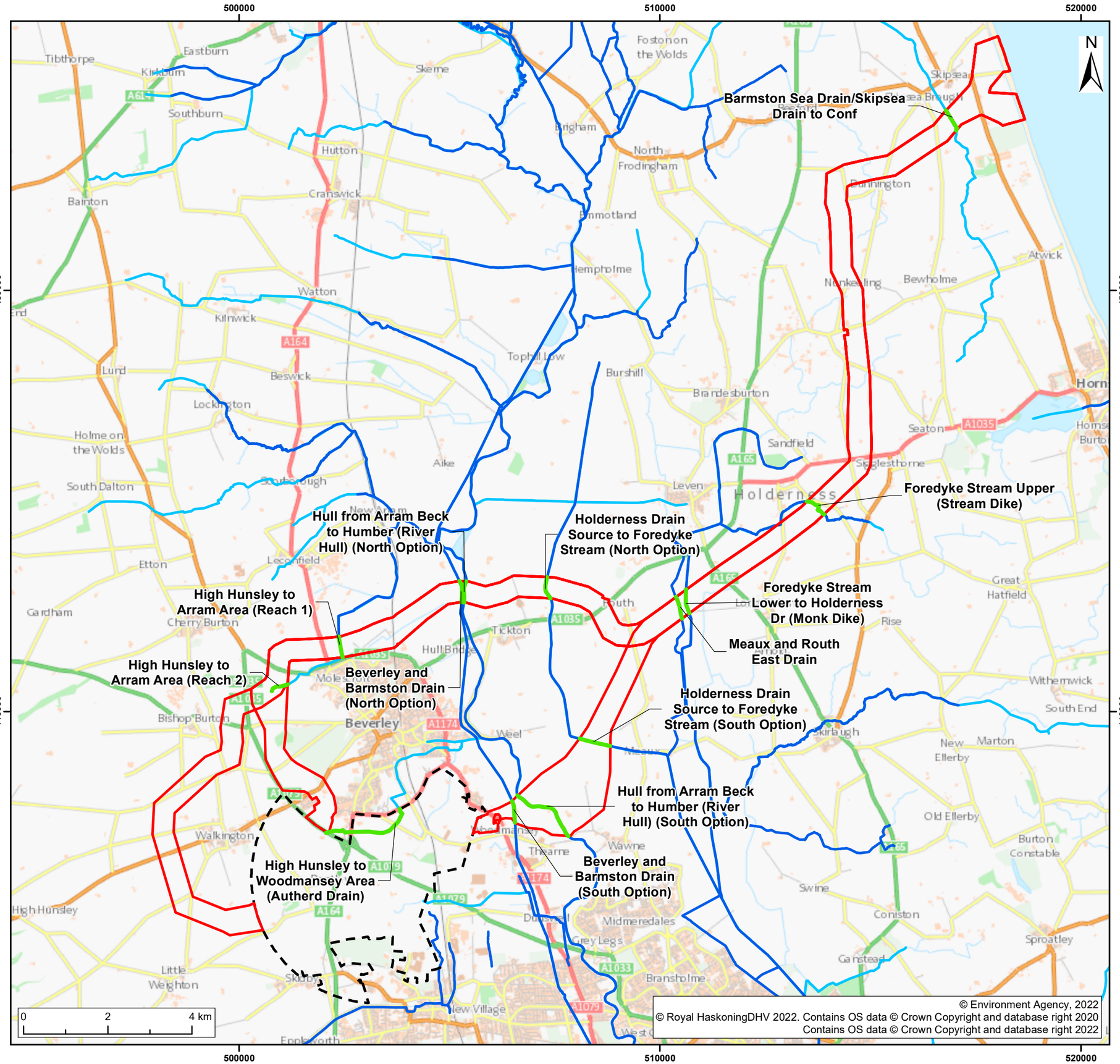
Table 20-1 Surveyed Watercourses

Crossing ID	Name	Type	Channel length within onshore export cable corridor (m)
21/20	Barmston Sea Drain / Skipsea Drain to Confluence	*Ordinary Watercourse & WFD Water Body	575
19	Foredyke Stream Upper (Stream Dike)	Main River & WFD Water Body	600
22	**Holderness Drain Source to Foredyke Stream (North Option)	Main River & WFD Water Body	524
18	Foredyke Stream Lower to Holderness Drain (Monk Dike)	Main River & WFD Water Body	560
17	Meaux and Routh East Drain	Main River	522
14	**Holderness Drain Source to Foredyke Stream (South Option)	Main River & WFD Water Body	724
10/11/13	**Hull from Arram Beck to Humber (River Hull) (South Option)	Main River & WFD Water Body	1700

Crossing ID	Name	Type	Channel length within onshore export cable corridor (m)
23	**Hull from Arram Beck to Humber (River Hull) (North Option)	Main River & WFD Water Body	491
8/9/12	**Beverley and Barmston Drain (South Option)	Main River & WFD Water Body	505
24	**Beverley and Barmston Drain (North Option)	Main River & WFD Water Body	515
25	High Hunsley to Arram Area (Reach 1)	Main River & WFD Water Body	450
26/27	High Hunsley to Arram Area (Reach 2)	Main River & WFD Water Body	405
2	High Hunsley to Woodmansey Area (Autherd Drain)	*Ordinary Watercourse & WFD Water Body	30

** Ordinary watercourses that are river water bodies were previously classified as main rivers, and as such have been included as water bodies in the RBMP. They have since had their status reviewed and are now ordinary watercourses, but the WER classification still stands. In other cases, watercourses that were classified as ordinary watercourses at the time that the first RBMP was drafted were not included as water bodies, but some of these may have since been upgraded to main river.*

***There were two potential onshore export cable route options when the geomorphological surveys were undertaken.*



Legend:

- Onshore Cable Corridor Options
- Refined Onshore Substation Area of Search
- Survey Location
- Main Rivers
- WFD River Water Body

S3	P01	08/09/2022	Suitable for Review & Comment	ND	LB	PB
SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR

Title:

Geomorphology Survey Locations

Figure: 20-1-1 | Drawing No: PB2340-RHD-ON-ZZ-DR-Z-0313

Co-ordinate system:	Page Size:	Scale:
British National Grid	A3	1:90,000

Project:	Report:
Dogger Bank South Offshore Wind Farms	Geomorphology Survey method Statement

Royal HaskoningDHV
Enhancing Society Together

RWE

20.1.3.2. Survey Methodology

7. A targeted walkover survey was undertaken to characterise the surface water conditions of these nine watercourses. The survey was undertaken between October 11th and October 12th 2022 by an experienced fluvial geomorphologist 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; and
   - River Restoration Centre (2011): Practical River Restoration Appraisal Guidance for Monitoring Options.

8. Following the best-practice guidance stated above, a visual inspection was undertaken along the study area for each watercourse. The main characteristics of each watercourse were carefully recorded from the bank top, which included detailed photographs and locations of key features using GPS. 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 types and the type and presence of bed forms such as pools, riffles and bars. Particular attention will also be paid to the extent of fine sedimentation on the bed of chalk river habitats.
   - Floodplain characteristics, including connectivity to the river channel, and the structure of the riparian zone.
   - Evidence of channel modification, including enlargement and re-sectioning, artificial bank protection, embankments and in-channel structures.
   - The survey aimed to identify 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.

9. At the proposed crossing points, the targeted walkover survey encompassed the onshore export cable corridor width. In areas where the spatial extent of the works is greater (e.g. the grid connection, substation and construction compounds), the targeted walkover survey encompassed the entire length of any watercourses within the footprint of the Projects. All terminology used for the survey was consistent with the latest standard for hydromorphology (CEN, 2018).

20.1.3.3. Survey Limitations

10. During the survey, water levels in the watercourses were predominately below bankfull and of low turbidity providing excellent visibility of the bed and banks of each watercourse to enable their overall geomorphological characteristics to be described. In addition, given the mild weather, the growth of aquatic plants was still very good despite the survey being undertaken in autumn.

20.1.4. Results

20.1.4.1. Barmston Sea Drain / Skipsea Drain to Confluence

11. The characteristics of the Barmston Sea Drain / Skipsea Drain to Confluence are described in **Table 20-2** and the results of the walkover survey are presented in **Table 20-3**.

Table 20-2 Details of Barnston Sea Drain / Skipsea Drain to Confluence

Parameter	Details
WFD Water Body	Barnston Sea Drain / Skipsea Drain to Confluence
Water Body ID	GB104026077780
Watercourse Type	Ordinary Watercourse & WFD Water Body
Grid Reference	TA16802 54278

Table 20-3 Geomorphological Walkover Survey of Barnston Sea Drain / Skipsea Drain to Confluence

Parameter	Description
Overview	Barnston Sea Drain / Skipsea Drain to Confluence consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 1**).  *Plate 1 Barnston Sea Drain*
Flow Conditions	Barnston Sea Drain is characterised by low energy glide flows, with some in-channel features potentially providing flow diversity at high flows (see below). The drain at the time of the survey, was characterised by low flows which were relatively clear.

Parameter	Description
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 8 m – 10 m high, stable (with no signs of erosion) and well vegetated. The channel is approximately 6 m – 8 m wide at the bank top, and 4 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels) (**Plate 1**). An inset bench was present creating a two-stage channel with local geomorphological complexity (**Plate 2**). This is likely to be indicative of natural channel narrowing in response to historical channel enlargement and resectioning. The substrate is dominated by sands and silts, although in places these overlaid pebbles and cobbles (**Plate 2**). Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 2 Barnston Sea Drain Channel Form Complexity and Substrate*

Parameter	Description
Floodplain Characteristics	Floodplain connectivity is likely to be constrained at lower flows due to the deeply incised nature of the channel.
In-channel / riparian vegetation	Good riparian vegetation is present, with the banks and margins well vegetated in places with rushes, sedges and reeds. Some in-channel aquatic vegetation growth was also recorded, although this was predominantly duck weed (*Lemna mino*) and organic leaf material (**Plate 3**).  *Plate 3 Barnston Sea Drain In-Channel Habitat*
Modifications/Structures/Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. No bank protection works were noted or signs of diffuse or point source pollution, with water quality clear and evidence of small fish.

20.1.4.2. Foredyke Stream Upper (Stream Dike)

12. The characteristics of the Foredyke Stream Upper (Stream Dike)are described in **Table 20-4** and the results of the walkover survey are presented in **Table 20-5**.

Table 20-4 Details of Foredyke Stream Upper (Stream Dike)

Parameter	Details
WFD Water Body	Foredyke Stream Upper
Water Body ID	GB104026066890
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA13581 44980

Table 20-5 Geomorphological Walkover Survey of Foredyke Stream Upper (Stream Dike)

Parameter	Description
Overview	Foredyke Stream Upper (Stream Dike) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 4**).  *Plate 4 Foredyke Stream Upper*

Parameter	Description
Flow Conditions	Foredyke Stream Upper is characterised by low energy glide flows, with some in-channel features potentially providing flow diversity during higher flows (see below). The drain at the time of the survey, was characterised by low flows which were relatively clear.

Parameter	Description
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 5 m – 6 m high, stable (with no signs of erosion) and well vegetated. The channel is approximately 6 m – 8 m wide at the bank top and 4 m wide at the bank base, displaying a U shape or trapezoidal uniform channel cross section (typical of land drainage channels) (**Plate 4**). An inset bench was present in places, creating a two-stage channel and local geomorphological complexity (**Plate 5**). This is likely to be indicative of natural channel narrowing in response to historical channel enlargement and resectioning. The substrate is dominated by sands and silts, although in places these overlaid pebbles and cobbles. Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural fields and upstream in the catchment. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 5 Foredyke Stream Upper Channel Form Complexity*
Floodplain Characteristics	Floodplain connectivity is likely to be constrained at lower flows due to the deeply incised nature of the channel.

Parameter	Description
In-channel / riparian vegetation	Good riparian vegetation growth was present, with the banks and margins well vegetated in places with rushes, sedges and reeds. Some in-channel aquatic vegetation growth was also recorded, although this was predominantly duck weed (*Lemna mino*) and organic leaf material (**Plate 6**), although overall limited in aquatic macrophytes.  *Plate 6 Foredyke Stream Upper In-Channel Habitat*
Modifications/Structures/Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. No bank protection works were noted or signs of diffuse or point source pollution, with water quality clear.

20.1.4.3. Holderness Drain Source to Foredyke Stream (North Option)

13. The characteristics of the Holderness Drain Source to Foredyke Stream (North Option) are described in **Table 20-6** and the results of the walkover survey are presented in **Table 20-7**.

Table 20-6 Details of Holderness Drain Source to Foredyke Stream (North Option)

Parameter	Details
WFD Water Body	Holderness Drain Source to Foredyke Stream
Water Body ID	GB104026066950
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA07370 42726

Table 20-7 Geomorphological Walkover Survey of Holderness Drain Source to Foredyke Stream (North Option)

Parameter	Description
Overview	Holderness Drain (North Option) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland and downstream of Ticton Pumping Station (**Plate 7**).  *Plate 7 Holderness Drain Source to Foredyke Stream (North Option)*

Parameter	Description
Flow Conditions	Holderness Drain (North Option) is characterised by low energy glide flows, although some flow diversity and in-channel features were observed (see below). The drain at the time of the survey, was characterised by low flows which were relatively clear.
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 12 m – 15 m high, stable (with no signs of erosion) and well vegetated. The channel is approximately 6 m – 8 m wide at the bank top and 4 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels). An inset bench was present in places in response to good marginal vegetation encroaching into the channel increasing the degree of channel form complexity (**Plate 8**). This is also likely to be indicative of natural channel narrowing in response to historical channel enlargement and resectioning. The substrate is dominated by sands and silts, although in places these overlaid pebbles and cobbles. Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural fields and upstream in the catchment. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.

Parameter	Description
	 *Plate 8 Holderness Drain Source to Foredyke Stream (North Option) Channel Form Complexity*
Floodplain Characteristics	Floodplain connectivity is likely to be constrained at lower flows due to the deeply incised nature of the channel.
In-channel / riparian vegetation	Good riparian vegetation growth was present, with the banks and margins well vegetated in places with rushes, sedges and reeds. Some in-channel aquatic vegetation growth was also recorded, such as duck weed (*Lemna mino*), Frogbit (*Hydrocharis morsus-ranae*) and organic leaf material (**Plate 9**).  *Plate 9 Holderness Drain Source to Foredyke Stream (North Option) In-Channel Habitat*

Parameter	Description
Modifications/Structures/Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. No bank protection works were noted or signs of diffuse or point source pollution, with water quality clear. The site is downstream of Ticton Pumping Station (see **Plate 7**).

20.1.4.4. Foredyke Stream Lower to Holderness Drain (Monk Dike)

14. The characteristics of the Foredyke Stream Lower to Holderness Drain (Monk Dike) are described in **Table 20-8** and the results of the walkover survey are presented in **Table 20-9**.

Table 20-8 Details of Foredyke Stream Lower to Holderness Drain (Monk Dike)

Parameter	Details
WFD Water Body	Foredyke Stream Lower to Holderness Drain
Water Body ID	GB104026066910
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA10618 42622

Table 20-9 Geomorphological Walkover Survey of Foredyke Stream Lower to Holderness Drain (Monk Dike)

Parameter	Description
Overview	Foredyke Stream Lower to Holderness Drain (Monk Dike) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 10**).  *Plate 10 Foredyke Stream Lower to Holderness Drain*
Flow Conditions	Foredyke Stream Lower to Holderness Drain is characterised by low energy glide flows, with limited flow diversity or in-channel features observed. The drain at the time of the survey, was characterised by low flows which were turbid.

Parameter	Description
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 6 m – 8 m high, relatively stable (with some minor signs of erosion noted) and well vegetated. The channel is approximately 8 m –15 m wide at the bank top and 3 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels) (**Plate 10**). The substrate is dominated by sands and silts, although in places these overlaid pebbles and cobbles. Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. This was evident by the turbid nature of the flows. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.
Floodplain Characteristics	Floodplain connectivity is likely to be constrained at lower flows due to the deeply incised nature of the channel.
In-channel / riparian vegetation	No riparian mature trees were present, although the banks and margins were well vegetated in places with rushes, sedges and reeds. Some in-channel aquatic vegetation growth was also recorded, although this was predominantly duck weed (*Lemna mino*) and organic leaf material (**Plate 11**), although overall limited in aquatic macrophytes.  *Plate 11 Foredyke Stream Lower to Holderness Drain In-Channel Habitat*

Parameter	Description
Modifications/Structures/Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. Minor rock bank protection works were noted along the drain (**Plate 12**). No signs of diffuse or point source pollution were observed, although the water column was turbid.  *Plate 12 Foredyke Stream Lower to Holderness Drain Minor Rock Bank Protection*

20.1.4.5. Meaux and Routh East Drain

15. The characteristics of the Meaux and Routh East Drain are described in **Table 20-10** and the results of the walkover survey are presented in **Table 20-11**.

Table 20-10 Details of Meaux and Routh East Drain

Parameter	Details
WFD Water Body	Meaux and Routh East Drain
Water Body ID	NA
Watercourse Type	Main River
Grid Reference	TA10563 43665

Table 20-11 Geomorphological Walkover Survey of Meaux and Routh East Drain

Parameter	Description
Overview	Meaux and Routh East Drain consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 13**).  *Plate 13 Meaux and Routh East Drain*

Parameter	Description
Flow Conditions	Meaux and Routh East Drain is characterised by low energy glide flows, although some flow diversity and in-channel features were observed (see below). The drain at the time of the survey was characterised by low flows which were relatively clear.
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 5 m –6 m high, relatively stable (with some signs of erosion noted) and well vegetated. The channel is approximately 6 m – 8 m wide at the bank top and 2 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels) (**Plate 13**). The substrate is dominated by sands and silts, although in places these overlaid pebbles and cobbles (**Plate 14**). Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 14 Meaux and Routh East Drain Channel Substrate*

Parameter	Description
Floodplain Characteristics	Floodplain connectivity is likely to be constrained at lower flows due to the deeply incised nature of the channel.
In-channel / riparian vegetation	No riparian mature trees were present, although banks and margins were well vegetated in places with rushes, sedges and reeds. Some in-channel aquatic vegetation growth was also recorded with some locations along the drain displaying good in-channel habitat features. Such features included clean gravels and marginal vegetation encroaching into the channel (**Plate 15**).  *Plate 15 Meaux and Routh East Drain In-Channel Habitat*

Parameter	Description
Modifications/Structures/Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. Minor wooden bank protection works were noted (**Plate 16**). No signs of significant diffuse or point source pollution were observed, with water quality clear.  *Plate 16 Meaux and Routh East Drain Minor Wood Bank Protection*

20.1.4.6. Holderness Drain Source to Foredyke Stream (South Option)

16. The characteristics of the Holderness Drain Source to Foredyke Stream (South Option) are described in **Table 20-12** and the results of the walkover survey are presented in **Table 20-13**.

Table 20-12 Details of Holderness Drain Source to Foredyke Stream (South Option)

Parameter	Details
WFD Water Body	Holderness Drain Source to Foredyke Stream
Water Body ID	GB104026066950
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA09593 39041

Table 20-13 Geomorphological Walkover Survey of Holderness Drain Source to Foredyke Stream (South Option)

Parameter	Description
Overview	Holderness Drain Source to Foredyke Stream (South Option) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 17**).  *Plate 17 Holderness Drain Source to Foredyke Stream (South Option)*
Flow Conditions	Holderness Drain Source to Foredyke Stream (South Option) characterised by low energy glide flows, although some flow diversity and in-channel features were observed (see below). The drain at the time of the survey, was characterised by low flows which were relatively clear.

Parameter	Description
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 8 m –12 m high, stable (with no signs of erosion noted) and well vegetated. The channel is approximately 15 m – 20 m wide at the bank top; and 8 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels). However, in places the channel is encroached by marginal vegetation ,narrowing the channel and providing good channel form complexity in form of habitat benches and low flow channel (**Plate 18**). This is likely to be indicative of natural channel narrowing in response to historical channel enlargement and resectioning. The substrate is dominated by sands and silts. Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 18 Holderness Drain Source to Foredyke Stream (South Option) Channel Form Complexity*
Floodplain Characteristics	Floodplain connectivity is likely to be constrained at lower flows due to the deeply incised nature of the channel.

Parameter	Description
In-channel / riparian vegetation	No riparian present, although banks and margins are well vegetated in places with rushes, sedges and reeds. Some good in-channel habitat features, such as clean gravels and marginal vegetation encroaching into the channel (**Plate 19**).  *Plate 19 Holderness Drain Source to Foredyke Stream (South Option) In-Channel Habitat*
Modifications/Structures/ Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. No signs of bank protection or diffuse or point source pollution, with water quality clear.

20.1.4.7. Hull from Arram Beck to Humber (River Hull) (South Option)

17. The characteristics of the Hull from Arram Beck to Humber (River Hull) (South Option) are described in **Table 20-14** and the results of the walkover survey are presented in **Table 20-15**.

Table 20-14 Details of Hull from Arram Beck to Humber (River Hull) (South Option)

Parameter	Details
WFD Water Body	Hull from Arram Beck to Humber
Water Body ID	GB104026067212
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA06585 38135

Table 20-15 Geomorphological Walkover Survey of Hull from Arram Beck to Humber (South Option)

Parameter	Description
Overview	Hull from Arram Beck to Humber (South Option) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 20**).  *Plate 20 Hull from Arram Beck to Humber (South Option)*
Flow Conditions	The River Hull from Arram Beck to Humber (South Option) is characterised by low energy glide flows. The river at the time of the survey, was characterised by below bankfull flows which were relatively turbid.

Parameter	Description
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively shallow, approximately 1 m – 2 m high, with some minor signs of erosion noted in response to cattle, although both banks well vegetated. The channel is approximately 20 m –25 m wide at the bank top; and 20 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels) (**Plate 20**). Although an inset bench was present in places in response to good marginal vegetation encroaching into the channel increasing the degree of channel margin complexity (**Plate 21**). This is likely to be indicative of natural channel narrowing in response to historical channel enlargement and resectioning. The substrate is dominated by sands and silts. Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows and cattle eroding the banks (**Plate 21**), the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. This was evident by the turbid nature of the flows. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 21 Hull from Arram Beck to Humber (South Option) Channel Margin Complexity*

Parameter	Description
Floodplain Characteristics	Floodplain connectivity is relatively good in response to the wide but shallow nature of the channel, although the channel is confined within flood embankments.
In-channel / riparian vegetation	Patches of riparian present, with banks and margins vegetated in places with small pockets of rushes and sedges (**Plate 22**) although overall limited in aquatic macrophytes.  *Plate 22 Hull from Arram Beck to Humber (South Option) In-Channel Habitat*

Parameter	Description
Modifications/Structures/Pollution	The channel is over widened and straight; and confined within flood embankments (**Plate 20**). No bank protection works were noted or signs of diffuse or point source pollution, with water quality turbid.

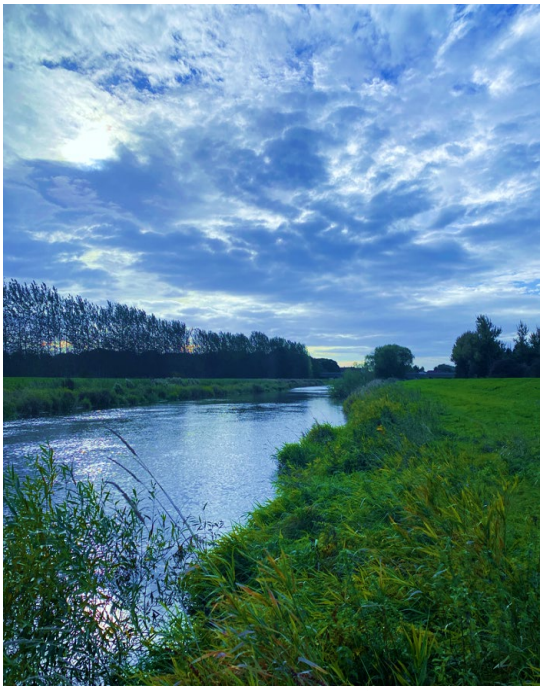
20.1.4.8. Hull from Arram Beck to Humber (River Hull) (North Option)

18. The characteristics of the Hull from Arram Beck to Humber (River Hull) (North Option) are described in **Table 20-16** and the results of the walkover survey are presented in **Table 20-17**.

Table 20-16 Details of Hull from Hull from Arram Beck to Humber (River Hull) (North Option)

Parameter	Details
WFD Water Body	Hull from Arram Beck to Humber
Water Body ID	GB104026067212
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA05377 42104

Table 20-17 Geomorphological Walkover Survey of Hull from Arram Beck to Humber (North Option)

Parameter	Description
Overview	Hull from Arram Beck to Humber (North Option) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 23**).  *Plate 23 Hull from Arram Beck (North Option)*

Parameter	Description
Flow Conditions	Hull from Arram Beck to Humber (North Option) is characterised by low energy glide flows, although some flow diversity and in-channel features were observed (see below). The river at the time of the survey, was characterised by below bankfull flows which were relatively clear.
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 1 m –2 m high, stable (with no signs of erosion noted) and well vegetated. The channel is approximately 25 m – 30 m wide at the bank top and 20 m wide at the bank base, displaying a wide but shallow uniform channel. However, in places the channel is encroached by marginal vegetation narrowing the channel and providing good channel margin complexity (**Plate 24**). This is likely to be indicative of natural channel narrowing in response to historical channel enlargement and resectioning. The substrate is dominated by sands and silts. Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 24 Hull from Arram Beck (North Option) Channel Margin Complexity*

Parameter	Description
Floodplain Characteristics	Floodplain connectivity is relatively good in response to the wide but shallow nature of the channel, although the channel is confined within flood embankments (**Plate 24**).
In-channel / riparian vegetation	Patches of riparian present, although banks and margins are well vegetated in places with rushes, sedges and reed which line the margins of the watercourse (**Plate 25**).  *Plate 25 Hull from Arram Beck (North Option) In-Channel Habitat*
Modifications/Structures/Pollution	The channel is over widened and straight; and confined within flood embankments (**Plate 24**). No bank protection works were noted or signs of diffuse or point source pollution, with water quality clear.

20.1.4.9. Beverley and Barmston Drain (South Option)

19. The characteristics of the Beverley and Barmston Drain (South Option) are described in **Table 20-18** and the results of the walkover survey are presented in **Table 20-19**.

Table 20-18 Details of Beverley and Barmston Drain (South Option)

Parameter	Details
WFD Water Body	Beverley and Barmston Drain
Water Body ID	GB104026067211
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA06363 38164

Table 20-19 Geomorphological Walkover Survey of Beverley and Barmston Drain (South Option)

Parameter	Description
Overview	Beverley and Barmston Drain (South Option) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland and the River Hull (**Plate 26**).  *Plate 26 Beverley and Barmston Drain (South Option)*

Parameter	Description
Flow Conditions	Beverley and Barmston Drain (South Option) is characterised by low energy glide flows, although some flow diversity and excellent in-channel habitat features (see below).The drain at the time of the survey, was characterised by low flows which were relatively clear.

Parameter	Description
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 1 m –2 m high, and stable (with some signs of erosion noted) and well vegetated. The channel is approximately 10 m – 15 m wide at the bank top and 8 m wide at the bank base, displaying a wide but shallow uniform channel. However, in places the channel is encroached by marginal vegetation narrowing the channel and providing excellent complexity to the channel margins (**Plate 27**). This is likely to be indicative of natural channel narrowing in response to historical channel enlargement and resectioning. The substrate is dominated by sands and silts. Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 27 Beverley and Barmston Drain (South Option) Channel Margin Complexity*

Parameter	Description
Floodplain Characteristics	Floodplain connectivity is relatively good in response to the overall smaller size channel.
In-channel / riparian vegetation	Patches of riparian present, although banks and margins are well vegetated in places with rushes, sedges and reed which line the margins of both banks providing a mosaic of in-channel wetland habitat of prime importance to wildlife (**Plate 28**). Duck weed (*Lemna mino*) and organic leaf material was also observed.  *Plate 28 Beverley and Barmston Drain (South Option) In-Channel Habitat*
Modifications/Structures/Pollution	The channel is incised and is likely to have been historically resectioned and enlarged for land drainage purposes. No bank protection works were noted or signs of diffuse or point source pollution, with water quality clear.

20.1.4.10. Beverley and Barmston Drain (North Option)

20. The characteristics of the Beverley and Barmston Drain (North Option) are described in **Table 20-20** and the results of the walkover survey are presented in **Table 20-21**.

Table 20-20 Details of Beverley and Barmston Drain (North Option)

Parameter	Details
WFD Water Body	Beverley and Barmston Drain
Water Body ID	GB104026067211
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA05330 42134

Table 20-21 Geomorphological Walkover Survey of Beverley and Barmston Drain (North Option)

Parameter	Description
Overview	Beverley and Barmston Drain (North Option) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland and the River Hull (**Plate 29**).  *Plate 29 Beverley and Barmston Drain (North Option)*

Parameter	Description
Flow Conditions	Beverley and Barmston Drain (North Option) is characterised by low energy glide flows, although some flow diversity and excellent in-channel habitat features (see below). The drain at the time of the survey, was characterised by low flows which were relatively clear.

Parameter	Description
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively steep, approximately 1 m –2 m high, stable (with no signs of erosion noted) and well vegetated. The channel is approximately 10 m – 15 m wide at the bank top and 8 m wide at the bank base, displaying a wide but shallow uniform channel. However, in places the channel is encroached by marginal vegetation narrowing the channel and providing excellent channel form complexity (**Plate 30**). This is likely to be indicative of natural channel narrowing in response to historical channel enlargement and resectioning. The substrate is dominated by sands and silts. Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel appears to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 30 Beverley and Barmston Drain (North Option) Channel Margin Complexity*

Parameter	Description
Floodplain Characteristics	Floodplain connectivity is relatively good in response to the wide but shallow nature of the channel, although the channel is adjacent a flood embankment which is shared with the River Hull (**Plate 29**).
In-channel / riparian vegetation	Patches of riparian present, although banks and margins are well vegetated in places with rushes, sedges and reed which line the margins of both banks providing a mosaic of in-channel wetland habitat of prime importance to wildlife (**Plate 31**).  *Plate 31 Beverley and Barmston Drain (North Option) In-Channel Habitat*
Modifications/Structures/Pollution	The channel is over widened and straight; and confined within flood embankments (**Plate 29**). No bank protection works were noted or signs of diffuse or point source pollution, with water quality clear.

20.1.4.11. High Hunsley to Arram Area (Reach 1)

21. The characteristics of the High Hunsley to Arram Area (Reach 1) are described in **Table 20-22** and the results of the walkover survey are presented in **Table 20-23**.

Table 20-22 Details of High Hunsley to Arram Area (Reach 1)

Parameter	Details
WFD Water Body	High Hunsley to Arram Area
Water Body ID	GB104026066841
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA02424 41459

Table 20-23 Geomorphological Walkover Survey of High Hunsley to Arram Area (Reach 1)

Parameter	Description
Overview	High Hunsley to Arram Area (Reach 1) consists of a uniform deep channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 32**).  *Plate 32 High Hunsley to Arram Area (Reach 1)*

Parameter	Description
Flow Conditions	High Hunsley to Arram Area (Reach 1) at the time of the survey was not flowing, although most likely the drain would be characterised by low energy glide flows.

Parameter	Description
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are steep, approximately 5 m –6 m high, stable (with no signs of erosion noted) and well vegetated. The channel is approximately 6 m – 8 m wide at the bank top and 2 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels) (**Plate 32**). The substrate is dominated by sands, silts and long grasses, although in places these overlaid pebbles and cobbles (**Plate 33**). Although the proportion of silts are likely to be derived from exposed banks during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel would appear to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 33 High Hunsley to Arram Area (Reach 1) Channel Substrate*
Floodplain Characteristics	Floodplain connectivity is likely to be constrained at lower flows due to the deeply incised nature of the channel.
In-channel / riparian vegetation	No riparian present, although banks and margins are well vegetated in places with rushes, sedges and reeds (**Plate 33**), although overall limited in aquatic macrophytes.

Parameter	Description
Modifications/Structures/Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. No bank protection works were noted or signs of diffuse or point source pollution, with water quality clear.

20.1.4.12. High Hunsley to Arram Area (Reach 2)

22. The characteristics of the High Hunsley to Arram Area (Reach 2) are described in **Table 20-24** and the results of the walkover survey are presented in **Table 20-25**.

Table 20-24 High Hunsley to Arram Area (Reach 2)

Parameter	Details
WFD Water Body	High Hunsley to Arram Area
Water Body ID	GB104026066841
Watercourse Type	Main River & WFD Water Body
Grid Reference	TA01419 40887

Table 20-25 Geomorphological Walkover Survey of High Hunsley to Arram Area (Reach 2)

Parameter	Description
Overview	High Hunsley to Arram Area (Reach 2) consists of a uniform relatively deep, narrow channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 34**).  *Plate 34 High Hunsley to Arram Area (Reach 2)*

Parameter	Description
Flow Conditions	High Hunsley to Arram Area (Reach 2) at the time of the survey was not flowing, although most likely the drain would be characterised by low energy glide flows.
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively deep, approximately 2 m –3 m high, with signs of bank erosion along the drain noted. The channel is approximately 2 m –3 m wide at the bank top; and 0.5 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels) (**Plate 32**). The substrate is dominated by sands, silts and pebbles. Although the proportion of silts are likely to be derived from exposed banks (**Plate 35**) during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel would appear to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 35 Exposed Banks of High Hunsley to Arram Area (Reach 2)*

Parameter	Description
Floodplain Characteristics	Floodplain connectivity is relatively good in response to the overall smaller size channel.
In-channel / riparian vegetation	Riparian vegetation is present, although the majority of the channel is overgrown with Bramble (*Rubus fruticosus*) (**Plate 36**).  *Plate 36 High Hunsley to Arram Area In-Channel Habitat*
Modifications/Structures/Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. No bank protection works were noted or signs of diffuse or point source pollution, although a discharge pipe was noted in the bank of the channel.

20.1.4.13. High Hunsley to Woodmansey Area (Autherd Drain)

23. The characteristics of the High Hunsley to Woodmansey Area (Autherd Drain) are described in **Table 20-26** and the results of the walkover survey are presented in **Table 20-27**.

Table 20-26 High Hunsley to Woodmansey Area (Autherd Drain)

Parameter	Details
WFD Water Body	High Hunsley to Woodmansey Area
Water Body ID	GB104026066820
Watercourse Type	Ordinary Watercourse & WFD Water Body
Grid Reference	TA03855 37603

Table 20-27 Geomorphological Walkover Survey of High Hunsley to Woodmansey Area (Autherd Drain)

Parameter	Description
Overview	High Hunsley to Woodmansey Area consists of a uniform relatively deep, narrow channel that has been artificially straightened and incised adjacent to arable farmland (**Plate 37**).  *Plate 37 High Hunsley to Woodmansey*

Parameter	Description
Flow Conditions	High Hunsley to Woodmansey Area at the time of the survey was not flowing, although most likely the drain would be characterised by low energy glide flows.
Channel Form, Soils and Substrates	The channel has a straight planform. The banks are relatively deep, approximately 1 m –2 m high, with signs of bank erosion along the drain noted. The channel is approximately 2 m –3 m wide at the bank top and 0.5 m wide at the bank base, displaying a U shape or trapezoidal uniform channel (typical of land drainage channels) (**Plate 37**). Although the channel was dry, the complexity of the channel appeared low, with no diversity of in-channel features observed (**Plate 38**). The substrate is dominated by sands, silts and pebbles. Although the proportion of silts are likely to be derived from exposed banks (which were noted) during higher-energy flows, the majority of the fine sediment load is likely to be sourced from the adjacent agricultural field and upstream in the catchment. Overall, the channel would appear to be within a typical sediment deposition zone, with slow flows, low gradients and low velocities contributing to the settling out of fine sediments/silts.  *Plate 38 High Hunsley to Woodmansey Channel Form Complexity*
Floodplain Characteristics	Floodplain connectivity is relatively good in response to the overall smaller size channel.
In-channel / riparian vegetation	Riparian is present along the drain in the form of small mature trees, shrubs and Bramble (*Rubus fruticosus*).

Parameter	Description
Modifications/Structures/Pollution	The channel is deeply incised and is likely to have been historically resectioned and enlarged for land drainage purposes. No bank protection works were noted or signs of diffuse or point source pollution, although a discharge pipe was noted in the bank of the channel.

References

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