NORTH FALLS

Offshore Wind Farm

ENVIRONMENTAL STATEMENT

Appendix 21.1 Geomorphology Baseline Survey

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Glossary of Acronyms

BNG	Biodiversity Net Gain
CEN	European Committee for Standardization
ES	Environmental Statement
GPS	Global Positioning Systems
PEIR	Preliminary Environmental Information Report

Glossary of Terminology

Onshore project area	The boundary within which all onshore infrastructure required for the Project will be located (i.e. landfall; onshore cable route, accesses, construction compounds; onshore substation and cables to the national grid substation).
The Project Or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Fine sediment (<2mm)	Sand, silts and clays.
Glide	Relatively calm water flowing smoothly.
Incised channel	A channel that is largely disconnected from the adjacent floodplain. In lowland agricultural settings on small watercourses this is often due to channel maintenance (dredging / desilting).
Main River	Main Rivers are usually larger rivers and streams. The Environment Agency carries out maintenance, improvement or construction work on Main Rivers to manage flood risk.
Ordinary Watercourse	Watercourses not classed as main rivers. Lead local flood authorities, district councils and internal drainage boards carry out flood risk management work on Ordinary Watercourses.
Riffle	Areas of shallow water created by deposition of coarse sediment.

1 Introduction

1. The aim of the geomorphology baseline survey is to characterise the geomorphological conditions of major watercourses that will be crossed by North Falls Offshore Wind Farm project (herein 'the Project'). Baseline information gathered during the survey has been used to inform the geomorphology assessment presented in ES Chapter 21 Water Resources and Flood Risk (Document Reference: 3.1.23) of the Environmental Statement (ES). Results have also been used in the assessment of likely significant effects on hydromorphological quality elements supported by river water bodies presented in ES Appendix 21.2 Water Environment Regulations Compliance Assessment (Document Reference: 3.3.28).
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. Baseline information has been used to determine how watercourses are likely to respond to the construction, operation 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.

2 Methodology

3. The location of surveyed watercourses is shown in Figure 1 (Annex 21.1.1) and summarised in Table 1. The study area includes all Main Rivers and Ordinary Watercourses within the onshore project area. The baseline surveyed was carried out based on the onshore project area at Preliminary Environmental Information Report (PEIR), which has since been updated for the ES. Figure 1 shows the onshore project area at PEIR and how this overlaps with the onshore project area at ES.

Table 1 Surveyed watercourses and cable corridor details

Watercourse	Type	Channel length within cable corridor (km)
Holland Brook headwaters (Abbott's Farm)	Ordinary Watercourse	0.4
Holland Brook lower course (Holland Haven)	Main River	0.2
Kirby Brook	Main River	2.7
Holland Brook tributaries	Ordinary Watercourse	0.3 – 0.5
Tendring Brook	Main River	0.4
Tributary of Tenpenny Brook	Ordinary Watercourse	0.9

Watercourse	Type	Channel length within cable corridor (km)
Tributary of Landermere Creek / Hamford Water	Main River	1.0

4. Industry good practice guidance for geomorphological characterisation and monitoring was followed, 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;
   - River Restoration Centre (2011): Practical River Restoration: Appraisal Guidance for Monitoring Option; and
   - European Committee for Standardization (CEN, 2018): Water Quality – Guidance standard for assessing the hydromorphological features of rivers.

5. Following these industry good practice documents, a visual inspection was undertaken along each watercourse. The main characteristics were carefully recorded from the bank top, which included detailed photographs and locations of key features using Global Positioning Systems (GPS). The following parameters were recorded to characterise the baseline geomorphology of each watercourse:

   - 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;
   - Flow conditions, including dominant flow types and the degree of variability within each reach;
   - Floodplain characteristics, including connectivity to the river channel, and the structure of the riparian zone;
   - In-channel / riparian vegetation, cross-checked against the results of ecological surveys; and
   - Evidence of channel modification, including enlargement and re-sectioning, artificial bank protection, embankments and in-channel structures.

6. The survey aimed to identify any visual contamination (e.g. excessive sedimentation / smothering, hydrocarbons, sewage fungus, discoloration), as well as any operating discharges / pipes (e.g. septic tank outflows). This helps to identify any evidence of contamination or local sources of pollution.

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

2.1 Survey limitations

8. The survey was undertaken between 22nd and 24th August 2022 by an experienced fluvial geomorphologist (Simon Foulds (PhD, MSc, BSc)). Most of the watercourses surveyed were easily accessible, but some were very overgrown with dense scrub and could only be viewed at a limited number of locations. These hard to access sites were: Holland Brook Tributaries (Section 3.1.4), Tendring Brook (Section 3.2.1) and parts of the tributary of Landermere Creek / Hamford Water (Section 3.4). Despite difficult access, enough sites were visited to allow accurate characterisation of channels and floodplains.

9. Due to prolonged dry weather, some channel sections were dry. Dry sections were recorded on Holland Brook tributaries (Section 3.1.4), Tendring Brook (Section 3.2.1), Landermere Creek / Hamford Water (Section 3.4) and the tributary of Tenpenny Brook (Section 3.3.1). Where this was the case, the channel bed was inspected for evidence of bedforms, and expert judgement used to evaluate the likely flow types resulting from the configuration of channel bed and banks.

3 Results

10. Surveyed watercourses fall into the following catchments:

- Holland Brook catchment
    - Holland Brook headwaters (Section 3.1.1). This is the upper course of the brook between the A120 and Little Bromley;
    - Holland Brook tributaries (unnamed). Two short watercourses that drain the eastern part of the catchment near Great Holland. Watercourses join Holland Brook near Great Holland Pits Nature Reserve;
    - Holland Brook lower course. Lower course of the brook immediately upstream of Holland Haven Outfall at the coast;
    - Kirby Brook. Watercourse that drains a large part of the south-eastern area of the catchment near Frinton. Flows through Holland Haven Marshes SSSI; and
    - Tendring Brook. Watercourse that drains the eastern area of the catchment near Tendring Heath, Tendring Green, Tendring and Weeley.
- Hamford Water catchment
    - Tributary (unnamed) of Landermere Creek / Hamford Water. A small catchment that drains the area near Beaumont and Thorpe le Soken.
- Tenpenny Brook catchment
    - Tributary of Tenpenny Brook. Watercourse that drains the area around Bromley Cross, Little Bromley and Great Bromley.

3.1 Holland Brook

3.1.1 Holland Brook headwaters (Abbott's Farm)

11. North of the A120 Holland Brook splits into three headwater branches. These channels rise in an area bounded by Welham's Farm, Little Bromley and Horsleycross Street. The onshore cable route crosses the main (central) branch of Holland Brook at Abbott's Farm, ~500m northwest of Horsley Cross on the A120. A single reach was surveyed covering the full width of the onshore cable route (~400m).

3.1.1.1 Channel form

12. The upstream end of the reach has an asymmetrical cross-section. The right bank has a near vertical scarp of ~1.50 to 1.75m due to bank erosion, and the left hand bank transitions to a gentler slope of ~1.0m height. (Plate 1). Channel width is ~1.0m and bankfull depth is ~0.30 to 0.50m. Channel planform is typically straight with evidence of a gently meandering thalweg.

13. Towards the bottom of the reach the channel appears to be heavily managed with a symmetrical trapezoidal cross-section (Plate 2), typical of desilting / dredging, and there was evidence of recent vegetation clearance. The channel has a gently meandering planform and channel width is ~1.0m and bankfull depth ~0.3m.

Plate 1 Incised channel and localised bank erosion at the upstream end of the reach

Plate 2 Trapezoidal cross-section and evidence of vegeation clearance

Plate 3 Frothy scum in stagnant areas of flow

Plate 4 In-channel vegeation and woody material

Plate 5 Channel substrates	
	

3.1.1.2 Flow conditions

14. Flows are typically low velocity / sluggish to stagnant with evidence of unidentified frothy scum on the surface in places (Plate 3). Locally, at the upstream end of the reach, in-channel woody material has led to the formation of a gently meandering thalweg and gentle riffles (Plate 4).

3.1.1.3 Soils and substrates

15. In sluggish to stagnant areas of flow the channel bed is covered in fine sediments (silt and clay), and the dominant processes appear to be depositional. At the upstream end of the reach where there are locally faster flows, there are patches of cleaner coarse substrates (coarse sand and gravel (Plate 5)). Floodplain sediments are massive, structureless silts and clays. Fines covering the bed are sourced from localised eroding scarp slopes (Plate 1), and soil erosion from arable land beside the channel and in the wider catchment.

3.1.1.4 Floodplain characteristics

16. The channel is typically incised 1.5 to 1.75m below the adjacent floodplain and there is limited opportunity for channel-floodplain connection. At the upstream end of the reach the left-hand bank is bordered by a mature hedgerow (Plate 1).

Plate 6 In-channel macrophytes (duckweed)	Plate 7 In-channel macrophytes (watercress)
	
Plate 8 Farm access culvert bridge	**Plate 9 Field drain outfall**
	

3.1.1.5 In-channel / riparian vegetation

17. At the lower end of the reach the channel appears to be regularly cleared of vegetation (Plate 2) and grass / riparian vegetation cut back. Towards the upstream end of the reach there are patches of duckweed and other aquatic vegetation (Plate 6, Plate 7).

3.1.1.6 Modifications / structures

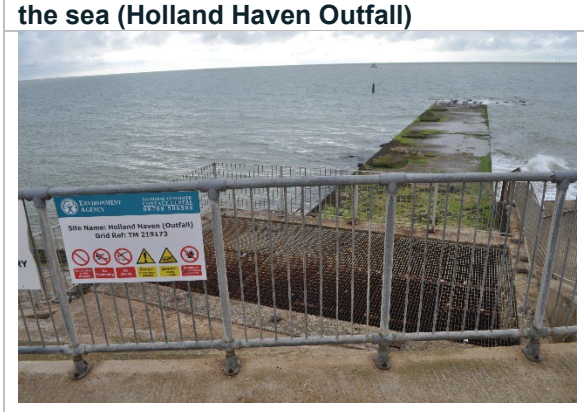
18. Where farm access tracks cross the channel, the bed and banks are formed by concrete culverts (Plate 8). There are also concrete and plastic field drain outfalls along the length of the channel (Plate 9).

3.1.2 Holland Brook lower course (Holland Haven)

19. A short section (~200m) of the lower course of Holland Brook falls within the onshore project area near the coast. This is the final section of the brook before it discharges to the sea.

3.1.2.1 Channel form

20. Over its lower course, Holland Brook is typical of a low energy, lowland river. The channel is ~6m wide and bankfull depth is ~1.5m (Plate 10, Plate 11). On the right bank the land rises steeply to the ridge (the 5m AOD contour) that separates the channel from the coast, and on the left, there appears to be a low embankment that limits inundation of the wider agricultural floodplain. The final section of the reach is impounded by a large sluice and the channel then flows to the sea via an outfall.

Plate 10 Lower course of Holland Brook	Plate 11 Lower course of Holland Brook upstream of the sluice
	
Plate 12 Surficial frothy scum	**Plate 13 The sluice that impounds the lower course of Holland Brook**
	
Plate 14 Holland Brook's confluence with the sea (Holland Haven Outfall)	
	

3.1.2.2 Flow conditions

21. Upstream of the influence of the sluice flows are sluggish / no evidence of flowing water to glides. Immediately upstream of the sluice flows are impounded with no discernible flow (Plate 12, Plate 13). Near the sluice there is a large amount of unidentified frothy scum on the surface (Plate 11, Plate 12, Plate 13) and signs of hydrocarbons (oily film in places). On the survey day there was also a very noticeable odour of sewage. No bedforms were visible, although the water column was quite turbid.

3.1.2.3 Soils and substrates

22. In places there were signs of erosion of bank tops due to recreational access (dog walking). At these locations the surface layer of the floodplain could be seen to be made up of silts and clays, typical of a lowland system. The channel bed, where visible, was silty and this material will be sourced from the extensive arable fields that dominate the catchment (including areas of maize that were observed, which are prone to soil erosion after harvesting in the autumn). The dominant processes appear to be depositional.

3.1.2.4 Floodplain characteristics

23. The natural floodplain of Holland Brook covers a large area of valley floor across Holland Haven. However, water levels are managed by operation of the sluice and it is likely that channel-floodplain connectivity occurs only during very wet weather. There are some artificial scrapes adjacent to the channel, but it is not clear if these are purely rain fed or if water is diverted from the channel.

3.1.2.5 In-channel / riparian vegetation

24. Both banks are backed by a ~5 -10m wide riparian zone characterised by grasses, rushes and reeds, and scrubby wooded areas (mainly hawthorn, blackthorn and elder) (Plate 10). In the channel there are areas of duckweed and stands of reeds and rushes.

3.1.2.6 Modifications / structures

25. At its lower limit the channel is impounded by a large sluice (Plate 13) and the left hand bank immediately upstream of the sluice is made of corrugated steel sheeting (Plate 11). Holland Brook's confluence with the shoreline is artificial and formed by a concrete outfall (Plate 14 (Holland Haven outfall)).

3.1.3 Kirby Brook

26. Kirby Brook rises to the south of Kirby Cross and follows a course around the western edge of Frinton-on-Sea, before flowing east to west across Holland Haven marshes. Kirby Brook is a left bank tributary of Holland Brook that joins the latter ~150 m upstream of the sluice shown in Plate 13. Most of Kirby Brook's lower course falls within the onshore project area.

3.1.3.1 Channel form

27. From the western edge of Frinton-on-Sea to near Sandy Point on the coast, Kirby Brook has a mostly straight (engineered) planform. Downstream of Sandy point, until joining Holland Brook, the channel has a stable meandering planform. The channel is dominated by reeds over its entire length (Plate 15), which makes accurate description of the channel difficult. Channel width appeared to vary between 2 to 4m and bankfull depth was typically 0.5 to 0.75m.

28. The main tributary of Kirby Brook is a small watercourse (Main River) that flows through Frinton Golf Course. Near the confluence with Kirby Brook (i.e. in the golf course) the channel is gently meandering but appears to be regularly cleared of vegetation, and very likely desilted (Plate 16). It its upper reach, near Great Holland, it flows through agricultural land and is straight and filled with reeds, similar to the main channel (Plate 17).

Plate 15 Kirby Brook at Holland Haven	Plate 16 Golf course tributary
	
Plate 17 Upper reach of the golf course tributary	**Plate 18 Reed filled channel of Kirby Brook**
	
Plate 19 Low rubble embankment of the left hand bank	
	

3.1.3.2 Flow conditions

29. Where the channel was visible, water levels were very low and there was no evidence of flowing water (Plate 18). Even with higher water levels, the very low gradient of the channels and dense vegetation means that sluggish glides are the most likely flow type in average to wet conditions.

30. Flow in the golf course tributary was generally ponded with no evidence of flowing water.

3.1.3.3 Soils and substrates

31. Where visible channel and floodplain sediments were fine grained (silts and clays). Areas in and around the channel also characterises by dark humic soils associated with the low lying, poorly drained marshes.

32. Soils along the golf course tributary are composed of silts and clays and the channel bed is silty in its upper reaches.

33. The dominant fluvial processes in the main channel and minor tributary appear to be depositional.

3.1.3.4 Floodplain characteristics

34. The floodplain of Kirby Brook encompasses a large area of Holland Haven Marshes to the north, which extends inland to roughly the 5 m AOD contour. The floodplain is mainly pastoral grazing land with some wildlife scrapes / ponds close to the sea wall. Water levels are managed via the sluice on Holland Brook, and it is likely channel-floodplain connectivity occurs only during very wet weather. There is also a low rubble embankment along parts of the brook that further limits connectivity (Plate 19).

35. The golf course tributary is generally incised ~1m below the surrounding agricultural land and golf course. There appears little opportunity for channel floodplain connectivity (except during flood conditions).

3.1.3.5 In-channel and riparian vegetation

36. The entire length of the channel in the study area was choked with dense stands of rushes and reeds up to 2m in height (Plate 15, Plate 18). There were also patches of duckweed in some deeper areas of water.

37. Similar to Kirby Brook, the golf course tributary is reed filled in its upper reaches (Plate 17) and lined with short, regularly cut grass on the golf course section (Plate 16).

3.1.3.6 Modifications / structures

38. No artificial structures were observed in the channel or on its banks, although the channel and riparian zone were generally very overgrown at the time of survey.

39. On the golf course tributary there are concrete culvert bridges to allow farm vehicle access, and the lower course is crossed by footbridges associated with the golf course.

3.1.4 Holland Brook tributaries

40. Between Kirby Cross and Great Holland the onshore cable route crosses two Ordinary Watercourses (over 300 to 500m) that drain NE-SW and join Holland Brook near Great Holland Pits Nature Reserve. Both watercourses are very similar in nature and flow through arable and pastoral fields in a narrow, scrubby, riparian corridor (Plate 20, Plate 21). The degree to which both watercourses were overgrown with dense scrub meant that direct access to the channels was very limited.

Plate 20 East bank tributary that joins Holland Brook near Holland Mill Wood	Plate 21 East bank tributary that joins Holland Brook near Hunters Bridge
	
Plate 22 Incised nature of the channels viewed from farm access bridge	**Plate 23 Ponded water and fine sediment substrates**
	
Plate 24 Marginal and in-channel reeds	
	

3.1.4.1 Channel form

41. Where the channels could be accessed, they are ~1.5m wide and bankfull depth is ~0.5 to 1m (Plate 22). Both tributaries have straight planforms with near vertical banks and channel beds are incised below the surrounding floodplain and valley sides.

3.1.4.2 Flow conditions

42. Where the channels of both tributaries were visible, they were dry, apart from isolated puddles and stagnant pools in shaded area amongst reeds and other vegetation (Plate 23).

3.1.4.3 Soils and substrates

43. Channels are characterised by fine grained deposits (silt and clay) which is most likely sourced from the surrounding arable fields. There were very few exposures of floodplain sediment but where visible they were of a similar nature.

44. The dominant fluvial processes in the main channel and minor tributary appear to be depositional.

3.1.4.4 Floodplain characteristics

45. Compared to other watercourses crossed by the onshore cable route, both tributaries are relatively steep (1.2% and 1.8%, respectively) and have very restricted floodplains (hillslopes reach close to the channel margin (Plate 20, Plate 21). Where floodplain areas are apparent, there is little or no connectivity because the channel is incised.

3.1.4.5 In-channel / riparian vegetation

46. Both tributaries are characterised by ~5 - 10m wide riparian zones that divide mainly arable fields. Vegetation is typically scrubby (grass, nettles and brambles with areas of hawthorn, blackthorn and elder) on the banks, with reeds and rushes in damper channel areas (Plate 24).

3.1.4.6 Modifications / structures

47. At the upstream end of the northernmost tributary the channel passes below a railway line. The channel could not be accessed because of scrub but it is likely the bed and banks are artificial.

3.2 Tendring Brook catchment

3.2.1 Tendring Brook

48. Tendring Brook rises near Tendring Heath and flows in a southerly direction before joining Holland Brook to the east of Weeley. The onshore cable route crosses a ~500m long reach of Tendring Brook between Tendring Green and Tendring – this is the headwater area of the brook.

3.2.1.1 Channel form

49. The channel is set in a ~15 - 20m wide riparian zone between arable fields and it is overgrown with dense scrub. As a result, there is limited access. Where the channel could be accessed (at locations where public footpaths and farm access tracks cross the channel), it is ~1.5 – 2m wide and bankfull depth is ~0.5 to 1m (Plate 25, Plate 26). The channel is straight in planform and has near vertical banks and is incised below the surrounding floodplain.

Plate 25 Incised and densely vegetated course of Tendring Brook	Plate 26 Incised and densely vegetated course of Tendring Brook
	
Plate 27 Gravel channel substrates	**Plate 28 Fine-grained floodplain sediment**
	
Plate 29 Tree roots lining both banks of the brook	**Plate 30 Farm access bridge and culvert**
	

3.2.1.2 Flow conditions

50. Flows are typically sluggish to stagnant and slightly impounded upstream of culvert structures. At the upstream end of the reach there are shallow riffles over localised areas of channel bed gravels (Plate 27).

3.2.1.3 Soils and substrates

51. Where visible, the channel bed is typically silty although there are areas of gravel at the upstream end of the reach. These gravels are smothered with fines where the channel is impounded by a culvert structure. Where visible, the floodplain is also characterised by silts and clays (Plate 28).

3.2.1.4 Floodplain characteristics

52. The channel is incised below the floodplain by up to 1m. There is little or no opportunity for channel-floodplain connectivity throughout the reach. The floodplain on both banks is used for arable agriculture.

3.2.1.5 In-channel / riparian vegetation

53. The channel is reed-choked throughout the reach and flows through a well-defined riparian zone made up of mature scrub and trees (mainly oak, hazel, blackthorn and elder) (Plate 25, Plate 26). In some places tree roots line the banks (Plate 29).

3.2.1.6 Modifications / structures

54. At the upstream end of the reach the channel is semi-impounded by a substantial culvert / farm bridge (Plate 30). A footbridge crosses the downstream end of the reach, but support structures do not form the channel's banks.

3.3 Tenpenny Brook catchment

3.3.1 Tributary of Tenpenny Brook

55. At the northern limit of the onshore project area, the ES onshore substation area crosses a tributary of Tenpenny Brook. The tributary flows in a southerly direction and merges with Bromley Brook near the A120 south of Great Bromley, to form Tenpenny Brook.

3.3.1.1 Channel form

56. At the upstream end of the reach the channel is ~1m wide and has a distinct trapezoidal cross-section indicative of regular maintenance (Plate 31). At the time of survey there had been recent vegetation clearance of the channel at this location. Bankfull is ~0.5 - 0.75m and the planform is straight. The channel had clearly been dry for some time prior to the survey as there was no water or exposed sediment on the channel bed. In the middle and downstream sections of the reach (Plate 32), channel form is similar although the channel is more deeply incised (~1m) and lined with scrubby vegetation.

Plate 31 Trapezoidal nature of the channel at the upstream end of the reach	Plate 32 Incised nature of the channel at the downstream end of the reach
	

Plate 33 Permanent pipework on the channel bank	Plate 34 Field drain outfall
	

3.3.1.2 Flow conditions

57. As stated above the channel was dry apart from some shallow ponded areas at the downstream end of the reach.

3.3.1.3 Soils and substrates

58. At the upstream end of the reach channel and floodplain substrates were not visible but at the downstream end both environments were charactered by fines (silt and clay). This material is likely sourced from runoff from the surrounding arable fields.

59. The dominant fluvial processes in the main channel and minor tributary appear to be depositional.

3.3.1.4 Floodplain characteristics

60. The channel is incised below the floodplain and there are no opportunities for channel-floodplain connection. Throughout the reach the floodplain is used for agriculture in the form of extensive arable fields.

3.3.1.5 In-channel / riparian vegetation

61. At the upstream end of the reach the only riparian vegetation is grass as the channel has been cleared. At the downstream end of the reach the channel is filled with reeds and grass and scrubby cover with small patches of duckweed is some of the pools. During a previous Extended Phase 1 Habitat Survey (non-native invasive water fern *Azolla filiculoides*) was identified in the upstream end of this watercourse.

3.3.1.6 Modifications / structures

Channel bed and banks are artificial (concrete) where they are formed by culverts to allow farm access across the channel. At the upstream end of the reach there is a permanent pipe network that appears be used for irrigation (Plate 33). Some of the piping is located on the banks. There are also concrete field drain outfalls (Plate 34).

3.4 Hamford Water catchment

3.4.1 Tributary of Landermere Creek / Hamford Water

62. The onshore cable route passes inland from the estuary of Hamford Water and crosses a 1 km wide section of an Ordinary Watercourse that rises near Thorpe Green. The watercourse connects to the estuary at Beaumont Cut, which then drains to Landemere Creek and Hamford Water. The watercourse occupies a shallow east facing valley dominated by arable land use (Plate 35).

3.4.1.1 Channel form

63. The channel incised between 1 and 2m below the surrounding valley floor and has a symmetrical trapezoidal cross-section, indicative of clearance and desilting (Plate 36, Plate 37). There is a narrow (~0.5m) floodplain / berm inset within the incised channel. Bankfull depth to the top of the floodplain / berm is ~0.5m. The channel is ~1.5m wide and has a mostly straight planform.

Plate 35 Setting of the watercourse in arable fields – the tree in the centre marks the channel's course

Plate 36 Incised nature of the channel

Plate 37 Well vegetated riparian margin of the incised channel

Plate 38 Scarp bank, likely caused by mechanical excavation

3.4.1.2 Flow conditions

64. Following prolonged dry weather the channel was dry. Given the evidence of desilting that has taken place, it is unlikely there would be any diverse flow structures and bedforms. In normal conditions it is likely there would be areas of faster flow where the channel is constricted by vegetation.

3.4.1.3 Soils and substrates

65. The channel bed was dry and cracked and was characterised by fines (silt and clay). Fines are probably sourced from the surrounding arable fields and erosion of scarp banks that appear to have been re-sectioned during desilting activities (Plate 38). The floodplain is characterised by similar fine grained alluvium.

66. The dominant fluvial processes in the main channel and minor tributary appear to be depositional.

3.4.1.4 Floodplain characteristics

67. A narrow inset floodplain / berm is evident in places onto which the channel would overflow during wet weather. It is highly unlikely there would be any connectivity with the wider valley, which is up to 2m above the channel in places.

3.4.1.5 In-channel / riparian vegetation

68. The incised channel is set within a ~5 - 10m wide riparian zone between arable fields. Due to the dry weather and lack of water, the entire length of the surveyed channel was choked with vegetation – mainly rushes in the channel and grasses and scrub on the banks. From the middle of the reach upstream the riparian zone changes to an area dominated by scrubby woodland (mainly hazel and blackthorn with some oak) and brambles that fringe the channel.

3.4.1.6 Modifications / structures

69. At the downstream end of the reach the channel crosses through a culvert under the adjacent road. Also, although not observed, based on other similar catchments in the area, it is likely that plastic and concrete field drains outfall to the channel.

4 Summary

70. A geomorphological baseline survey was undertaken between 22nd and 24th of August 2022. The survey has demonstrated that watercourses crossed by the onshore project area are low gradient, low energy and characterised by very limited morphological complexity. Most of the channels surveyed appear to have undergone periodic management (vegetation clearance and desilting). Channels are typically 1 - 2m wide (except for the lower course of Holland Brook (~6m) and incised below their adjacent floodplains. This means there are limited opportunities for channel-floodplain connectivity. Although watercourses were typically dry due to the prolonged dry weather, given the nature of the channels, it is unlikely there will be complex bedforms and associated flows during average conditions. Where water was observed, it was ponded / sluggish and there were no bedforms.

71. Channel banks are generally densely vegetated with grasses and scrubby undergrowth or choked with reeds. Aquatic plants (macrophytes) are evident in some reaches that had not been cleared. Channel and floodplain substrates are typically fine (silts and clays), and most of this material is likely to be sourced from adjacent agricultural fields and upstream in the wider catchment areas. The dominant fluvial processes in all watercourses appear to be depositional.

72. The results of the walkover survey have been used to inform the baseline geomorphology assessment presented in ES Chapter 21 Water Resources and Flood Risk (Document Reference: 3.1.23) of the ES. Results have also been used in the assessment of potential impacts on hydromorphological quality elements supported by river water bodies presented in ES Appendix 21.2 Water Environment Regulations Compliance Assessment (Document Reference: 3.3.28).

5 References

Environment Agency (2003) *River Habitat Survey in Britain and Ireland: Field Survey Guidance Manual*. Environment Agency, Bristol.
Environment Agency (2007) *Geomorphological monitoring guidelines for river restoration schemes*. Environment Agency, Bristol.
European Committee for Standardization (CEN) (2018) Water Quality – Guidance standard for assessing the hydromorphological features of rivers. CEN, Brussels.
The River Restoration Centre (2011) *Practical River Restoration Appraisal: Guidance for Monitoring Options.* The River Restoration Centre, Cranfield.

Annex 21.1.1 Figures

Figure 1. Geomorphology Baseline Study Area

610000 615000 620000 625000

230000 225000 220000 215000

N

Tributary of Tenpenny Brook

Holland Brook Headwaters (Abbot's Farm)

Tendring Brook

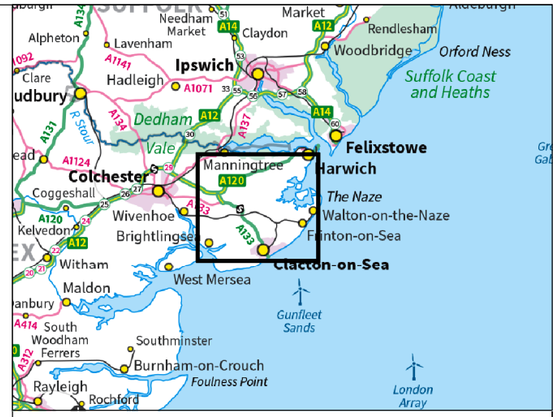
Tributary of Landermere Creek/ Hamford Water

Hamford Water

Holland Brook Tributaries

Kirby Brook

Holland Brook Lower Course



Legend

- Onshore PEIR Boundary
- Onshore Substation Area (PEIR)
- Onshore Project Area
- Main River
- Ordinary Watercourse

Water Body Catchment

- Coastal Catchment
- Holland Brook
- Tenpenny Brook
- Wrabness Brook

0 1 2 4 km

Drawing Title

Geomorphology Baseline Survey Study Area

Rev	Date	Remarks	Drwn	Chkd
02	30/05/2024	Second issue	FC	SF
01	01/02/2024	First issue	SB	SF

Drawing Number	Figure Number
PB9244-RHD-ZZ-ON-DR-GS-0474	1

Scale	Plot Size	Datum	Projection
1:65,000	A3	OSGB36	BNG

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NORTH FALLS
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NORTH FALLS

Offshore Wind Farm

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HARNESSING THE POWER OF NORTH SEA WIND

North Falls Offshore Wind Farm Limited

A joint venture company owned equally by SSE Renewables and RWE.

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Registered in England and Wales Company Number: 12435947