Norwich Western Link

Environmental Statement

Chapter 10: Biodiversity

Appendix 10.33: Biodiversity Net Gain Technical Report

Appendix D: River Condition Assessment

Author: WSP UK Limited

Document Reference: 3.10.33d

Version Number: 00

Date: March 2024

Contents

Tables

Figures

1 Methodology – River Condition Assessment

1.1.1 The following section details the method of the River Condition Assessment (RCA) as referred to in Section 4 of the Environmental Statement **Chapter 10: Biodiversity** - Appendix 33: Biodiversity Net Gain Technical Report (Document Reference: 3.10.33).

1.2 River condition assessment

1.2.1 The RCA methodology was developed to deliver the River and Streams component of a national Biodiversity Metric, to measure and account for losses and gains in river biodiversity as a result of development (Gurnell et al., 2020). The application of the RCA methodology is required in response to the Environment Act (2021) and the need to deliver biodiversity net gain. The RCA survey provides a baseline river condition and can be used to estimate potential impacts from developments and monitor change post-development. The RCA is used in this study to provide a baseline condition of the watercourses within the RLB, identify the post-development condition, identify appropriate enhancement opportunities and provide a condition assessment for the preferred enhancement scenario.

1.2.2 River condition, as required to inform Biodiversity Metric (3.1), is assessed using 32 of the RCA condition indicators generated in the virtual Cartographer workspace. Indicators are categorised as either positive (e.g. diversity and abundance of physical habitats) or negative indicators (e.g. anthropogenic modifications or Invasive Non-Native Species). A Preliminary Condition Score is generated from the 32 indicators (sum of the average of the positive scores and the average of the negative scores for the sub-reach). These indicator scores are captured as part of the MoRPh5 survey (described in Section 1.3). The Preliminary Condition Score is translated into a Final Condition Score based on the river type determined by the River Type Pro desk study (described in Section 1.5), using an additional 8 indicators.

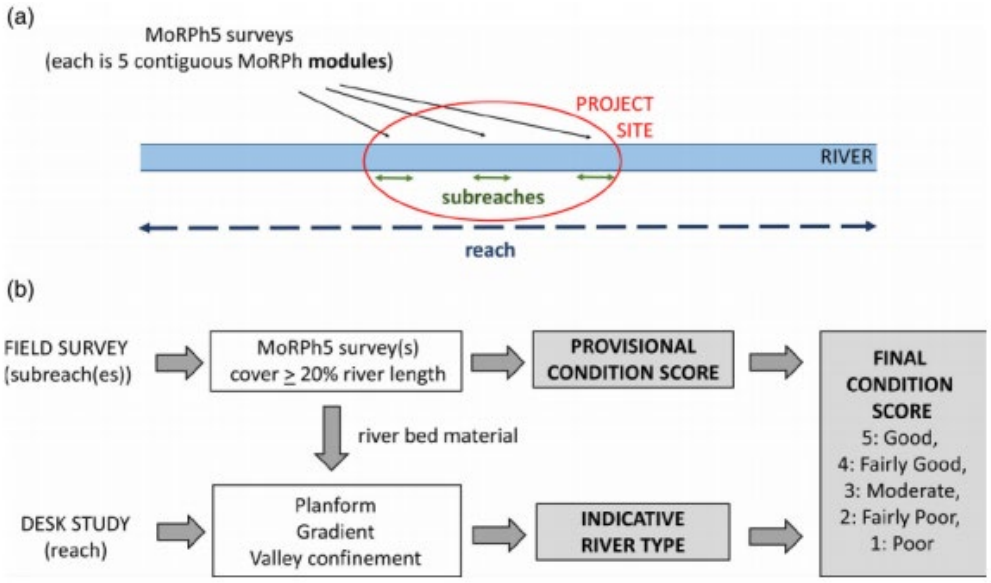
1.2.3 The RCA provides a final condition score for defined sub-reaches (5 - Good, 4 - Fairly Good, 3 - Moderate, 2 - Fairly Poor, 1 - Poor) relative to the type of river observed (**Figure 1-2**). In order to achieve this final condition score, the assessment methodology comprises two components; a field-based component (MoRPh5 survey) to assess the preliminary condition score and a desk-based component (River Type Pro) to determine the river type. In total, 40 indicators are used in the assessment to inform the final condition score which are summarised in Appendix E. An overview of the methodology for each component is outlined in **Figure 1-1** below, the full methodology is described by Gurnell et al. (2022).

1.2.4 RCAs should be undertaken by accredited surveyors and quality assured by an additional accredited surveyor. This assessment was completed and reviewed by surveyors who are all in receipt of a valid accreditation certificate.

1.2.5 The baseline river condition was assessed to identify the current condition of the River Wensum, Foxburrow Stream and to inform the design as to where potential improvements of the watercourses could be made, contributing to the net gain of the Proposed Scheme and WFD water body objectives. Further detail on the enhancements would then be refined at the detailed design stage.

1.2.6 Additionally, baseline ditch condition of the ditch network within the River Wensum floodplain was assessed to inform potential improvements and contributions to net gain and WFD objectives (see Section 1.6).

Figure 1-1- Overview of the River Condition Assessment Methodology



Note: (a) refers to the field-based component MoRPh5 survey to determine the provisional condition score and (b) refers to the desk-based component (River Type Pro) used to determine the River Type and how this is used to determine the Final Condition Score. Source: Gurnell *et al*. (2020).

1.3 MoRPh5 Survey

1.3.1 A MoRPh5 survey is completed for each sub-reach of the study site and comprises of 5 individual MoRPh surveys. The MoRPh survey is akin to an inventory whereby predetermined features on the bank top, bank face, channel margins and channel bed are recorded. Each feature is recorded as either Absent, Trace (less than 5% coverage), Present (greater than 5% and less than 33% coverage) or Extensive (greater than 33%).

1.3.2 The surveys can be completed at any time of year; however, the ideal survey window is between late spring or early summer when vegetation is visible but not sufficiently grown as to obscure other features. Survey data and photographs are uploaded to a dedicated virtual Cartographer workspace.

1.3.3 The initial field-based component was undertaken in May 2022 to capture the baseline condition of the River Wensum, Foxburrow Stream (a tributary of the River Tud) and River Wensum floodplain ditches within the Site Boundary.

Additionally, further surveys of nearby sections of the River Wensum and floodplain ditches were undertaken in November 2022 following identification of potential enhancement locations. It was noted the further surveys were carried out outside of the optimum survey season, however the data gathered was suitable for use as macrophyte cover and suitable flows were present for a sufficiently accurate baseline assessment.

1.3.4 Leading up to both surveys, the weather conditions were fair and dry with low flows prevailing on site, however, whilst onsite periods of heavy rain occurred, but did not affect the assessment as surveys were completed before significant changes to flow or turbidity occurred.

1.3.5 The assessment methodology outlines that surveyors should “record what they see, not what they know”. Therefore, features have been recorded as seen during the survey, with conditions and flow levels recorded in the notes within the online River Condition Assessment database and workspace, known as Cartographer.

1.3.6 Eight MoRPh5 surveys were completed as outlined in **Table 1-1** to provide representative conditions throughout for the Proposed Scheme. All MoRPh5 surveys were carried out within the Red Line Boundary (RLB), shown in Appendix A.

Table 1-1– Overview of MoRPh5 sub-reaches completed in the Study Area

MoRPh5 Survey	MoRPh5 approximate mid-point location	Average MoRPh river width (m)
Wensum 1	TG 14058 15407	10
Wensum 2	TG 13391 15744	16.2
Wensum 3	TG 12883 16412	14
Wensum 4	TG 12969 16245	16.2
Wensum 5	TG 12883 16412	16.2
Foxburrow 1	TG 10414 13455	1.3
Foxburrow 2	TG 10520 13343	1.5
Foxburrow 3	TG 10550 13305	1.5

1.4 River Shape

1.4.1 The Final Condition Score may be adjusted for watercourses that are considered overdeep and, therefore, laterally disconnected from the floodplain. This is to reflect that the natural processes associated with lateral floodplain connectivity are restricted and the condition of the channel is likely to be impacted. The river shape parameter calculated by Cartographer is used to assess the likelihood of a surveyed channel being sufficiently overdeep to adversely affect its hydrological and ecological lateral connection (Gurnell et al, 2022). The river shape is calculated by:

- River Shape = (Average MoRPh width) / (Average (water depth + lower bank height))
- Where a river shape value is less than or equal to 4 is watercourse is likely to be overdeep, and expert judgement should be exercised to assess if the final RCA condition score should be reduced by one class.

1.5 River Type Pro

1.5.1 The River Type Pro is a desk-based study used to categorise character of the watercourse in the study area. There are 13 river types defined in the RCA methodology as outlined in **Figure 1-2**. The desk-based study identifies distinct reaches within the study area with a River Type Pro assessment carried out for each reach. The start and end of a reach may be defined by a number of features including large in-channel structures, significant tributary junctions (contributing > 10% of flow) or a notable change in planform.

1.5.2 For each reach, eight indicators are estimated using maps or aerial imagery and field-based data as outlined in **Table 1-2**.

Figure 1-2 - An overview of the 13 river types (A-M) considered within the River Condition Assessment Methodology. Source: Gurnell et al. (2022)

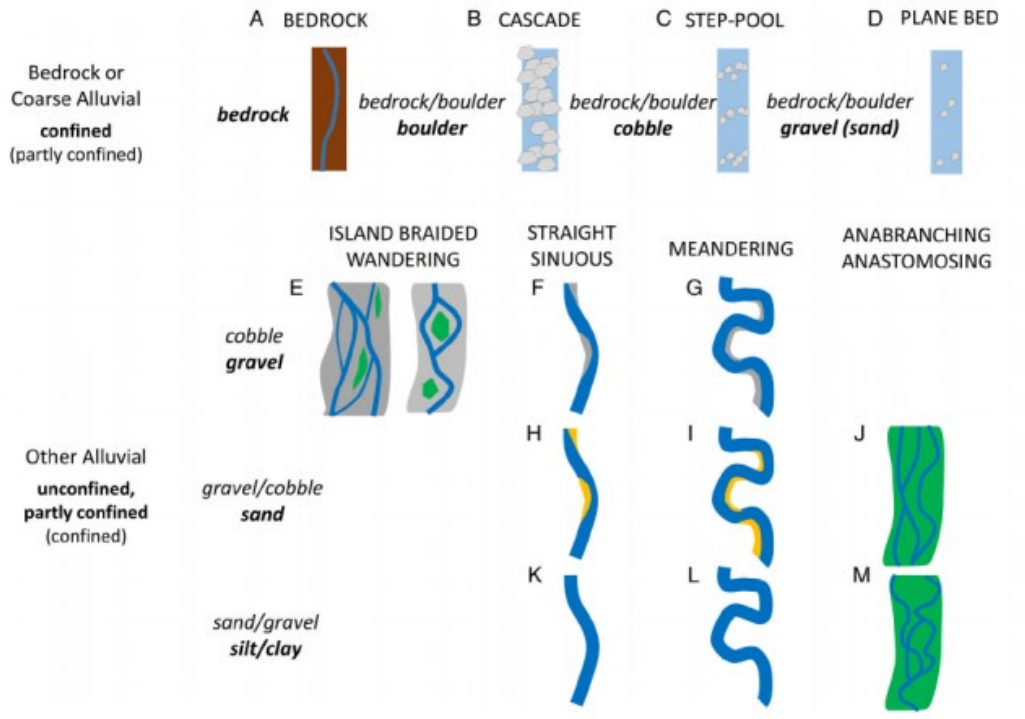


Table 1-2 – Overview of River Type Pro indicators and sources of information used to categorise the river type of reaches in the RCA.

Indicator	Source
Braiding index	Desk Study
Sinuosity index	Desk Study
Anabranching index	Desk Study
Level of confinement	Desk Study
Valley gradient	Desk Study
Bedrock reaches	Field survey
Coarsest bed material size class	Field survey
Average alluvial bed material size class	Field survey

1.6 Ditch Condition Assessment

1.6.1 Ditch condition assessments are assessed using a standard proforma outlined in Natural England (2022b) and relates to watercourses which can be defined as:

"Ditches are artificially created, linear water conveyancing features that are less than 5m wide and likely to retain water for more than 4 months of the year. Their hydraulic function is primarily for land drainage, and although partially or fully connected to a river system, they would not have been present without human intervention." (Natural England, 2022a).

1.6.2 The locations of ditches were identified during the desk study and confirmed on site through analysis of topographic survey. A ditch habitat survey consists of the eight criteria identified below:

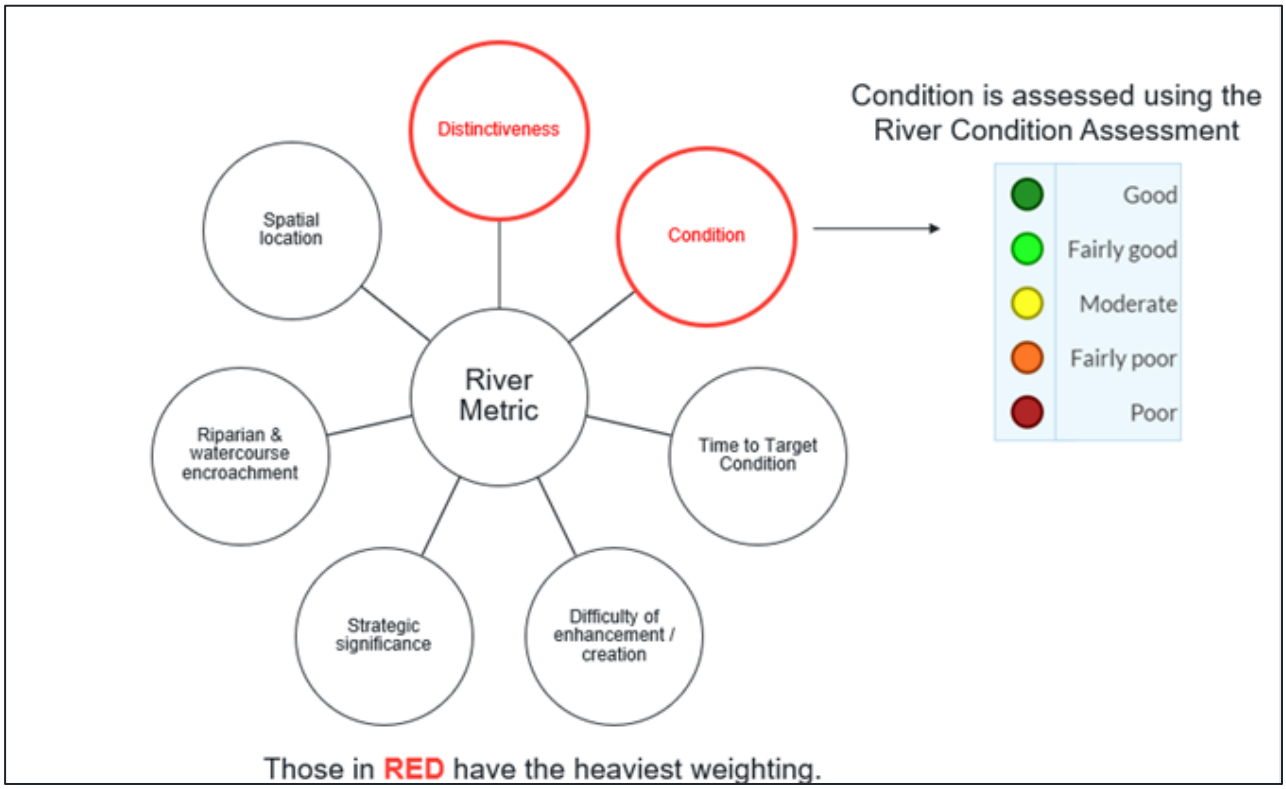
- The ditch is of good water quality, with clear water (low turbidity) indicating no obvious signs of pollution.
- A range of emergent, submerged and floating leaved plants are present.
- There is less than 10% cover of filamentous algae and / or duckweed.
- A fringe of marginal vegetation is present along more than 75% of the ditch.
- Physical damage evident along less than 5% of the ditch, such as excessive poaching, damage from machinery use or storage, or any other damaging management activities.
- Sufficient water levels are maintained; as a guide a minimum summer depth of approximately 50cm in minor drains and 1m in main drains.
- Less than 10% of the ditch is heavily shaded.
- There is an absence of non-native plant and animal species.

1.6.3 Based on the number of criteria met, the ditch will be given a classification of either Good (8 of 8 criteria), Moderate (6 or 7 of 8 criteria) or Poor (5 or less of 8 criteria).

1.7 Completing The Biodiversity Metric 3.1

1.7.1 There are several input parameters for BM3.1 which contribute to the value of biodiversity units in the baseline and post-development scenarios (displayed in **Figure 1-3**). The methodology for determining each of these parameters is explained below. The same process is followed for on-site and off-site, as well as baseline, river creation and river enhancement.

Figure 1-3 - Components of the river metric



Distinctiveness

1.7.2 The distinctiveness of the watercourses within the RLB was assessed during the site visit and using Priority River Habitat maps (Freshwater Biological Association, 2023).

1.7.3 Priority Habitat watercourses are highly naturally functioning stretches of rivers and have a very high distinctiveness. These watercourses are identified by using the Priority River Habitat Map and via an assessment of watercourse character against UK Biodiversity Action Plan (BAP) criteria (JNCC, 2011). Priority Habitats are defined by the UK BAP as watercourses which meet the following criteria:

- Riverine waterbodies as high hydromorphological / ecological status;
- Headwaters;
- Chalk Rivers;
- Active Shingle rivers;
- Sites of Special Scientific Interest (SSSI); and
- Watercourses which are habitats to specific species.

1.7.4 Other Rivers and Streams are watercourses with a high distinctiveness which do not satisfy the criteria for being a Priority Habitat or a canal, ditch or culvert. These watercourses were identified using freely available OS maps and the distinctiveness of all watercourses was verified on site.

1.7.5 Canals and ditches are excluded from being priority habitats. Canals and ditches have a medium distinctiveness and culverts have a low distinctiveness.

Length (baseline, length retained and length enhanced)

1.7.6 The length of each distinct section of watercourse within the planning boundary was measured using relevant tools within Geographic Information Systems (GIS).

1.7.7 Channel alignments have been estimated from the General Arrangement Plans (Document Reference: 2.03.00), Drainage Design Plans (Document Reference: 2.07.00) and Structure Drawings (Document Reference: 2.06.00). The length of the proposed culverts was assessed using a precautionary approach, whereby the length was a maximum extent between the footprint of

each apron. This is due to a culvert being at a lower distinctiveness than a river.

Strategic significance

1.7.8 All baseline data was assumed to be within the Local River Basin Management Plan, with the exception of the River Wensum, which was recorded as within Priority Habitat for restoration and any existing culverts, which were recorded as having 'low potential / action not identified in any local plan'. In the post-development scenario any elements deemed to have a negative impact on the watercourse (captured within the metric in C2 – River Creation) were classified as having 'low potential / action not identified in any local plan' with a multiplier of 1. Any proposed enhancements (captured in C3 – River Enhancements) were considered to be beneficial and therefore within the Local River Basin Management Plan or Priority Habitat, with a higher multiplier of 1.15.

1.7.9 Proposed enhancements to the River Wensum are considered to contribute positively to the River Wensum Restoration Strategy (Natural England, 2009). This states an ambition to restore the river and return it to a favourable ecological condition, by restoring a measure of hydrological functioning so that it can sustain wildlife and fisheries characteristic of the river type.

Watercourse encroachment

1.7.10 Watercourse encroachment was guided by the principles set out in the BM3.1 User Guide (p.93).

Riparian encroachment

1.7.11 Riparian encroachment was guided by the principles set out in the BM3.1 User Guide (p.89-92). The negative impacts of cattle poaching on the riparian zone was also considered following review of literature relating to biogeomorphic agents and potential wider impacts to aquatic ecology (e.g., Trimble and Mendel, 1995; Conroy et al., 2016; O'Callaghan et al., 2018)). Additionally, following recently released riparian zone encroachment guidance

set out in the BM4.0 User Guide (Natural England, 2023) that describe agriculture interventions as potential riparian encroachment features.

1.8 Identifying Enhancement Opportunities

1.8.1 Potential on-site enhancement opportunities have been identified for areas immediately upstream and downstream of the Site Boundary, along the River Wensum, Foxburrow Stream and River Wensum floodplain ditches. Multiple opportunities for enhancements have been considered and investigated, such as: implementing improvements to the existing watercourse to improve the river or ditch condition score; restoration of floodplain connectivity; and reinstating length to a modified watercourse by restoring (re-meandering) an artificially straightened section of the River Wensum to a historical alignment.

Habitat created in advance / delay in starting habitat creation

1.8.2 Habitat created in advance of the Proposed Scheme would provide a greater biodiversity unit value, whilst any delay to enhancements and creation would provide a smaller biodiversity unit value. This is captured in the metric by the Final Time to target multiplier, which captures creation in advance as a higher multiplier, and delays as a discount multiplier.

1.8.3 It was assumed that, to minimise the risk of disturbance and limits relating to the practicability of completing enhancement works during construction, any enhancements or creation could take up to 2 years from the commencement of construction of the Proposed Scheme to be completed and therefore a 2-year delay was selected for these parameters.

1.8.4 Where sections of ditch are to be temporarily culverted to allow for the construction of a temporary works platform (TWP), it is expected the TWP would be in place throughout the construction period whilst the viaduct is being constructed. The change will be recorded in the metric as a loss and then creation, with a 4 year delay selected on the creation tab.

Enhancement on existing reaches

1.8.5 The potential benefit of enhancements was estimated through developing a scenario within Cartographer. Baseline RCA survey data were manipulated on Cartographer to reflect enhancements to features that scored poorly in the initial assessment. Enhancements considered included, but are not limited to:

- Removing artificial bank top cover;
- Increasing the extent and variety of vegetation on the bank top and bank face;
- Reducing the extent of artificial bank profiles to a more natural cross-section;
- Introduction of large wood features and wood dam structures to enhance in-channel morphology;
- Gravel augmentation and creation of a varying river bed topography;
- Reduction of encroachment in the riparian zone and in the watercourse (e.g. remove redundant bank protection features or structures, set back land use, reduce maintenance);
- Improvement of the distinctiveness of the watercourse within the site (e.g., change back from culvert to a natural open channel), improving floodplain connectivity and reduction of impacts from overdeeping.

1.8.6 The final condition score of the scenario was used in the enhancement scenario iteration of BM3.1.

Re-meandering of existing reaches

1.8.7 Historic maps of the area surrounding the Proposed Scheme, from 1885 to 1952, were downloaded from the National Library of Scotland (2023) and checked against current maps using GIS. This provided an indication into historical planform alignment and evidence of channel modification. This exercise identified where straightened channel sections had potential for enhancement.

1.8.8 The difference in length between the historic channel and the current channel was assumed to be the length that could be restored and, therefore, added to the length of the current watercourse within the metric. However, the final length of enhancement would be informed by further assessment and determined at the detailed design stage post-planning.

2 Results – Baseline River Condition Assessment

2.1.1 The following section details the results of the River Condition Assessment as referred to in Section 6 of the Environmental Statement **Chapter 10: Biodiversity** - Appendix 33: Biodiversity Net Gain Technical Report (Document Reference: 3.10.33).

2.1.2 Results of the River Condition Assessment relating to the River Wensum have been assessed separately from the Foxburrow Stream and ditches, as it has been excluded from the BNG assessment process.

2.2 MoRPh5 Surveys

River Wensum - Priority Habitat

2.2.1 The River Wensum within the RLB is estimated at 857m in length. Five MoRPh5 surveys were taken along this watercourse to ensure 20% of the watercourse length was assessed, with distinctiveness and average widths identified below (**Table 2-1**). Maps with survey locations along the River Wensum in or within 10m of the RLB are shown in Appendix G.

Table 2-1 – River Wensum – Priority Habitat. Within the Red Line Boundary.

MoRPh5 Survey	Distinctiveness	Average Width (m)
Wensum 1	Priority Habitat	10
Wensum 2	Priority Habitat	16.2
Wensum 3	Priority Habitat	14
Wensum 4	Priority Habitat	16.2
Wensum 5	Priority Habitat	16.2

2.2.2 The sub-reach in which the River Wensum Viaduct is proposed to cross the River Wensum (Wensum 1) scored an overall Fairly Good (1.2510) condition. The highest positive indicator scores (≥3) for this sub-reach included bank face natural bank profile richness, channel margin physical feature extent, channel aquatic morphotype richness, and channel bed material richness. However, lowest negative scores (≤-2) included bank face artificial bank profile extent and bank top managed ground cover.

2.2.3 Within the upstream sub-reaches (Wensum 2-5), the watercourse scored overall Moderate condition, with scores for each sub-reach as follows; 1.1700, 1.1660, 1.0121, 1.0121. The highest positive scores (≥3) observed included bank face natural bank profile richness, and channel margin aquatic vegetation extent. The lowest negative scores (≤-3) included bank top managed ground cover, and bank face artificial bank profile extent.

2.2.4 A review of the river shape parameter calculated for these MoRPh5 surveys and site observations supported a reduction in overall condition score for Wensum 1 and Wensum 4 (**Table 2-2**). Additionally, as described within the River Wensum Restoration Strategy (Natural England, 2009), historical dredging has resulted in sections of overdeepened channel within the River Wensum. Therefore, the overall condition score has been downgraded from Fairly Good to Moderate (Wensum 1) and Moderate to Fairly Poor (Wensum 4) to reflect the potential impact of anthropogenic modification on the River Wensum.

Table 2-2 – River Shape on the River Wensum

MoRPh5 Survey	Baseline River Condition	River Shape	Updated River Condition	Notes
Wensum 1	Fairly Good	4.05	Moderate	Clear undercutting of banks, narrow channel with high bank top in relation to width of channel. Habitat homogeneity. Evidence of reduced lateral connectivity with the floodplain.
Wensum 4	Moderate	3.19	Fairly Poor	Clear undercutting of banks, narrow channel with high bank top in relation to width of channel. Habitat homogeneity. Evidence of reduced lateral connectivity with the floodplain.

2.2.5 Photographs showing representative sections of the River Wensum within the site are provided in Appendix F.

Foxburrow Stream

2.2.6 The Foxburrow Stream within the RLB is estimated at 828m in length. Three MoRPh5 surveys were taken along this watercourse to ensure 20 % of the watercourse length was surveyed, with distinctiveness and average widths identified below (**Table 2-3**). Two pipe culverts were present within the RLB, upstream and downstream of the proposed culvert. Maps with survey locations along the Foxburrow Stream in and within 10m of the RLB are shown in Appendix G.

Table 2-3 – Foxburrow Stream – Other Rivers and Streams Within the Red Line Boundary

MoRPh5 Survey	Distinctiveness	Average Width (m)
Foxburrow 1	High	1.3
Foxburrow 2	High	1.5
Foxburrow 3	High	1.5
Culvert 1	Low	<0.5
Culvert 2	Low	<0.5

2.2.7 In the sub-reach in which the culvert (CU2) associated with the carriageway is proposed to cross the Foxburrow Stream (Foxburrow 2), the river watercourse scored an overall Moderate (0.8057) condition. The highest positive indicator scores (≥3) for this sub-reach included bank face riparian vegetation structure, bank face natural bank profile material richness, bank face bare sediment extent, channel margin aquatic vegetation extent, channel aquatic morphotype richness, and channel bed material richness. The lowest negative scores (≤-3) included bank top managed ground cover, bank face artificial bank profile extent and channel bed siltation.

2.2.8 Within the upstream sub-reach (Foxburrow 1), the watercourse also scored overall Moderate (0.7126) condition, with similar positive and negative indicators to Foxburrow 2.

2.2.9 Within the downstream sub-reach (Foxburrow 3), the watercourse also scored overall Moderate (1.3158) condition, with similar positive and negative indicators to Foxburrow 1 and Foxburrow 2.

2.2.10 Photographs showing representative sections of the Foxburrow Stream within the site are provided in Appendix F.

2.3 River Type Pro Assessment

2.3.1 On site observations of substrate (coarsest bed material and average bed material) were used within the River Type Pro Assessment for the River Wensum and Foxburrow Stream.

2.3.2 This indicated that the River Wensum was classified as a Type K watercourse, defined as watercourses with a straight / sinuous planform. The River Wensum was identified as having a braiding index of 1, an anabranching index of 1 and a sinuosity index of 1.16. The average bed material is identified as silt, with the coarsest bed material identified as fine sand on a Type K watercourse.

2.3.3 The Foxburrow Stream was classified as a Type H watercourse, defined as a single thread watercourse, with a straight / sinuous planform. The watercourse was identified as having a braiding index of 1, an anabranching index of 0 and a sinuosity index of 1.28. The average bed material is identified as sand with the coarsest bed material identified as gravel-pebble on a Type H watercourse.

2.3.4 The typical features and characteristics of River Type K and H in a natural condition have been provided in Table 2-4.

Table 2-4 – Features typically observed in River Type K and H (Gurnell et al, 2022)

Feature Location	Type K (River Wensum)	Type H (Foxburrow Stream)
Channel bed physical features	Pool	Riffle Pool
Channel bed vegetation types	Not applicable	Not applicable
Channel bed vegetation types	Emergent broad- / linear leaved Submerged broad- / linear- / fine-leaved	Not applicable
Channel bank physical features	Not applicable	Side bar – unvegetated Side bar - vegetated
Channel bank vegetation types	Emergent broad- / linear-leaved	Emergent broad- / linear-leaved
Bank top physical features	Wetland (any types) Connected / disconnected backwaters and side channels	Not applicable

2.4 Ditch Condition Assessment

2.4.1 Within the RLB, 12 ditches were identified using the topographic survey provided ahead of the site visits. These were split into 22 representative sections of ditch and assessed individually during surveys using the Ditch Condition Assessment methodology.

2.4.2 A summary table describing the baseline condition of each ditch section is shown in **Table 2-5**. Maps with survey locations on ditches in and within 10m of the RLB are shown in Appendix G.

2.4.3 Across the majority of the ditches identified, there were common themes across the assessment:

- Evidence of eutrophication and excess nutrients, indicating poor water quality.
- A fringe of marginal vegetation was present along the entire ditch (densely vegetated throughout).
- Where no fencing was in place, extensive evidence of physical damage from cattle poaching.
- Evidence of regular maintenance, including machinery use.
- All ditches had marginal vegetation present along more than 75% of the ditch.
- There was no variety of emergent and submerged plants identified.
- There were no non-native plant and animal species identified.

2.4.4 Photographs showing representative sections of the ditches within the site are provided in Appendix F.

2.4.5 The majority of ditches were classified as poor, satisfying between 2 and 5 of the criteria within the ditch habitat assessment. A minority were classified as moderate, satisfying between 6 and 7 of the criteria.

2.5 Baseline Final Condition Score

2.5.1 The final baseline condition of the Foxburrow Stream sub-reach was categorised as Moderate using the RCA methodology. Where there are two existing pipe culverts, the condition is assumed to be Poor, based on the standard protocol for culverts (Natural England, 2022). Final baseline condition scores for the River Wensum, Foxburrow Stream and ditches are summarised in **Table 2-5**.

Table 2-5 – Baseline Watercourses Summary

Watercourse	Section	Preliminary Condition Score	Baseline Final Condition
Wensum	Wensum 1	0.7328	Moderate
Wensum	Wensum 2	1.1700	Moderate
Wensum	Wensum 3	1.1660	Moderate
Wensum	Wensum 4	1.0121	Fairly Poor
Wensum	Wensum 5	1.0121	Moderate
Foxburrow	Foxburrow 1	0.7126	Moderate
Foxburrow	Foxburrow 2	0.8057	Moderate
Foxburrow	Foxburrow 3	1.3158	Moderate
Foxburrow	Culvert 1	Not applicable	Poor
Foxburrow	Culvert 2	Not applicable	Poor
Ditches	Ditch1	4 (satisfies 4 of the 8 criteria)	Poor
Ditches	Ditch2	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC1	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	Ditch B	4 (satisfies 4 of the 8 criteria)	Poor
Ditches	WC5	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC7	2 (satisfies 2 of the 8 criteria)	Poor

Watercourse	Section	Preliminary Condition Score	Baseline Final Condition
Ditches	WC5Mid2	5 (satisfies 6 of the 8 criteria)	Poor
Ditches	WC5Mid3	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC5Mid4	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC5Mid4 - MOAT	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC5off	4 (satisfies 4 of the 8 criteria)	Poor
Ditches	WC5offx2	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	DitchCUS	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	DitchCoff	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	DitchCoffUs	7 (satisfies 7 of the 8 criteria)	Moderate
Ditches	DitchCoffx2	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	WC5off	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	Ditch K	2 (satisfies 2 of the 8 criteria)	Poor
Ditches	Ditch L	2 (satisfies 2 of the 8 criteria)	Poor
Ditches	WC2	4 (satisfies 4 of the 8 criteria)	Poor
Ditches	WC3	3 (satisfies 3 of the 8 criteria)	Poor
Ditches	WC4	3 (satisfies 3 of the 8 criteria)	Poor

3 Results – No Enhancement RCA Scenario

3.1 MoRPh5

3.1.1 The General Arrangement Plans (Document Reference: 2.03.00), Drainage Design Plans (Document Reference: 2.07.00) and Structure Drawings (Document Reference: 2.06.00) were used to estimate a preliminary condition score of the Proposed Scheme following construction, should no enhancements to watercourses be undertaken. These scores are presented in **Table 3-1**. The scenario also assumes that vegetation included within the Landscaping Plans (Document Reference: 2.07.00) are fully established during assessment and adopts the assessment methodology principle of "record what you see, not what you know". For example, if topsoil and vegetation were providing coverage over harder engineered measures, the former was recorded within the scenario testing.

River Wensum

3.1.2 As part of the bespoke assessment for the River Wensum, the installation of the River Wensum Viaduct structure (BR1) across the watercourse resulted in the addition of a bridge, a negative indicator score, and a reduced abundance of short / creep / grasses and tall herbs / grasses for modules 1-4 of Wensum 1 MoRPh5 survey area.

3.1.3 No significant changes would be anticipated to the channel bed and water margin indicators. Based on the design, the condition of some tree and bank indicators could show a minor decrease due to the presence of the viaduct, with a potential loss of mature vegetation that is unlikely to re-establish following construction.

Foxburrow Stream

3.1.4 On Foxburrow Stream, the installation of a 72m culvert (CU2) below the carriageway resulted in a predicted loss of 77m of the stream, due to the straightening of the channel. The installation of a culvert automatically downgrades the condition of the watercourse to Poor. Five surface water drainage outfalls and associated scour protection reduced the abundance of

short / creep / grasses and tall herbs / grasses throughout the Foxburrow 2 MoRPh5 sub-reach where the culvert is not present and increased artificial bank and channel reinforcement.

3.1.5 Changes to the positive and negative condition indicator scores of Foxburrow 2 are provided in Appendix E. Despite certain design features to oversize the culvert structure and creature a channel bed with natural substrate within it, the structure length (including aprons) will be recorded as a culvert (poor distinctiveness) within the BNG calculations.

Table 3-1 – No Enhancement Scenario Watercourses Summary

Watercourse	Section	Preliminary Condition Score	Baseline Final Condition
Wensum	Wensum 1	0.7328	Moderate
Wensum	Wensum 2	1.1700	Moderate
Wensum	Wensum 3	1.1660	Moderate
Wensum	Wensum 4	1.0121	Fairly Poor
Wensum	Wensum 5	1.0121	Moderate
Foxburrow	Foxburrow 1	0.7126	Moderate
Foxburrow	Foxburrow 2	Not applicable - Culvert	Poor
Foxburrow	Foxburrow 3	1.3158	Moderate
Foxburrow	Culvert 1	Not applicable	Poor
Foxburrow	Culvert 2	Not applicable	Poor

3.2 River Type Pro Assessment

3.2.1 For the River Wensum, the introduction of the viaduct did not result in a change to the River Type, therefore, the post-development River Type remains as Type K.

3.2.2 For the Foxburrow Stream, the changes to channel alignment did not result in a change to the River Type, therefore, the post-development River Type remains as Type H.

4 Results – Enhancement RCA Scenario

4.1 MoRPh5

4.1.1 As above, the General Arrangement Plans (Document Reference: 2.03.00), Drainage Design Plans (Document Reference: 2.07.00) and Structure Drawings (Document Reference: 2.06.00) were used to estimate a preliminary condition score of the Proposed Scheme following construction, should enhancements to watercourses be undertaken. The scenario also assumes that vegetation included within the Landscaping Plans (Document Reference: 2.07.00) are fully established during assessment and adopts the assessment methodology principle of “record what you see, not what you know” as per Section 1.3.

River Wensum

4.1.2 As part of the bespoke assessment for the River Wensum, the same results were scenario tested relating to the installation of the viaduct across the watercourse, and changes in indicator scores remain the same as described in Section 3.1.

4.1.3 Two enhancement opportunities were investigated, and scenario tested: the reconnection of a historic meander to restore river length, and enhancement of the existing channel features. On both scenarios, it was possible to increase the abundance of trees with branches trailing into channel, fallen trees, and wet woodland native species vegetation throughout the MoRPh5 sub-reach. Notable improvements could be provided through the construction of riffle-pool features, and the creation of self-forming in-channel features related to large wood structures that deflect flow (e.g., riverbed substrate and flow type diversity, marginal backwater features, the creation of mid-channel

and lateral bars, accumulation of organic material, etc). In addition, negative indicators associated with animal poaching could be reduced through fencing.

4.1.4 Changes to the positive and negative condition indicator scores of the River Wensum are provided in Appendix E. Significant improvements to the bank top managed ground cover and bank face artificial bank profile extent indicators could potentially be achieved.

Foxburrow Stream

4.1.5 On Foxburrow Stream, the same changes to condition score associated with Proposed Scheme structures were recorded, as per Section 3.1.

4.1.6 Along the Foxburrow Stream sections upstream and downstream of the culvert (Foxburrow 1 and Foxburrow 3), it is possible to increase the abundance of trees with branches trailing into channel, fallen trees, and wet woodland native species vegetation throughout the MoRPh5 sub-reach. Notable improvements could be provided through the construction of large wood dams that retain flow, increase floodplain connectivity by developing a wet woodland, and establishing a more diverse riverbed substrate (varying from sand to fine gravel), flow type (e.g., pools and leaky-dam features), and promoting accumulation of in-channel organic material. In addition, animal poaching can be controlled though fencing, hence, reducing the release of silt to the aquatic environment.

4.1.7 Changes to the positive and negative condition indicator scores of the two sub-reaches are provided in Appendix E. Significant improvements to bank top tree feature richness, bank top water related features, bank top managed ground cover, bank face artificial bank profile extent, among other indicators could potentially be achieved.

4.2 River Type Pro Assessment

4.2.1 For the River Wensum, the introduction of the viaduct and proposed enhancements did not result in a change to the River Type, therefore, the post-development River Type remains as Type K.

4.2.2 For the Foxburrow Stream, the changes to channel alignment did not result in a change to the River Type, therefore, the post-development River Type remains as Type H.

4.3 Final Condition Score

4.3.1 The final condition scores are presented in **Table 4-1**. Overall, the score for the Proposed Scheme for River Wensum with the proposed enhancements increased from 1.17 to 1.68 (Wensum 2), 1.17 to 1.47 (Wensum 3), 1.01 to 1.58 (Wensum 4), 1.01 to 1.58 (Wensum 5), and from a Moderate to a Fairly Good condition within the enhancement areas (Wensum 2-5). As per Section 5.3, at the viaduct crossing the score for Wensum 1 reduced from 1.25 to 0.73 but remained as Moderate condition.

4.3.2 For the Foxburrow Stream, given the constraints on the site and level of reinforcements required within the design (such as the proposed culvert, outfalls and associated scour protection), the proposed enhancements have contributed minor improvements to the final condition scores. Overall, the score for Foxburrow 1 and Foxburrow 3 increased from 0.71 to 1.83 and 0.81 to 2.00 respectively, increasing from Moderate to Fairly Good condition. Foxburrow 2 reduced from Moderate to Poor condition, as per Section 3.1.

4.3.3 As per Section 3.1, the installation of a permanent 22m culvert on WC5 resulted in the loss of 22m in length of Poor ditch habitat. The temporary diversion of ~100m of Ditch C is not expected to result in a reduction in criteria scoring, and there would be no reduction in final condition, as it is already in Poor condition.

4.3.4 Seven sections of ditch within the River Wensum floodplain with specified lengths were selected for enhancement (chosen for their suitability for improvement and feasibility) resulted in an increase in the criteria scoring of a number of ditch sections. These included:

- WC5Mid2 – criteria increased from 5 to 6 (out of 8)
- WC5Mid 3 – criteria increased from 5 to 6 (out of 8)

- WC5Mid4 – criteria increased from 5 to 6 (out of 8)
- WC5off – criteria increased from 5 to 6 (out of 8)
- Ditch K – criteria increased from 2 to 6 (out of 8)
- Ditch L – criteria increased from 2 to 6 (out of 8)
- WC3 – criteria increased from 3 to 6 (out of 8)

4.3.5 Increases in ditch criteria scores can be achieved by the following enhancement measures:

- Macrophyte and riparian vegetation planting, to achieve 10 or more species of emergent, floating or submerged plants in a 20m ditch length and a fringe of marginal vegetation along 75% of the ditch.
- Reduction of maintenance pressures and agricultural practices (such as drainage management, cutting or excessive poaching), resulting in evidence of physical damage in less than 5% of the ditch.
- Targeted reduction in overhanging branches or thick vegetation to reduce heavy shading to less than 10% of the ditch.
- Removal, management and monitoring of invasive non-native plant and animal species, resulting in an absence of these invasive species within the ditch.

Table 4-1 – Enhancement Scenario Watercourses Summary

Watercourse	Section	Preliminary Condition Score	Post Development Final Condition
Wensum	Wensum 1	0.7328	Moderate
Wensum	Wensum 2	1.6842	Fairly Good
Wensum	Wensum 3	1.4737	Fairly Good
Wensum	Wensum 4	1.5790	Moderate
Wensum	Wensum 5	1.5790	Fairly Good
Foxburrow	Foxburrow 1	1.8300	Fairly Good

Watercourse	Section	Preliminary Condition Score	Post Development Final Condition
Foxburrow	Foxburrow 2	Not applicable - Culvert	Poor
Foxburrow	Foxburrow 3	2.0040	Fairly Good
Foxburrow	Culvert 1	Not applicable - Culvert	Poor
Foxburrow	Culvert 2	Not applicable	Fairly Good
Ditches	Ditch1	4 (satisfies 4 of the 8 criteria)	Poor
Ditches	Ditch2	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC1	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	Ditch B	4 (satisfies 4 of the 8 criteria)	Poor
Ditches	WC5	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC7	2 (satisfies 2 of the 8 criteria)	Poor
Ditches	WC5Mid2	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	WC5Mid3	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	WC5Mid4	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC5Mid4 - MOAT	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	WC1off	4 (satisfies 4 of the 8 criteria)	Poor
Ditches	WC1offx2	5 (satisfies 5 of the 8 criteria)	Poor
Ditches	DitchCUS	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	DitchCoff	6 (satisfies 6 of the 8 criteria)	Moderate

Watercourse	Section	Preliminary Condition Score	Post Development Final Condition
Ditches	DitchCoffUs	7 (satisfies 7 of the 8 criteria)	Moderate
Ditches	DitchCoffx2	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	WC5off	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	Ditch K	6 (satisfies 6 of the 8 criteria)	Moderate
Ditches	Ditch L	6 (satisfies 2 of the 8 criteria)	Moderate
Ditches	WC2	4 (satisfies 4 of the 8 criteria)	Poor
Ditches	WC3	6 (satisfies 3 of the 8 criteria)	Moderate
Ditches	WC4	3 (satisfies 3 of the 8 criteria)	Poor

5 Summary

5.1.1 Post development enhancement scenario resulted in a potential change in Final Condition in the following sections of the Foxburrow Stream, as follows:

- Foxburrow 1 – improvement from Moderate to Fairly Good;
- Foxburrow Culvert 1 – improvement from Poor (culvert) to Fairly Good;
- Foxburrow 3 – improvement from Moderate to Fairly Good; and
- Foxburrow 2 – reduction from Moderate to Poor (culvert).

5.1.2 Post development enhancement scenario resulted in a potential change in Final Condition in the following sections of ditch, as follows:

- WC5off, WC5Mid2, WC5Mid3, Ditch K, Ditch L and WC3 – improvement from Poor to Moderate.

5.1.3 Post development enhancement scenario resulted in a potential change in Final Condition in the following sections of the River Wensum, as follows:

- Wensum 4 – improvement from Fairly Poor to Moderate.
- Wensum 2, Wensum 3 and Wensum 5 – improvement from Moderate to Fairly Good.

5.1.4 The baseline and post development enhancement scenario final condition scores described within this document are used in the BNG metric to inform calculated gains in River Baseline Units. This process is described in Section 6 of the of the Environmental Statement Chapter 10: Biodiversity - Appendix 33: Biodiversity Net Gain Technical Report (Document Reference: 3.10.33).

5.1.5 Enhancements would be secured through submission of a Habitat Management and Monitoring Plan under the Biodiversity Gain Plan, to be submitted to discharge the pre-commencement biodiversity gain condition.

6 References

Ref 1 Conroy, E.; Turner, J.N.; Rymszewicz, A.; O'Sullivan, J.J.; Bruen, M.; Lawler, D.; Lally, H.; Kelly-Quinn, M. The Impact of Cattle Access on Ecological Water Quality in Streams: Examples from Agricultural Catchments within Ireland. Sci. Total Environ. 2016, 547, 17–29.

Ref 2 Freshwater Biological Association (2023). Discovering Priority Habitats in England (Available at: Priority Habitats)

Ref 3 Gurnell, A. M., Scott, S. J., England, J., Gurnell, D., Jeffries, R., Shuker, L., & Wharton, G. (2020). Assessing river condition: A multiscale approach designed for operational application in the context of biodiversity net gain. River Research and Applications, 36(8), 1559-1578.

Ref 4 Gurnell, A., England, J., Scott, S. and Shuker, L., (2022).

A Guide to Assessing River Condition Part of the Rivers and Streams Component of the BioDiversity Net Gain Metric. [e-book] pp.8-25 [Accessed 14 September 2021].

Ref 5 JNCC (2011). UK Biodiversity Action Plan Priority Habitat Descriptions (Available at: UK Biodiversity Action Plan)

Ref 6 National Library of Scotland (2023). Historical OS maps (Available at: National Library of Scotland) [Accessed 18.05.2023]

Ref 7 Natural England (2021) Priority Habitat Inventory (England) Opensource dataset. [Accessed 21.11.2022]

Ref 8 Natural England (2021). The Biodiversity Metric 3.1 (JP039) [online]. Available: The Biodiversity Metric 3.1 - JP039 (Available at: The Biodiversity Metric) [accessed 21.11.2022]

Ref 9 Natural England (2022). The Biodiversity Metric 3.1 (JP039) [online]. Available: The Biodiversity Metric 3.0 - JP039 [accessed 21.11.2022]

Ref 10 Natural England (2022a). Biodiversity Metric 3.1 – User Guide (Available at: Natural England)

Ref 11 Natural England (2022b). Biodiversity Metric 3.1 – Technical Supplement (Available at: Natural England)

Ref 12 Natural England (2023). The Biodiversity Metric 4.0 (JP039) [online]. Available: The Biodiversity Metric 4.0 - JP039 [accessed 18.05.2023]

Ref 13 O'Callaghan P, Kelly-Quinn M, Jennings E, et al. 2018. The environmental impact of cattle access to watercourses: A review. J Environ Qual 48: 340–351.

Ref 14 Trimble, S. W., & Mendel, A. C. (1995). The cow as a geomorphic agent—a critical review. Geomorphology, 13(1-4), 233-253.