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Drought Plan: Environmental Assessment Report – North West Area Reservoirs

Final

Report for Yorkshire Water Services Ltd

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Yorkshire Water Services Ltd

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Glossary

Abstraction Licence

The authorisation granted by the Environment Agency (England) or Natural Resources Wales (for sites in Wales) to allow the removal of water from a source.

Biochemical Oxygen Demand (referred to as BOD)

The amount of oxygen that would be consumed if all the organic material in one litre of water were oxidised by bacteria and protozoa.

Compensation Releases

Water company licences that authorise abstractions from a reservoir may have conditions imposed, whereby specified amount of water has to be released into the watercourse, downstream of the reservoir in order to compensate the river for the abstraction.

Discharge Consent

A written consent issued by the Environment Agency permitting the discharge of specific pollutants into the aquatic environment. Discharge consents have conditions attached to them that limit the amount and concentration that can be discharged to ensure that there is no threat to the environment.

Drought Order

An authorisation granted by the Secretary of State (England) or Welsh Ministers (Wales) under drought conditions which imposes restrictions upon the use of water and/or allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis.

Drought Permit

An authorisation granted by the Environment Agency (England) or Natural Resources Wales (for sites in Wales) under drought conditions which allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis.

Environmental Drought

Environmental droughts arise from reduced water flows in rivers and streams. In the summer raised temperatures may further exacerbate drought conditions. Such conditions cause physiological stress to living organisms, the degree of stress increasing with drought severity and time.

Environmental Quality Ratio (EQR)

EQRs express the current condition of a biological quality element such as macroinvertebrates or fish. This is achieved by comparing the observed value of the appropriate metric (for example WHPTASPT) calculated from samples with the value of the same metric expected at WFD reference state.

Local Wildlife Sites (LWS)

Local Wildlife Sites are non-statutory designations. They are areas which are locally important for the conservation of wildlife. They are identified and selected for the significant habitats and species that they contain.

Lotic-Invertebrate Index Flow Evaluation (referred to as LIFE)

Is a method that allows the aquatic invertebrate community recorded at a site to be scored according to its dependence on current velocity. The LIFE value obtained can be compared to that predicted for the site under normal flow conditions and may show if the invertebrate community is experiencing flow related stress. Comparing observed and predicted scores for each gives an Environmental Quality Index (EQI) that is used as a measure of stress experienced at a site from low flow. A value of 1.0 indicates that the invertebrate community has the flow sensitivity predicted for the site. A value of less than 0.975 indicates the possibility of significant stress due to low flow.

Macroinvertebrate

Macroinvertebrates are small, but visible with the naked eye, animals without backbones (insects, worms, larvae etc.). Waterbodies have communities of aquatic macroinvertebrates. The species composition, species diversity and abundance in a given waterbody can provide valuable information on the relative health and water quality of a waterway.

Natural Environment and Rural Communities (NERC) Act Section 41

The Natural Environment and Rural Communities (NERC) Act came into force on 1 October 2006. Section 41 of the Act requires the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The NERC Act Section 41 list contains many of England's rarest and most threatened species. The lists are known as the Section 41 habitats of principal importance (also known as 'priority habitats') and the Section 41 species of principal importance (also known as 'priority species').

pH

A measure of the acidity of alkalinity of a liquid based on a logarithmic scale of concentration of hydrogen ions. < 7 is acidic, > 7 is alkaline.

Ramsar site

Internationally important wetland site.

Special Area of Conservation (SAC)

Special Area of Conservation – Designated under the European Habitats Directive (1991)

Special Protection Area (SPA)

Special Protection Area – Classified under the European Birds Directive (1979)

Site of Special Scientific Interest (SSSI)

A site given a statutory designation by Natural England or Natural Resources Wales because it is particularly important, on account of its nature conservation value.

Supply Drought

A supply drought occurs when water sources are at low levels due to a lack of rainfall. Water companies manage resources to ensure public supplies do not run out.

Walley Hawkes Paisley Trigg (referred to as WHPT)

Is a method that allows the aquatic invertebrate communities recorded at a site to be scored according to their tolerance to environmental pressures such as organic pollution. WHPT can be expressed as a score (the sum of values for each taxon in a sample), as an average score per taxon (ASPT) and as the number of scoring taxa (N-taxa). WFD status is based on ASPT and N-taxa. WHPT was introduced as the basis for the UK's river invertebrate status classification under the Water Framework Directive in the second River Basin Management Plans, published in 2015.

Abbreviations

AOD	–	Above Ordnance Datum
BOD	–	Biochemical Oxygen Demand
CIEEM	–	Chartered Institute of Ecology and Environmental Management
DPG	–	Environment Agency (2020) Drought Plan Guideline
EcIA	–	Ecological Impact Assessment
EMP	–	Environmental Monitoring Plan
EQR	–	Ecological Quality Ratio
JNCC	–	Joint Nature Conservation Committee
LIFE	–	Lotic-invertebrate Index for Flow Evaluation
LNR	–	Local Nature Reserve
LWS		Local Wildlife Site
Ml	–	Megalitres (1Ml is equivalent to 1000 cubic metres or 1,000,000 litres)
NERC	–	Natural Environment and Rural Communities (refers to Section 41 of the Act)
NNR	–	National Nature Reserve
RHS	–	River Habitat Survey
SAC	–	Special Area of Conservation
SPA	–	Special Protection Area
SSSI	–	Site of Special Scientific Interest
WFD		Water Framework Directive: Council of the European Communities 2000 Directive 2000/60/EC (OJ No L 327 22.12.2000) (establishing a framework for Community action in the field of water policy). As transposed into UK law by The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. Statutory Instrument 2003 No. 3242
WHPT	–	Walley Hawkes Paisley Trigg (see Glossary)
WwTW	–	Wastewater Treatment Works

Executive summary

This Environmental Assessment Report (EAR) provides an independent and robust assessment of the potential environmental effects of the implementation of Yorkshire Water Services Ltd's (YWSL) North West Area reservoir drought options. The report has been prepared in support of a drought permit/order application by YWSL in late summer 2022.

The environmental assessment has been conducted in accordance with Government regulations and using the Environment Agency's 2020 Drought Plan Guideline (DPG)[1] and the Environment Agency's July 2020 'Environmental Assessment for Water Company Drought Plans- supplementary guidance'.

In accordance with the DPG, the environmental assessment comprises the following components:

- an assessment of the likely changes in hydrology (flow/level regime) due to implementing the proposed drought options;
- identification of the key environmental features that are sensitive to these changes and an assessment of the likely impacts on these features;
- identification of mitigation that may be required to prevent or reduce impacts on sensitive features; and
- recommendations for baseline, in-drought and post-drought order monitoring requirements.

The environmental assessment focuses on the potential changes to water availability (levels and flows) and any consequent implications for geomorphology, water quality, ecology and other relevant environmental receptors, for example, landscape, navigation, recreation and heritage.

This EAR considers the impacts of the North West Area reservoir drought options in Appendix A and Appendix B, with a summary presented in Sections 5 and 6. Cumulative impacts with other drought options listed in YWSL's Drought Plan 2022 are considered. The assessments undertaken confirm the features requiring consideration of monitoring and mitigation, which are summarised in Section 6 and provided in full in the Drought Plan 2022 Environmental Monitoring Plan (EMP).

Throughout the environmental assessment process, YWSL have proactively engaged key stakeholders, including the Environment Agency and Natural England.

Key stakeholders will be further consulted throughout the drought permit/order application process.

[1] Environment Agency (2020) Water Company Drought Plan Guideline, April 2020.

Table of Contents

1 Introduction

1.1 Purpose of document

The Yorkshire Water Services Ltd (YWSL) Drought Plan 2022[2] was developed in line with the Environment Agency's Drought Plan Guideline (DPG)[3]. The DPG requires that water companies must demonstrate in their drought plan that they have met their responsibility to monitor, assess and where possible mitigate for the environmental impact of all their supply side drought options, including drought permits and drought orders.

Drought permits/orders are management actions that, if granted, can allow more flexibility to manage water resources and the effects of drought on public water supply and the environment. Ultimately, the environmental assessments should inform choices on when and how to use the different supply side drought options considered in a drought plan.

The objective of this Environmental Assessment Report (EAR) is to provide an independent and robust assessment of the potential environmental effects of the implementation of the North West Area reservoir drought permits.

This EAR has been prepared in support of a drought permit application in late summer 2022 to the Environment Agency, in accordance with the Water Resources Act 1991, as amended by the Environment Act 1995, the Water Act 2003 and subsequently the Water Act 2014.

The environmental assessment has been conducted in accordance with Government regulations and using the Environment Agency's 2020 DPG and the Environment Agency's July 2020 'Environmental Assessment for Water Company Drought Plans - supplementary guidance'.

In accordance with the DPG, the environmental assessment comprises the following components:

1. an assessment of the likely changes in hydrology (flow/level regime) due to implementing the proposed drought options.
2. identification of the key environmental features that are sensitive to these changes and an assessment of the likely impacts on these features.
3. identification of mitigation that may be required to prevent or reduce impacts on sensitive features.
4. recommendations for baseline, in-drought and post-drought order monitoring requirements.

The methodology for this environmental assessment was developed during preparation of the 'shelf copy' environmental assessment[4] in consultation with the Environment Agency, and is documented separately in 'YWSL's Drought Plan 2022 Environmental Assessment Methodology'[5]. A summary of the assessment approach is provided in Section 3.

The assessments undertaken in this EAR confirm the features requiring consideration of mitigation and appropriate monitoring triggering mitigation. Appropriate mitigation actions identified are both available and practicable and reflect previous agreement with the Environment Agency (see Section 1.3). The methodologies and details for monitoring and mitigation requirements are documented in the standalone document 'YWSL's Draft Drought Plan 2022 Environmental Monitoring Plan (EMP)' which accompanies the drought permit/order application. A summary of the monitoring and mitigation requirements are also included in Section 6 of this EAR.

This EAR should be read alongside the Methodology and EMP documents.

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2 Yorkshire Water (2022) Yorkshire water Final Drought Plan 2022. April 2022, Available at: https://www.yorkshirewater.com/about-us/resources/drought-plan/

3 Environment Agency (2020) Water Company Drought Plan Guideline, April 2020.

4 Ricardo Energy & Environment (2021). Drought Plan: Environmental Assessment Report – River Ouse. Report for Yorkshire Water Services Ltd. February 2021.

5 Ricardo Energy & Environment (2020). Yorkshire Water Drought Plan 2022. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. June 2020.

1.2 Background to study

Water companies in England and Wales are required to prepare and maintain Statutory Drought Plans under Sections 39B and 39C of the Water Industry Act 1991, as amended by the Water Act 2003 (and subsequently the Water Act 2014), which set out the short operational steps a company will take before, during and after a drought. The Water Industry Act 1991 defines a Drought Plan as 'a plan for how the water undertaker will continue, during a period of drought, to discharge its duties to supply adequate quantities of wholesome water, with as little recourse as reasonably possible to drought orders or drought permits'.

The Drought Plan (England) Direction 2016 states that Drought Plans should be submitted within 4 years and 3 months after the date on which its Drought Plan, or its last revised Drought Plan, is published. Yorkshire Water Services Limited (YWSL) published their current statutory Drought Plan in April 2022The Drought Plan provides a comprehensive statement of the actions YWSL will consider implementing during drought conditions to safeguard essential water supplies to customers and minimise environmental impact.

Drought Plans encompass a number of drought options that will only be implemented if and when required. Each drought is different in terms of its severity, season, location and duration and each combination of these factors may require a bespoke reaction in terms of measures. In the context of drought planning, individual drought options are taken to constitute alternatives. YWSL's Final Drought Plan 2022 comprises a total of 63 drought options (49 ordinary supply-side options, 9 long term supply-side options, 5 demand options).

This EAR has been prepared in support of a drought permit application in late summer 2022. It provides an update to the 'shelf copy' report which was produced in support of YWSL's Drought Plan 2022.

Following agreement with the Environment Agency[6], the physical environment and environmental features assessments presented in the 'shelf copy' report have been retained for this application EAR. The assessments are considered suitable to support the current application as no significant dry weather events have been experienced in the Yorkshire region subsequent to the completion of the 'shelf copy' assessments in 2021. However, in order to provide sufficient evidence that no changes have occurred to the sensitivity of protected/notable species or the macroinvertebrate or fish communities within the impacted reaches, a full review and analysis of additional baseline monitoring data has been undertaken. This review had included incorporation of the available 2020-21 data from the YWSL and Environment Agency baseline monitoring programmes as well as review of updated Water Framework Directive (WFD) status of designated waterbodies which contain the impacted reaches. The results of this analysis are presented as accompanying spreadsheets in support of the drought permit application. In addition, a review of water quality pressures has been undertaken following progression of the YWSL Storm Overflow Assessment Framework (SOAF) programme since the 'shelf copy' assessments were undertaken. Where applicable, changes have been made to the outcomes of the physical environment assessment to reflect this review.

1.3 Consultation

Throughout the preparation and submission of the Final Drought Plan 2019 YWSL proactively engaged with key stakeholders and regulators regarding the scope and outcomes of the environmental assessment, including with the Environment Agency and Natural England. Discussions were also held between YWSL and the Environment Agency on the scope of monitoring/mitigation in Autumn 2018 following a period of prolonged dry weather. These discussions identified certain issues around the appropriateness and practicality of YWSL's monitoring-led mitigation plan as set out in its Draft Drought Plan 2019 EMP. The outcome of these discussions and resulting agreements have informed the basis

[6] Email exchange between Yasmina Gallaher (Yorkshire Water), and Ineke Jackson (Environment Agency) on 20 July 2022.

of the approach for the update of the environmental assessments and EMP for the Draft Drought Plan 2021.

YWSL then held a number of meetings during the early stages of the preparation of the Draft Drought Plan 2021, including several meetings focused on the proposed approach to the environmental assessments which are documented in the Drought Plan 2022 Environmental Assessment Methodology[7]. Proactive consultation continued to be conducted for the Drought Plan 2022 submission, including on the outcomes of the environmental assessment process.

Further consultation with key stakeholders will be undertaken throughout the drought permit/order application process.

1.4 Content of report

The structure of this EAR is provided below with reference to other relevant documents.

Section 1: **Introduction**

Section 2: **Drought management proposals** - including an overview of YWSL's water supply system, drought planning, the need for the applications, alternative options and proposed drought permit/order details (to be completed at the time of a drought permit application)

Section 3: **Approach to environmental assessment** - description of the approach to assessing environmental impacts and identification of mitigation and monitoring requirements, with reference to the details which are provided in YWSL's Drought Plan 2022 Environmental Assessment Methodology[8].

Section 4: **Drought options overview: North West Area options** - overview of drought permit conditions.

Section 5: **Physical environment effects: North West Area options** - baseline assessment of physical environment and assessment of potential changes in the physical environment as a result of the drought options, and from cumulative operation with options described in other EARs. Detailed information is provided in **Appendix A** and summarised in Section 5.

Section 6: **Features assessment, monitoring and mitigation: North West Area options** - impact assessment on environmental features, identification of mitigation and monitoring requirements, including cumulative reaches. Detailed information is provided in **Appendix B** and in YWSL's Drought Plan 2022 EMP and summarised in Section 6. **Appendix C** summarises the full suite of monitoring and mitigation measures as detailed in the EMP.

Appendices

Appendix A Physical Environment

Appendix B Environmental Features

Appendix C Environmental Monitoring and Mitigation Measures

[7] Ricardo Energy & Environment (2020). Yorkshire Water Drought Plan 2022. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. June 2020.

[8] Ricardo Energy & Environment (2020). Yorkshire Water Drought Plan 2022. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. June 2020.

2 Drought management proposals

See YWSL drought permit application supporting documentation.

3 Approach to environmental assessment

3.1 Overview

The environmental assessment of the drought options in this report has been prepared in accordance with Environment Agency's 2020 DPG; specifically the Environment Agency's July 2020 'Environmental Assessment for Water Company Drought Plans - supplementary guidance'. The approach to environmental assessment and the bespoke assessment methodologies used have been developed in consultation with the Environment Agency and are documented separately in YWSL's Drought Plan 2022 Environmental Assessment Methodology[9] ('the Methodology').

Depending on the particular ongoing water resources drought, different management options may be available and the full range of drought permits may not be used by YWSL at the same time. This EAR considers the impacts of implementation of all eleven of the YWSL North West Area reservoir drought permits and the Environment Agency drought order.

The Environment Agency's 2020 DPG requires the completion of environmental assessment and production of an environmental monitoring plan for each of supply side actions included in a drought plan. The environmental assessments should also include any mitigation measures that could be implemented. The Methodology provides detailed approaches to the specific requirements of the DPG which are:

1. Setting out the likely changes to the hydrology (or hydrogeology) due to a proposed action (see Section 3.4 and Section 3.5 of the Methodology).
2. Identifying the key features of the environment which are likely to be affected by these changes and assess their sensitivity (see Section 3.6 of the Methodology).
3. Assess the likely impact on these features, allocate a level of confidence in your assessment and set out the actions you will take to reduce uncertainty (see Section 3.7 of the Methodology).
4. Mitigating against the potential impacts and where datasets are considered insufficient to undertake an environmental assessment it is the responsibility of the water company to implement environmental monitoring to generate the information required (see Section 3.8 of the Methodology).

The overall approach taken in completing the environmental assessment to demonstrate an understanding of the impact on the environment of implementing the proposed drought options is illustrated in F**igure 3.1**.

Results of the assessment have also informed the Habitats Regulations Assessment (HRA)[10] and Strategic Environmental Assessment (SEA)[11] which support YWSL's Drought Plan 2022 and are documented separately.

The Environment Agency's 2020 DPG also requires water companies to 'consider the combined environmental effects of your supply side drought options, and where relevant, the combination effects of your actions with those of neighbouring water companies and other abstractors'. The SEA and HRA for a drought plan as a whole has informed these combined assessments.

3.2 Limitations of assessment

Details on the quality of the data collected and used in the assessment, limitations and any assumptions made, are included in the relevant technical appendices (**Appendix A** and **B**).

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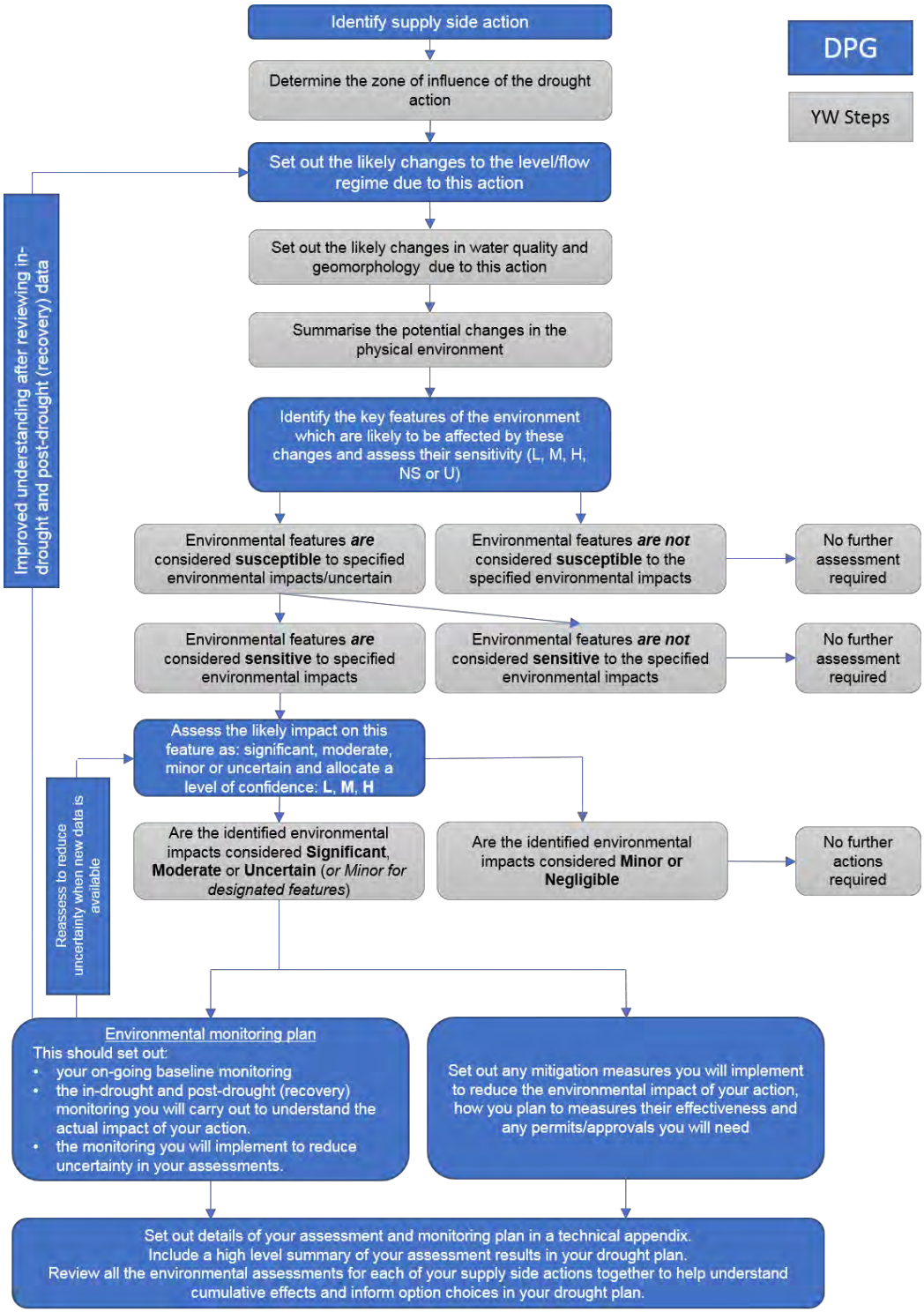
9 Ricardo Energy & Environment (2020). Yorkshire Water Drought Plan 2022. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. June 2020.

10 Yorkshire Water (2022) Yorkshire Water Drought Plan 2022 Habitats Regulation Screening Report, April 2022. Available at https://www.yorkshirewater.com/media/vzenyqzb/yorkshire-water-drought-plan-2022-hra.pdf.

11 Yorkshire Water (2022) Yorkshire Water Drought Plan 2022 SEA Environmental Report, April 2022. Available at https://www.yorkshirewater.com/media/c2qgvnsf/yorkshire-water-drought-plan-2022-sea-environmental-report.pdf.

For features where the assessment remains uncertain because of data limitation, the requirement for additional targeted monitoring has been considered and is documented in YWSL's Drought Plan 2022 EMP.

Figure 3.1 Approach to undertaking environmental assessments as identified in the 2020 DPG.
Steps in blue are 2020 DPG tasks. Tasks indicated in grey are YWSL tasks



4 Drought options overview

4.1 Drought permit descriptions

This EAR assesses the potential impacts on the environmental features of the North West Area during the period of implementation of associated drought options.

The North West Area options comprise drought permits at one maintained river flow and at eleven reservoirs with compensation flows as summarised in **Table 4.1**:

1. Springhead Weir Maintained Flow drought permit
2. Leeming Reservoir drought permit
3. Leeshaw Reservoir drought permit
4. Doe Park Reservoir drought permit
5. Hewenden Reservoir drought permit
6. Eldwick Reservoir drought permit
7. Reva Reservoir drought permit
8. Weecher Reservoir drought permit
9. Silsden Reservoir drought permit
10. Embsay Reservoir drought permit
11. Grimwith Reservoir drought permit
12. Carr Bottom Reservoir drought permit.

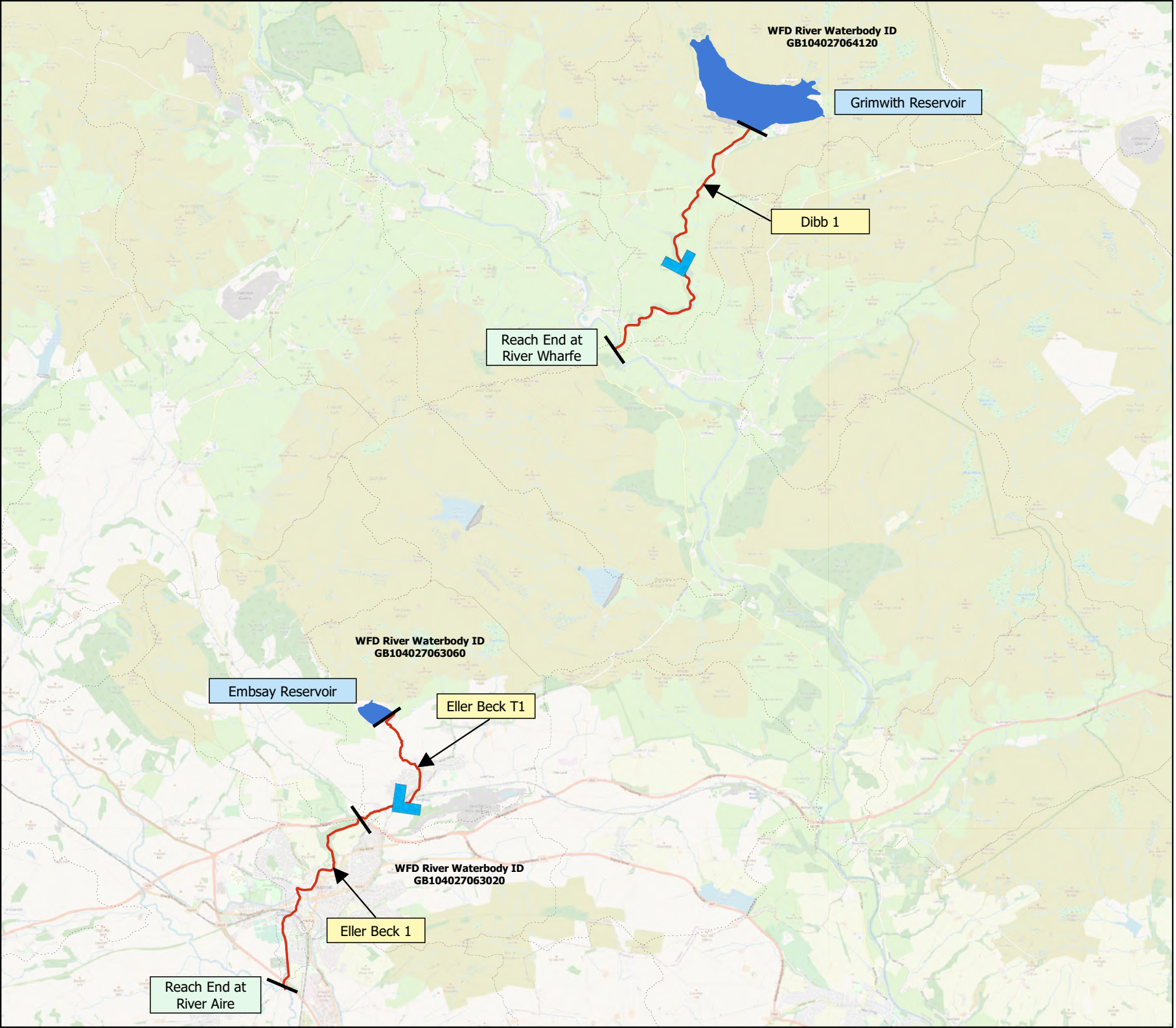
Further details on the existing arrangements at each site and the proposed drought options are found in **Appendix A**, Section A2. The study area is illustrated in **Figures 4.1** and **4.2**.

Table 4.1 North West Area reservoirs drought permit descriptions

Compensation Water Source	Receiving Watercourse	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Springhead Weir Maintained Flow drought permit[12]						
River Worth Springhead Weir	River Worth	6.00 (can be 8.00Ml/d)	3.00-4.00	3.00-4.00	2.00-2.67	4.00-5.33
Leeming Reservoir drought permit						
Leeming	Leeming Water	4.00 (can vary between 3.25 and 5.25)	1.625-2.63	1.63-2.63	1.07-1.73	2.18-3.52
Leeshaw Reservoir drought permit						
Leeshaw	Moorhouse Beck	4.00 (can vary between 2.75 and 4.00)	1.38-2.00	1.38-2.00	0.91-1.32	1.84-2.68
Doe Park Reservoir drought permit						
Doe Park	Denholme Beck	1.8 (when stocks are below control line) 3.6 (when stocks are above control line)	N/A	N/A	1.20	0.60-2.40
Hewenden Reservoir drought permit						
Hewenden	Hewenden Beck	6.3	3.15	3.15	2.08	4.22
Eldwick Reservoir drought permit						
Eldwick	Eldwick Beck	1.00	0.50	0.50	0.33	0.67
Reva Reservoir drought permit						
Reva	Jum Beck	0.79	0.40	0.40	0.26	0.53
Weecher Reservoir drought permit						
Weecher	Weecher Brow Beck	0.43	0.22	0.22	0.14	0.29
Silsden Reservoir drought permit						
Silsden	Silsden Beck	2.41	1.21	1.21	0.80	1.61
Embsay Reservoir drought permit						
Embsay	Embsay Beck	1.19	0.60	0.60	0.39	0.80

[12] A possible flow trial at Springhead Weir would, if progressed, have potential impacts on the Springhead Weir, Leeming and Leeshaw drought permits, which would be discussed with the Environment Agency during agreement on flow trial conditions.

Grimwith Reservoir drought permit						
Grimwith	River Dibb	3.80-15.10	1.90-7.55	1.90-7.55	1.25-4.98	2.55-10.12
Carr Bottom drought permit						
Carr Bottom	Carr Beck	0.09	0.05	0.05	0.03	0.06



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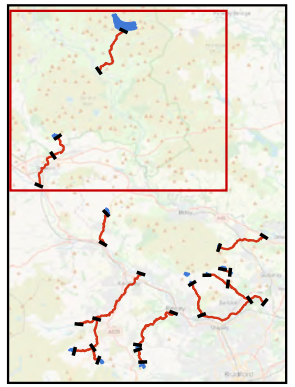
Legend

N

- Reach Divides
- River Reaches
- Reservoir
- WFD Management Catchment
- Flow Direction

Location of figure within North West Option area:

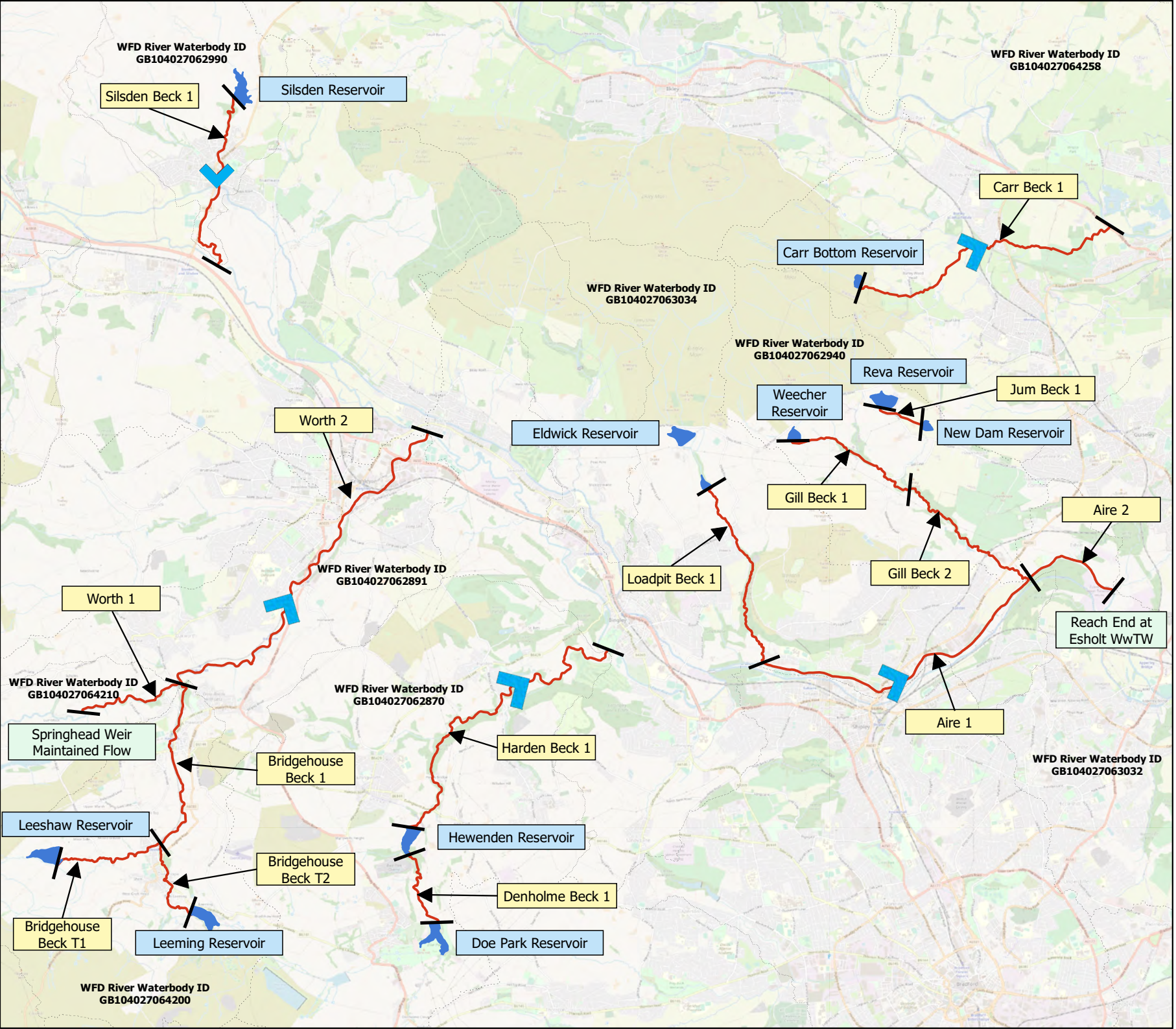


Project title:
Yorkshire Water Drought Plan Environmental Assessment

Figure title:
North West Overview Map

Figure 4.1	**Date:** July 2020
NGR: SE 01525 57666	**Scale:** 1:80000

Note: All locations are approximate



RICARDO YorkshireWater

Legend

N

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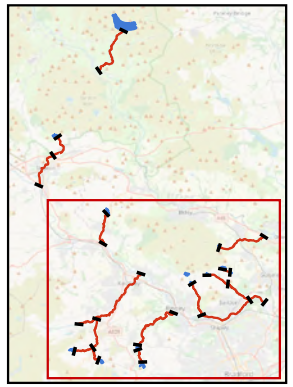
Location of figure within North West Option area:



Project title:
Yorkshire Water Drought Plan Environmental Assessment

Figure title:
North West Overview Map

Figure 4.2	**Date:** July 2020
NGR: SE 10122 41302	**Scale:** 1:80000

Note: All locations are approximate

4.2 Potentially impacted reaches

The zone of influence associated with each drought option is defined through hydrological effects. Within the overall zone of influence, reaches are then defined on a hydrological basis. Section 3.4 of YWSL's Drought Plan 2022 Environmental Assessment Methodology[13] sets out this approach in detail. The reaches for the North West Area drought permits have been defined previously during the environmental assessment of YWSL past drought plans. **Table 4.2** provides details of these reaches, which are illustrated in **Figures 4.1** and **4.2**, and in a schematic below in **Figure 4.3**

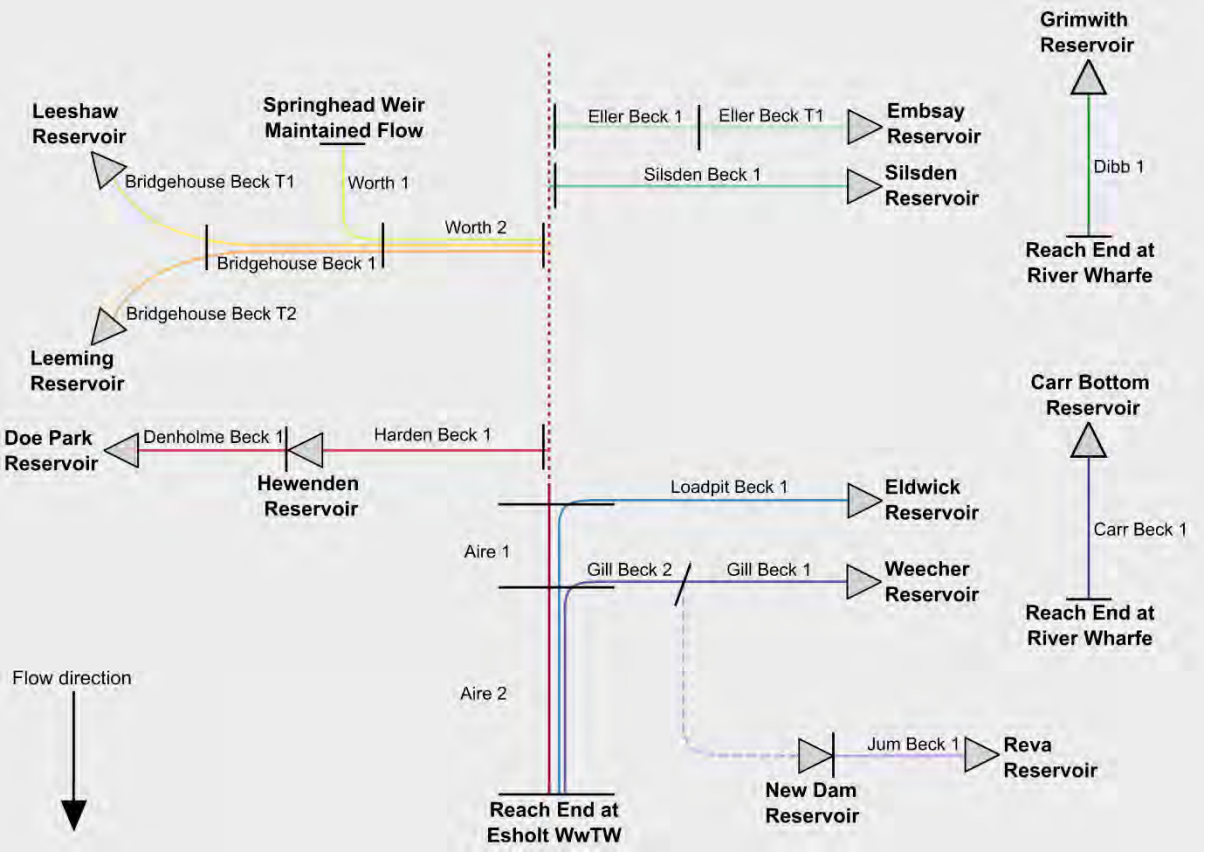
[13] Ricardo Energy & Environment (2020). Yorkshire Water Drought Plan 2022. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. June 2020.

Table 4.2 North West Area reach details

Reach name	Watercourse name	Reach start	Reach end	Downstream reach	Drought measure											
					Springhead Weir Maintained Flow	Leeming Reservoir	Leeshaw Reservoir	Doe Park Reservoir	Hewenden Reservoir	Eldwick Reservoir	Reva Reservoir	Weecher Reservoir	Silsden Reservoir	Embsay Reservoir	Grimwith Reservoir	Carr Bottom Reservoir
Eller Beck T1	Embsay Beck	Embsay Reservoir	Eller Beck	Eller Beck 1										✓		
Eller Beck 1	Eller Beck	Haw Beck	River Aire	N/A										✓		
Silsden Beck 1	Silsden Beck	Silsden Reservoir	River Aire	N/A									✓			
Bridgehouse Beck T1	Moorhouse Beck	Leeshaw Reservoir	Bridgehouse Beck	Bridgehouse Beck 1			✓									
Bridgehouse Beck T2	Leeming Water	Leeming Reservoir	Bridgehouse Beck	Bridgehouse Beck 1		✓										
Bridgehouse Beck 1	Bridgehouse Beck	Leeming Water & Moorhouse Beck confluence	River Worth	Worth 2		✓	✓									
Worth 1	River Worth	River Worth & Sladen Beck confluence	River Worth & Bridgehouse Beck confluence	Worth 2	✓											
Worth 2	River Worth	River Worth & Bridgehouse Beck confluence	River Aire	N/A	✓	✓	✓									
Denholme Beck 1	Denholme Beck	Doe Park Reservoir	Hewenden Reservoir	Harden Beck 1				✓								
Harden Beck 1	Hewenden Beck/ Harden Beck	Hewenden Reservoir	River Aire	N/A				✓	✓							
Loadpit Beck 1	Eldwick Beck/ Loadpit Beck	Eldwick Reservoir	River Aire	Aire 1						✓						
Gill Beck 1	Gill Beck	Weecher Reservoir	Gill Beck & Jum Beck confluence	Gill Beck 2								✓				
Gill Beck 2	Gill Beck	Gill Beck & Jum Beck Confluence	River Aire	Aire 2								✓				
Jum Beck 1	Jum Beck	Reva Reservoir	New Dam Reservoir	N/A							✓					
Aire 1	River Aire	River Aire & Loadpit Beck confluence	River Aire and Gill Beck confluence	Aire 2	✓	✓	✓		✓							
Aire 2	River Aire	River Aire and Gill Beck confluence	River Aire at Asholt STW	N/A	✓	✓	✓		✓							
Dibb 1	River Dibb	Grimwith Reservoir	Confluence between River Dibb and the River Wharfe	N/A											✓	
Carr Beck 1	Carr Beck	Carr Bottom Reservoir	Confluence with the River Wharfe	N/A												✓

Footnote: those drought measures which are located upstream of the River Aire mainstem reaches Aire 1 and Aire 2, but that do not significantly influence flow in those reaches are shaded grey. A bespoke assessment for any future drought permit/order application for these drought options only would not incorporate these reaches. Similarly the monitoring and mitigation specification would not reference these reaches

Figure 4.3 North West Area reservoirs drought permits reach schematic



4.3 WFD waterbodies in study area

The study area and focus of the environmental assessment covers the WFD waterbodies listed in **Table 4.3.** The WFD waterbodies are also illustrated on **Figures 4.1** and **4.2**.

Table 4.3 WFD waterbodies considered in the assessment

Drought Options	Reach	WFD Waterbody
Embsay Reservoir	**Eller Beck T1 (Major)**	Haw Beck GB104027063060
Embsay Reservoir	**Eller Beck 1 (Major)**	Eller Beck GB104027063020
Silsden Reservoir	**Silsden Beck 1 (Major)**	Silsden Beck GB104027062990
Leeshaw Reservoir	**Bridgehouse Beck T1 (Major)**	Bridgehouse Beck from Source to River Worth GB104027064200
Leeming Reservoir	**Bridgehouse Beck T2 (Major)**	Bridgehouse Beck from Source to River Worth GB104027064200
Leeshaw Reservoir; Leeming Reservoir	**Bridgehouse Beck 1 (Major)**	Bridgehouse Beck from Source to River Worth GB104027064200
Springhead Weir Maintained Flow	**Worth 1 (Major)**	Worth from Source to Bridgehouse Beck GB104027064210
Leeshaw Reservoir; Leeming Reservoir; Springhead Weir Maintained Flow	**Worth 2 (Major)**	Worth from Bridgehouse Beck to River Aire GB104027062891
Doe Park Reservoir	**Denholme Beck 1 (Major)**	Harden Beck from Source to River Aire GB104027062870
Doe Park Reservoir; Hewenden Reservoir	**Harden Beck 1 (Major)**	Harden Beck from Source to River Aire GB104027062870
Eldwick Reservoir	**Loadpit Beck 1 (Major)**	River Aire (River Worth to Gill Beck) GB104027063034
Weecher Reservoir	**Gill Beck 1 (Major)**	Gill Beck (Baildon) from Source to River Aire GB104027062940
Weecher Reservoir	**Gill Beck 2 (Major)**	Gill Beck (Baildon) from Source to River Aire GB104027062940
Reva Reservoir	**Jum Beck 1 (Major)**	Gill Beck (Baildon) from Source to River Aire GB104027062940
Springhead Weir Maintained Flow; Leeming Reservoir; Leeshaw Reservoir; Hewenden Reservoir	**Aire 1 (Minor)**	Aire (River Worth to Gill Beck) GB104027063034
Springhead Weir Maintained Flow; Leeming Reservoir; Leeshaw Reservoir; Hewenden Reservoir	**Aire 2 (Minor)**	Aire from Gill Beck (Baildon) to River Calder GB104027063032
Grimwith Reservoir	**Dibb1 (Major)**	Barben Beck/River Dibb Catchment (trib of Wharfe) GB104027064120
Carr Bottom Reservoir	**Carr Beck1 (Major)**	Wharfe from Hundwith Beck to River Washburn GB104027064258

5 Physical environment effects: North West Area reservoirs

Potential impacts on the physical environment due to the North West Area reservoir drought permits are summarised below in **Table 5.1**. Full details are provided in **Appendix A**.

Table 5.1 Summary of potential changes in the physical environment as a result of the North West Area reservoirs drought options

Reach	River flow impact	Flow depleted reaches and risks*	Risk to river habitats	Risk to water quality
Eller Beck T1	Major (summer/autumn/winter)	None	Major	Minor
Eller Beck 1	Moderate (summer/autumn) Minor (winter)	~5m; Major	Minor	Moderate
Silsden Beck 1	Major (summer/autumn/winter)	None	Major	Minor
Bridgehouse Beck T1	Major (summer/autumn/winter)	None	Moderate	Minor
Bridgehouse Beck T2	Major (summer/autumn/winter)	None	Major	Minor
Bridgehouse Beck 1	Major (summer/autumn/winter)	None	Moderate	Moderate
Worth 1	Major (summer/autumn/winter)	None	Major	Moderate
Worth 2	Major (summer/autumn/winter)	None	Major	Moderate
Denholme Beck 1	Major (summer/autumn/winter)	None	Moderate	Minor
Harden Beck 1	Major (summer/autumn/winter)	None	Moderate	Moderate
Loadpit Beck 1	Major (summer/autumn/winter)	None	Major	Minor
Gill Beck 1	Major (summer/autumn/winter)	None	Major	Moderate
Gill Beck 2	Moderate (summer/autumn) Minor (winter)	None	Major	Moderate
Jum Beck 1	Major (summer/autumn/winter)	None	Major	Moderate
Aire 1	Moderate (summer/autumn) Minor (winter)	None	Minor	Moderate
Aire 2	Moderate (summer/autumn) Minor (winter)	None	Minor	Minor
Dibb 1	Major (summer/autumn/winter)	None	Major (at times without regulation release from Grimwith Reservoir)	Minor
Carr Beck 1	Major	None	Major	Minor

* the length of flow depleted reach is indicated where appropriate. 'Flow depleted reach' refers to the length between the abstraction and discharge point of non-consumptive licences (e.g. aquaculture, hydro-power).

6 Features assessment, monitoring and mitigation: North West Area reservoirs

6.1 Summary of impacts

Potentially sensitive receptors (environmental features) have been identified within each impacted reach considering the level of impact on the physical environment identified in Section 5 and Appendix A. This sensitivity assessment has been used to identify features which have been considered for detailed assessment. Both these stages are documented in full in **Appendix B**.

Potential impacts on environmental features due to the North West Area reservoir drought permits are summarised below in **Table 6.1**.

Table 6.1 Summary of potential impacts to environmental features as a result of the North West Area reservoirs drought options

Reach	Eller Beck T1	Eller Beck 1	Silsden Beck 1	Bridge-house Beck T1	Bridge-house Beck T2	Bridge-house Beck 1	Worth 1	Worth 2	Denholme Beck 1	Harden Beck 1	Loadpit Beck 1	Gill Beck 1	Gill Beck 2	Jum Beck 1	Aire 1	Aire 2	Dibb1	Carr Beck1
Associated Drought Options	Embsay Reservoir	Embsay Reservoir	Silsden Reservoir	Leeshaw Reservoir	Leeming Reservoir	Leeshaw Reservoir; Leeming Reservoir	Springhead Weir Maintained Flow	Leeshaw Reservoir; Leeming Reservoir; Springhead Weir	Doe Park Reservoir	Doe Park Reservoir; Hewenden Reservoir	Eldwick Reservoir	Weecher Reservoir	Weecher Reservoir	Reva Reservoir	Springhead Weir Maintained Flow; Leeming Reservoir;	Springhead Weir Maintained Flow; Leeming Reservoir;	Grimwith Reservoir	Carr Bottom Reservoir
WFD Waterbody	GB104027063060 Haw Beck	GB104027063020 Eller Beck	GB104027062990 Silsden Beck	GB104027064200 Bridge-house Beck from Source to River Worth	GB104027064200 Bridge-house Beck from Source to River Worth	GB104027064200 Bridge-house Beck from Source to River Worth	GB104027064210 Worth from Source to Bridge-house Beck	GB104027062891 Worth from Bridge-house Beck to River Aire	GB104027062870 Harden Beck from Source to River Aire	GB104027062870 Harden Beck from Source to River Aire	GB104027063034 River Aire (River Worth to Gill Beck)	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027063034 Aire (River Worth to Gill Beck)	GB104027063032 Aire from Gill Beck (Baildon) to River Calder	GB104027064120 Barben Beck/River Dibb Catchment (trib of Wharfe)	GB104027064258 Wharfe from Hundwith Beck to River Washburn
Statutory designated sites/Local wildlife sites																		
Harden Beck Wood LWS										Moderate								
Hawksworth Spring Wood LWS												Moderate	Moderate					
Tong Park LWS												Negligible	Minor					
NERC and Notable Species Receptors																		
White-clawed crayfish	Major	Moderate				Moderate	Major		Moderate	Moderate	Moderate	Major	Moderate				Major	Moderate
Otter	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Water vole	Moderate								Moderate	Moderate						Moderate		Moderate
Riolus subviolaceus	Moderate				Minor													
Atlantic salmon																	Major	
Barbel															Minor			
Brook lamprey	Major	Moderate					Major	Major										
Brown trout	Major	Moderate	Major	Moderate	Major	Moderate	Major	Major	Moderate	Moderate	Major	Major	Moderate	Major	Moderate	Moderate	Major	Major
Bullhead	Moderate	Minor (summer / autumn only)	Moderate	Minor	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minor	Moderate	Minor	Minor	Moderate	Moderate
European eel															Moderate	Moderate		
Grayling			Moderate					Moderate		Moderate					Minor	Minor		
River lamprey	Moderate																	
Birds																		
WFD Waterbody WFD Status Receptors																		
Fish	Major	Moderate	Major	Moderate	Major	Moderate	Major	Major	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minor	Minor	Major	Moderate
Invertebrates	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minor	Moderate	Moderate	Moderate	Moderate	Moderate	Minor	Minor	Moderate	Moderate

* Numbers refer to unique codes for each habitat as included in the Natural England 'Priority Habitat Inventory (England)'.

6.2 Monitoring and mitigation

The Environment Agency's 2020 DPG requires YWSL to set out a monitoring plan following assessment of the sensitivity and impacts associated with drought options, as indicated in **Figure 3.1**. In particular the DPG indicates that any drought plan should be accompanied by an EMP that sets out:

- on-going baseline monitoring to inform sensitivity and impact assessments.
- the monitoring that will be implemented to reduce uncertainty identified in the assessment of either the sensitivity of the environment or impacts on features considered in the detailed assessment.
- the in-drought and post-drought (recovery) monitoring that will be carried out to understand the actual impact of drought options.

As indicated in **Figure 3.1** the DPG also requires YWSL to set out a mitigation plan following the assessments of potential impacts associated with each drought management action. In particular the DPG indicates that any drought plan should be accompanied by an EMP that sets out:

- mitigation measures to reduce adverse impacts on the environment of supply side drought options; and
- compensation measures for adverse effects that remain after mitigation measures have been applied.

The DPG requires that this information is set out as a separate document alongside, and linked to, each environmental assessment.

The assessments undertaken in this EAR confirm the features requiring consideration of mitigation and appropriate monitoring triggering mitigation. YWSL's Drought Plan 2022 EMP provides a comprehensive description of the schedule of monitoring and trigger-based mitigation agreed as relevant and practicable based on the nature and timing of permit implementation. The mitigation and monitoring proposals will act as a safeguard that responds and is responsive to both predicted and unpredicted drought impacts.

The monitoring and mitigation recommendations have been developed through agreement with the Environment Agency, in particular during 2018 and 2020 (see Section 1.3). Consultation between YWSL and the Environment Agency is ongoing, and the EMP will be updated as required to reflect future agreements.

The EMP also documents the baseline monitoring recommendations which have been identified as required following the completion of the environmental assessment. Baseline monitoring will ensure that sufficient baseline data is available to inform the sensitivity and impact assessment and to reduce any uncertainty in the assessment.

A summary of the monitoring and mitigations recommendations for the North West Area reservoir drought permits are provided in **Tables 6.2** and **6.3**.

Table 6.2 Summary of recommended monitoring for the North West Area reservoirs drought options

River Reach		Eller Beck T1	Eller Beck 1	Silsden Beck 1	Bridgehouse Beck T1	Bridgehouse Beck T2	Bridgehouse Beck 1	Worth 1	Worth 2	Denholme Beck 1	Harden Beck 1	Loadpit Beck 1	Gill Beck 1	Gill Beck 2	Jum Beck 1	Aire 1	Aire 2	Dibb1	Carr Beck1
Associated Drought Options		Embsay Reservoir	Embsay Reservoir	Silsden Reservoir	Leeshaw Reservoir	Leeming Reservoir	Leeshaw Reservoir; Leeming Reservoir	Springhead Weir Maintained Flow	Leeshaw Reservoir; Leeming Reservoir; Springhead Weir Maintained Flow	Doe Park Reservoir	Doe Park Reservoir; Hewenden Reservoir	Eldwick Reservoir	Weecher Reservoir	Weecher Reservoir	Reva Reservoir	Springhead Weir Maintained Flow; Leeming Reservoir; Leeshaw Reservoir; Hewenden Reservoir	Springhead Weir Maintained Flow; Leeming Reservoir; Leeshaw Reservoir; Hewenden Reservoir	Grimwith Reservoir	Carr Bottom Reservoir
		GB1040 2706306 0	GB1040 2706302 0	GB1040 2706299 0	GB1040 2706420 0	GB1040 2706420 0	GB1040 2706420 0	GB1040 2706421 0	GB1040 2706420 0	GB1040 2706287 0	GB1040 2706287 0	GB1040 2706303 4	GB1040 2706294 0	GB1040 2706294 0	GB1040 2706294 0	GB1040 2706303 4)	GB1040 2706303 2	GB1040 2706412 0)	GB1040 2706425 8
WFD Waterbody		Haw Beck	Eller Beck	Silsden Beck	Bridgehouse Beck from Source to River Worth	Bridgehouse Beck from Source to River Worth	Bridgehouse Beck from Source to River Worth	Worth from Source to Bridgehouse Beck	Bridgehouse Beck from Source to River Worth	Harden Beck from Source to River Aire	Harden Beck from Source to River Aire	River Aire (River Worth to Gill Beck)	Gill Beck (Baildon) from Source to River Aire	Gill Beck (Baildon) from Source to River Aire	Gill Beck (Baildon) from Source to River Aire	Aire (River Worth to Gill Beck	Aire from Gill Beck (Baildon) to River Calder	Barben Beck/River Dibb Catchment (trib of Wharfe	Wharfe from Hundwith Beck to River Washburn
Baseline Monitoring																			
Routine baseline monitoring																			
BMON_1	Routine flow/levels	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BMON_2	Routine WQ	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BMON_3	Macro-invertebrate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
BMON_4	Fisheries	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Targeted baseline monitoring																			
BMON_5	Crayfish	✓	✓				✓	✓		✓	✓	✓	✓	✓				✓	✓
BMON_7	Lamprey	✓	✓					✓	✓										
On-set of Environmental Drought Monitoring																			
ODMON_1	River condition walkover survey	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
In-Drought (During Drought Option Implementation) Monitoring																			
IDMON_1	Surveillance walkover (habitat quality and ecological stress) prior and post flow reduction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMON_2	Surveillance walkover (water quality and ecological stress) prior and post						✓		✓		✓								

River Reach		Eller Beck T1	Eller Beck 1	Silsden Beck 1	Bridgehouse Beck T1	Bridgehouse Beck T2	Bridgehouse Beck 1	Worth 1	Worth 2	Denholme Beck 1	Harden Beck 1	Loadpit Beck 1	Gill Beck 1	Gill Beck 2	Jum Beck 1	Aire 1	Aire 2	Dibb1	Carr Beck1
	flow reduction																		
IDMON_3	Storm intensity forecasting to predict likely CSO spill events and the need for pre-emptive mitigation		✓						✓							✓			
Post-Drought (Drought Option removed) Monitoring																			
PDMON_1	Crayfish	✓	✓				✓	✓		✓	✓	✓	✓	✓				✓	✓

Table 6.3 Summary of recommended mitigation measures for the North West Area reservoirs drought options

Reach		Eller Beck T1	Eller Beck 1	Silsden Beck 1	Bridgehouse Beck T1	Bridgehouse Beck T2	Bridgehouse Beck 1	Worth 1	Worth 2	Denholme Beck 1	Harden Beck 1	Loadpit Beck 1	Gill Beck 1	Gill Beck 2	Jum Beck 1	Aire 1	Aire 2	Dibb1	Carr Beck1
Associated Drought Options		Embsay Reservoir	Embsay Reservoir	Silsden Reservoir	Leeshaw Reservoir	Leeming Reservoir	Leeshaw Reservoir; Leeming Reservoir	Springhead Weir Maintained Flow	Leeshaw Reservoir; Leeming Reservoir; Springhead Weir Maintained Flow	Doe Park Reservoir	Doe Park Reservoir; Hewenden Reservoir	Eldwick Reservoir	Weecher Reservoir	Weecher Reservoir	Reva Reservoir	Springhead Weir Maintained Flow; Leeming Reservoir; Leeshaw Reservoir; Hewenden Reservoir	Springhead Weir Maintained Flow; Leeming Reservoir; Leeshaw Reservoir; Hewenden Reservoir	Grimwith Reservoir	Carr Bottom Reservoir
WFD Waterbody		GB104027063060 Haw Beck	GB104027063020 Eller Beck	GB104027062990 Silsden Beck	GB104027064200 Bridgehouse Beck from Source to River Worth	GB104027064200 Bridgehouse Beck from Source to River Worth	GB104027064200 Bridgehouse Beck from Source to River Worth	GB104027064210 Worth from Source to Bridgehouse Beck	GB104027064200 Bridgehouse Beck from Source to River Worth	GB104027062870 Harden Beck from Source to River Aire	GB104027062870 Harden Beck from Source to River Aire	GB104027063034 River Aire (River Worth to Gill Beck)	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027063034) Aire (River Worth to Gill Beck	GB104027063032 Aire from Gill Beck (Baildon) to River Calder	GB104027064120) Barben Beck/River Dibb Catchment (trib of Wharfe	GB104027064258 Wharfe from Hundwith Beck to River Washburn
In-drought (Drought Options Implemented)																			
IDMIT_1	Third party abstraction		✓																
IDMIT_3	Improving the effluent quality						✓		✓		✓								
IDMIT_4	Freshets for water quality						✓		✓										
IDMIT_5	Discharge aeration						✓		✓										
IDMIT_6	Gradual phase in of reduction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_7	Gradual compensation reduction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_8	Temporary abstraction volume reduction / compensation increase	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_9	Freshet	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_10	Refuges	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_11	In-stream structures	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_12	Channel narrowing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
IDMIT_13	Bird scaring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_14	Gravel washing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_15	Aeration of watercourse	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Reach		Eller Beck T1	Eller Beck 1	Silsden Beck 1	Bridgehouse Beck T1	Bridgehouse Beck T2	Bridgehouse Beck 1	Worth 1	Worth 2	Denholme Beck 1	Harden Beck 1	Loadpit Beck 1	Gill Beck 1	Gill Beck 2	Jum Beck 1	Aire 1	Aire 2	Dibb1	Carr Beck1
IDMIT_16	Flow structure modification	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
IDMIT_17	Freshet releases for migration	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓			✓	✓
IDMIT_19	Capture/re-locate over barriers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
IDMIT_20	Fish/crayfish rescue and relocate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_21	Fish rescue and retain	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
IDMIT_23	CSO Prioritisation		✓						✓							✓			
Post-Drought (Drought Options Removed)																			
PDMIT_1	Habitat enhancement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PDMIT_2	Freshets	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓			✓	✓
PDMIT_3	Barrier modification	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓			✓	✓
PDMIT_4	Capture and relocate	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓			✓	✓
PDMIT_5	Juvenile relocation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
PDMIT_6	Lamprey restocking	✓	✓					✓	✓										
PDMIT_7	Broodstock restocking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PDMIT_8	Coarse fish restocking						✓		✓				✓		✓				

Appendices

Appendix A Physical Environment

Appendix B Environmental Features

Appendix C Environmental Monitoring and Mitigation Measures

Appendix A – Physical Environment

A1 Introduction

This appendix assesses the potential impacts on the physical environment of the North West Area during the period of implementation of associated drought options.

The North West Area reported in this appendix comprises drought permits at one maintained river flow and at eleven reservoirs with compensation flows:

1. Springhead Weir Maintained Flow drought permit
2. Leeming Reservoir drought permit
3. Leeshaw Reservoir drought permit
4. Doe Park Reservoir drought permit
5. Hewenden Reservoir drought permit
6. Eldwick Reservoir drought permit
7. Reva Reservoir drought permit
8. Weecher Reservoir drought permit
9. Silsden Reservoir drought permit
10. Embsay Reservoir drought permit
11. Grimwith Reservoir drought permit
12. Carr Bottom Reservoir drought permit.

Details regarding the approaches/methodologies used for assessing susceptibility and sensitivity to drought options and the assessment of the impacts associated with drought options are presented in YWSL's Drought Plan 2022 Environmental Assessment Methodology[1].

This EAR has been prepared in support of a drought permit application in late summer 2022. It provides an update to the 'shelf copy' report which was produced in support of YWSL's Drought Plan 2022. Following agreement with the Environment Agency, the physical environment and environmental features assessments presented in the 'shelf copy' report have been retained for this application EAR (see main EAR Section 1.2).

This appendix is set out in the following sections:

Section A.2 Drought options

Section A.3 Study area

Section A.4 Physical environment effects – this includes for each reach:

1. Reach introduction
2. Reach setting
3. River flow regime
4. River habitats
5. River water quality
6. Summary of potential changes in the physical environment as a result of the drought options.

Annex 1 provides a list of all regulated abstractions in each reach.

Annex 2 provides a list of all wastewater treatment works (WwTW) and combined sewer overflows (CSOs) considered in the assessment.

1 Ricardo Energy & Environment (2020). YWSL Drought Plan 2022. Environmental Assessment Methodology. Report for YWSL Services Ltd. June 2020.

A2 Drought options

The North West Area operational catchment comprises 12 drought options as reported in this appendix:

- Springhead Weir Maintained Flow
- Leeming Reservoir
- Leeshaw Reservoir
- Doe Park Reservoir
- Hewenden Reservoir
- Eldwick Reservoir
- Reva Reservoir
- Weecher Reservoir
- Silsden Reservoir
- Embsay Reservoir
- Grimwith Reservoir
- Carr Bottom Reservoir.

The licence conditions and drought permit conditions of each are introduced below.

A2.1 Springhead Weir Maintained Flow

YWSL is licensed to abstract water from Ponden Reservoir for supply to customers under abstraction licence number 2/27/14/058. The terms of the licence state YWSL must release flow from Ponden Reservoir to compensate the downstream receiving watercourse, the River Worth. YWSL is licensed to abstract water from Lower Laithe Reservoir for supply to customers under the abstraction licence (2/27/14/009). The terms of the licence state YWSL must release flow from Lower Laithe Reservoir to compensate the downstream receiving watercourse, Sladen Beck. Under both Ponden and Lower Laithe licence conditions YWSL must ensure the flow of water at Springhead Weir, which is below the confluence of the two watercourses, shall not fall below 6.00 Ml/d, when the combined compensation flow from Leeming and Leeshaw reservoirs is 8.00 Ml/d, or 8.00 Ml/d when the combined compensation flow from Leeming and Leeshaw reservoirs reduces to 6.00 Ml/d. The drought permit application for the Springhead Weir Maintained Flow is to reduce the maintained flow at Springhead Weir when regional stocks are at or approaching the drought control line. The maintained flow would reduce to 4.00 Ml/d providing Leeshaw and Leeming reservoirs are below the control lines and to reduce further to 2.67 Ml/d if regional reservoir stocks are below the regional Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.1**. The reference condition without a drought permit is set out as 8.00Ml/d.

Table A2.1 Springhead Weir Maintained Flow licence data[2]

Maintained flow location	Watercourse	NGR	Normal Maintained flow Ml/d	Proposed Drought Option Maintained flow Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Maintained flow Ml/d (Trigger 2)	Benefit Ml/d
Springhead Weir	River Worth	SE 026377	6.00 (can be 8.00)	3.00-4.00	3.00 - 4.00	2.00 -2.67	4.00 - 5.33

A2.2 Leeming Reservoir drought permit

YWSL releases water from Leeming Reservoir under conditions defined by the Leeming Reservoir impoundment licence (NE/027/0014/010). The terms of the licence state YWSL must release flow from Leeming Reservoir to compensate the downstream receiving watercourse, Leeming Water. The volume YWSL releases is dependent on the stock levels in Leeming Reservoir and in Leeshaw Reservoir, which is operated under the terms of the Leeshaw Reservoir impoundment licence. Under the Leeming

[2] A possible flow trial at Springhead Weir would, if progressed, have potential impacts on the Springhead Weir, Leeming and Leeshaw drought permits, which would be discussed with the Environment Agency during agreement on flow trial conditions.

Reservoir impoundment licence conditions, YWSL must continuously discharge not less than 4.00 Ml/d when both the Leeshaw and Leeming reservoir levels are above the control lines defined in the licences, or 5.250 Ml/d when the Leeming reservoir level is above the control line and Leeshaw reservoir level is below the control line, or 3.250 Ml/d when both the Leeshaw and Leeming reservoir levels are below the control lines.

The drought permit application for Leeming Reservoir is to reduce the compensation release required when the reservoirs are both below the control lines to 1.63 Ml/d (or to 2.63 Ml/d if above the control lines). There would then be a further reduction to 1.07 Ml/d if regional reservoir stocks were below the regional Drought Control Line for four consecutive weeks or more (or 1.08 Ml/d if above control lines), as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.2**.

Table A2.2 Leeming Reservoir licence data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Leeming	Leeming Water	SE 037343	4.00 (can vary between 3.25 and 5.25)	1.63-2.63	1.63 - 2.63	1.07-1.73	2.18-3.52

A2.3 Leeshaw Reservoir drought permit

YWSL releases water from Leeshaw Reservoir under conditions defined by the Leeshaw Reservoir impoundment licence (NE/027/0014/011). The terms of the licence state YWSL must release flow from Leeshaw Reservoir to compensate the downstream receiving watercourse, Dunkirk Beck. Under the licence conditions, YWSL must continuously discharge not less than 4.00 Ml/d when the reservoir level is above the control line defined in the licence, or 2.75 Ml/d when the reservoir level is below the control line.

The drought permit application for Leeshaw Reservoir is to reduce the compensation release required when the reservoir stocks are above the control line to 2.00 Ml/d, or when the reservoir stocks are below the control line to 1.38 Ml/d. There would then be a further reduction to 0.91 Ml/d (only if stocks are below the reservoir control line) if regional reservoir stocks were below the regional Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.3**.

Table A2.3 Leeshaw Reservoir licence data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Leeshaw	Moorhouse Beck	SE 016351	4.00 (can vary between 2.75 and 4.00)	1.38-2.00	1.38-2.00	0.91-1.32	1.84-2.68

A2.4 Doe Park Reservoir drought permit

YWSL releases water from Doe Park Reservoir under conditions defined by the Doe Park Reservoir impoundment licence (NE/027/0016/021). The terms of the licence state YWSL must release flow from Doe Park Reservoir to compensate the downstream receiving watercourse, Denholme Beck. Under the licence conditions, YWSL must continuously discharge not less than 3.60 Ml/d when the reservoir level is above the control line defined in the licence, or 1.80 Ml/d when the reservoir level is below the control line.

The drought permit application for Doe Park Reservoir is to reduce the compensation release to 1.2 Ml/d if regional reservoir stocks were below the regional Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.4**.

Table A2.4 Doe Park Reservoir licence data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Doe Park	Denholme Beck	SE 077342	1.80 (when stocks below control line) 3.60 (when stocks above control line)	N/A	N/A	1.20	0.60-2.40

A2.5 Hewenden Reservoir drought permit

Under the terms of the Bradford Waterworks Act 1854, YWSL must release water from Hewenden Reservoir to compensate the downstream water course, the Hewenden Beck. The terms of the Act state that YWSL must release flow from Hewenden Reservoir at mill owners' discretion. YWSL currently operate the compensation flow under the terms of a flow trial agreement held with the Environment Agency, whereby we continuously discharge not less than 6.30 Ml/d. The drought permit application for Hewenden Reservoir is to reduce the compensation release required to 3.15 Ml/d. The drought permit application for Hewenden Reservoir is to provide a continuous release of 3.15 Ml/d, which could be reduced to 2.08 Ml/d if regional reservoir stocks were below the regional Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.5**.

Table A2.5 Hewenden Reservoir Licence Data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Hewenden	Hewenden Beck	SE 074357	6.30	3.15	3.15	2.08	4.22

A2.6 Eldwick Reservoir drought permit

Under the terms of Shipley Waterworks and Police Act 1854, YWSL must release water from Eldwick Reservoir to compensate the downstream water course, the Eldwick Beck. The terms of the Act state that YWSL must release two fifths of the average daily inflow to the reservoir between 05:00 and 20:00 every day (barring Sunday, Christmas Day, and Good Friday). YWSL currently operate the compensation flow under the terms of a flow trial agreement held with the Environment Agency, whereby YWSL continuously discharges not less than 1.00 Ml/d. The drought permit application for Eldwick Reservoir is to reduce the compensation release required to 0.50 Ml/d. This could be reduced to 0.33 Ml/d if regional reservoir stocks were below the regional Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.6**.

Table A2.6 Eldwick Reservoir Licence Data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Eldwick	Eldwick Beck	SE 122412	1.00	0.50	0.50	0.33	0.67

A2.7 Reva Reservoir drought permit

YWSL is licensed to abstract water from Reva Reservoir for supply to customers under the Yeadon Waterworks Act 1916. The terms of the Act state that YWSL must release not less than 0.791 Ml/d (174,000 gallons per day) to compensate the downstream water course, the Hawksworth Beck. The drought permit application for Reva reservoir is to reduce the compensation release required to 0.396 Ml/d, giving a benefit of 0.395Ml/d. There would be a further reduction to 0.264 Ml/d if regional reservoir stocks were below the regional Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.7**.

Table A2.7 Reva Reservoir Licence Data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Reva	Jum Beck	SE 151425	0.79	0.40	0.40	0.26	0.53

A2.8 Weecher Reservoir drought permit

YWSL is licensed to abstract water from Weecher Reservoir for supply to customers by permit under the Baildon Local Water Act 1890. The terms of the Act state that YWSL must release not less than 110,273 gallons (0.501 Ml) per working day Monday to Saturday to compensate the downstream water course, the Weecher Brow Beck. YWSL currently operates the compensation release under an agreement held with the Environment Agency to discharge 0.43 Ml/d. The drought permit application for Weecher Reservoir is to reduce the compensation release required to 0.215 Ml/d. There would be a further reduction to 0.143 Ml/d if regional reservoir stocks were below the regional Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.8**.

Table A2.8 Weecher Reservoir Licence Data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Weecher	Weecher Brow Beck	SE 136420	0.43	0.22	0.22	0.14	0.29

A2.9 Silsden Reservoir drought permit

YWSL is licensed to abstract water from Silsden Reservoir for supply to customers under abstraction licence number 2/27/15/149. The terms of the licence include a prescribed flow condition of 2.41 Ml/d to be discharged to Silsden Beck, whereby no water can be abstracted if the flow exiting the reservoir is below this level. YWSL does not currently abstract from Silsden Reservoir, however under normal operations YWSL releases the prescribed flow volume to compensate the downstream watercourse. The drought action for Silsden Reservoir is to reduce the compensation release to 1.21 Ml/d. There would be a further reduction to 0.80 Ml/d if regional reservoir stocks were below the regional Drought

Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.9**.

Table A2.9 Silsden Reservoir Licence Data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Silsden	Silsden Beck	SE 045475	2.41	1.21	1.21	0.80	1.61

A2.10 Embsay Reservoir drought permit

YWSL is licensed to abstract water from Embsay Reservoir for supply to customers under the Skipton Water and Improvement Act 1904 and abstraction licence number 2/27/15/45 (the "Embsay licence"). The terms of the Act state that YWSL must release not less than 1.19 Ml/d (261,000 gallons per day) to compensate the downstream water course, the Embsay Beck. The Embsay licence states a flow of not less than 0.27 Ml/d (60,000 gallons per day) must remain in Mill Beck, immediately downstream of the abstraction point, when abstraction takes place. The drought permit application for Embsay Reservoir is to reduce the compensation release required to 0.60 Ml/d. There would be a further reduction to 0.39 Ml/d if regional reservoir stocks were below the regional Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. All releases would be greater than 0.27 Ml/d, therefore consistent with the Embsay licence condition. These conditions are set out in **Table A2.10**.

Table A2.10 Embsay Reservoir Licence Data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Embsay	Embsay Beck	SE 002546	1.19	0.60	0.60	0.39	0.80

A2.11 Grimwith Reservoir drought permit

Under the terms of an impoundment licence (NE/027/0019/011) issued by the Environment Agency, YWSL must release flow from Grimwith Reservoir to compensate the downstream water course, the River Dibb, a tributary to the River Wharfe. The required volume of flow is dependent on seasonal variations, with 15.1Ml/d being released between 1st November and 19th April (winter), 7.8Ml/d between 20th April and 10th May and 12th October and 31st October (spring and autumn) and 3.8 Ml/d between 11th May and 11th October (summer). The drought permit application for Grimwith Reservoir is to reduce the compensation release by 50% to 7.55Ml/d in winter, 3.90Ml/d in spring and autumn, and 1.90Ml/d in summer from the date the permit is granted. A further reduction to 5.03Ml/d in winter, 2.60Ml/d in spring and autumn, and 1.27Ml/d in summer if regional reservoir stocks are below the Regional Drought Control Line, as defined in the YWSL Drought Plan, for more than four consecutive weeks. These conditions are set out in **Table A2.11**.

YWSL is also required to release a regulating flow from Grimwith Reservoir to support abstractions from the River Wharfe at low flows. YWSL can abstract from two abstraction points on the River Wharfe, which are at Lobwood (under the terms of licence 2/27/19/129/R01) and Arthington (under the terms of licence 2/27/20/196/R01). YWSL has a drought option to temporarily suspend the regulatory flow and a further option to increase the annual volume we take from the River Wharfe at Lobwood. Both options require a drought permit and details are provided in the River Wharfe supporting document.

Table A2.11 Grimwith Reservoir Licence Data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Grimwith	River Dibb	SE 059640	15.10 (1 Jan – 19 Apr; 1 Nov – 31 Dec) 7.80 (20 Apr – 10 May; 12-31 Oct) 3.80 (11 May – 11 Oct)	7.55 - 1.90	1.90 - 7.55	1.25 – 4.98	2.55 – 10.12

A2.12 Carr Bottom Reservoir drought permit

YWSL is licensed to transfer water from Carr Bottom Reservoir ultimately for supply to customers under the Burley in Wharfedale Urban District Water Act 1899 which governs YWSL to release compensation water from Carr Bottom Reservoir. The Act states a flow of not less than 0.085 Ml/d (60,000 gallons per day) must remain in Carr Beck, immediately downstream of the reservoir. The drought permit application for Carr Bottom Reservoir is to reduce the compensation release required to 0.0425 Ml/d. There would be a further reduction to 0.028 Ml/d if reservoir stocks were below the Drought Control Line for four consecutive weeks or more, as defined in the YWSL Drought Plan. These conditions are set out in **Table A2.12**.

Table A2.12 Carr Bottom Reservoir Licence Data

Compensation Water Source	Receiving Watercourse	NGR	Normal Compensation Release Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 1)	Benefit Ml/d	Proposed Drought Option Compensation Release Ml/d (Trigger 2)	Benefit Ml/d
Carr Bottom	Carr Beck	SE146445	0.09	0.05	0.05	0.03	0.06

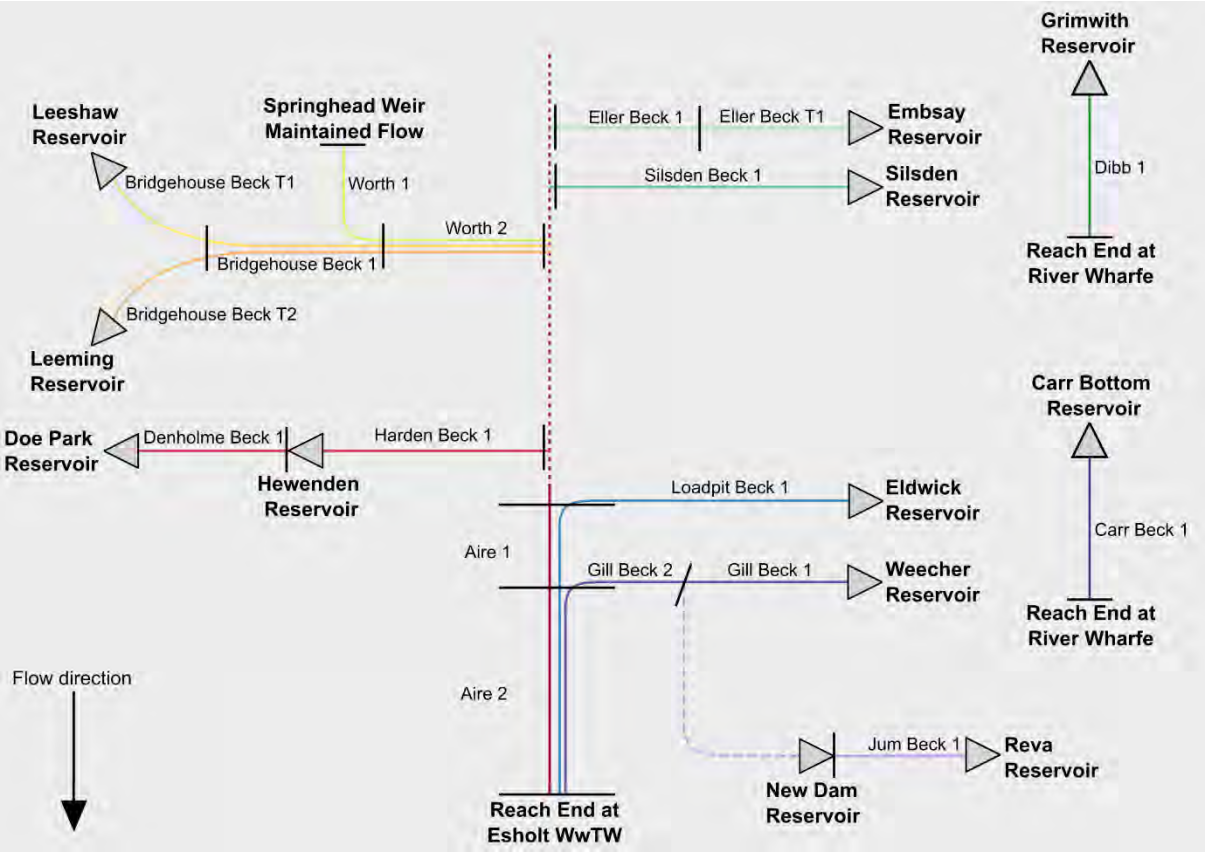
A3 Study area

The zone of influence associated with each drought option is defined through hydrological effects. Within the overall zone of influence, reaches are then defined on a hydrological basis. YWSL's Drought Plan 2022 Environmental Assessment Methodology[3] sets out this approach in detail in Section 3.4. The zone of influence and individual reaches for assessment of impacts are set out in **Section A3.1** below. Information on the likely timings of drought options are set out in **Section A3.2** below.

A3.1 Zone of influence of the drought options

The reaches for the North West area drought options have been defined previously during the environmental assessment of YWSL past drought plans. **Table A3.1** provides details of these reaches, and the reaches are illustrated in main EAR **Figures 4.1-4.2** and in a schematic below in **Figure A3.1**.

Figure A3.1 North West Area reach schematic



3 Ricardo Energy & Environment (2020). YWSL Drought Plan 2022. Environmental Assessment Methodology. Report for YWSL Services Ltd. June 2020.

Table A3.1 North West Area reach details

Reach name	Watercourse name	Reach start	Reach end	Downstream reach	Drought measure											
					Springhead Weir Maintained Flow	Leeming Reservoir	Leeshaw Reservoir	Doe Park Reservoir	Hewenden Reservoir	Eldwick Reservoir	Reva Reservoir	Weecher Reservoir	Silsden Reservoir	Embsay Reservoir	Grimwith Reservoir	Carr Bottom Reservoir
Eller Beck T1	Embsay Beck	Embsay Reservoir	Eller Beck	Eller Beck 1										✓		
Eller Beck 1	Eller Beck	Haw Beck	River Aire	N/A										✓		
Silsden Beck 1	Silsden Beck	Silsden Reservoir	River Aire	N/A									✓			
Bridgehouse Beck T1	Moorhouse Beck	Leeshaw Reservoir	Bridgehouse Beck	Bridgehouse Beck 1			✓									
Bridgehouse Beck T2	Leeming Water	Leeming Reservoir	Bridgehouse Beck	Bridgehouse Beck 1		✓										
Bridgehouse Beck 1	Bridgehouse Beck	Leeming Water & Moorhouse Beck confluence	River Worth	Worth 2		✓	✓									
Worth 1	River Worth	River Worth & Sladen Beck confluence	River Worth & Bridgehouse Beck confluence	Worth 2	✓											
Worth 2	River Worth	River Worth & Bridgehouse Beck confluence	River Aire	N/A	✓	✓	✓									
Denholme Beck 1	Denholme Beck	Doe Park Reservoir	Hewenden Reservoir	Harden Beck 1				✓								
Harden Beck 1	Hewenden Beck/ Harden Beck	Hewenden Reservoir	River Aire	N/A				✓	✓							
Loadpit Beck 1	Eldwick Beck/ Loadpit Beck	Eldwick Reservoir	River Aire	Aire 1						✓						
Gill Beck 1	Gill Beck	Weecher Reservoir	Gill Beck & Jum Beck confluence	Gill Beck 2								✓				
Gill Beck 2	Gill Beck	Gill Beck & Jum Beck Confluence	River Aire	Aire 2								✓				
Jum Beck 1	Jum Beck	Reva Reservoir	New Dam Reservoir	N/A							✓					
Aire 1	River Aire	River Aire & Loadpit Beck confluence	River Aire and Gill Beck confluence	Aire 2	✓	✓	✓		✓							
Aire 2	River Aire	River Aire and Gill Beck confluence	River Aire at Asholt STW	N/A	✓	✓	✓		✓							
Dibb 1	River Dibb	Grimwith Reservoir	Confluence between River Dibb and the River Wharfe	N/A											✓	
Carr Beck 1	Carr Beck	Carr Bottom Reservoir	Confluence with the River Wharfe	N/A												✓

Footnote: those drought measures which are located upstream of the River Aire mainstem reaches Aire 1 and Aire 2, but that do not significantly influence flow in those reaches are shaded grey. A bespoke assessment for any future drought permit/order application for these drought options only would not incorporate these reaches. Similarly the monitoring and mitigation specification would not reference these reaches

The end of each study area has been defined previously from review of hydrological information – either flow gauge data that corroborates that drought option hydrological impacts have reduced to negligible, or by simple review of contributing catchment area where there is an order of magnitude step change in this from confluence with a significantly larger river or joining tributary. No significant impacts related to the drought options occur below these points (see **Table A3.2**).

Table A3.2 North West Area extent of zone of influence

Reach	Description	Downstream impacts
Aire 2	River Aire at the Esholt Wastewater Treatment Works (WwTW) discharge	The potential hydrological impact of the drought options on the River Aire (Aire 2) is considered at an assessment point early in the reach. At that assessment point reference condition flow statistics (see Figure A4.16) were summer Q95 139.77Ml/d, summer Q99 97.89Ml/d annual Q50 589.04Ml/d, annual Q95 157.43Ml/d. Even without consideration of flow accretion along the reach, Esholt WwTW discharge alone adds a dry weather flow of 130Ml/d at the reach end point. Adding that discharge to the Aire 2 assessment point statistics identifies the following negligible impacts at the end of the reach: • summer/autumn (6% reduction in Q95 and 7% reduction in Q99) • winter (2% reduction in Q50 and 6% reduction in Q95).
Dibb 1	Confluence of the River Dibb with the larger River Wharfe	WRAPsim modelling shown in **Figure A3.2** has shown there is imperceptible change to flow in the River Wharfe when the drought option is in use. Hence, the potential impact of the drought option on the River Wharfe is considered to be negligible.
Carr Beck 1	Confluence of the Carr Beck with the larger River Wharfe.	As a result of the reduction of the Carr Bottom Reservoir compensation release of 0.057Ml/d the reduction in flow statistics for the Wharfe at Addingham would be less than 10%. The potential hydrological impact of the drought option on the River Wharfe, following the confluence of the River Wharfe with Carr Beck, is considered to be negligible.

A3.2 Timing of drought measure effects

The drought permit application is anticipated to be submitted by YWSL in late summer 2022 and the implementation period would therefore be likely to cover autumn/winter 2022.

A4 Physical environment effects

A4.1 Introduction

This section provides a characterisation of the physical environment within the zone of influence (as defined above in **Section A3**) and includes the following information for each reach:

1. Reach setting
2. River flow regime (reference conditions and sensitivity)
3. River habitats (reference conditions and likely sensitivity)
4. River water quality, including water quality pressure (reference conditions and sensitivity).

An assessment of likely changes from drought option implementation for each reach within the zone of influence is then provided.

YWSL's Drought Plan 2022 Environmental Assessment Methodology[4] provides details of the approach in Section 3.5. The approach has been developed to ensure compliance with the Environment Agency's 2020 Drought Plan Guideline (DPG)[5] and Section 3 of the Environment Agency's 2019 consultation draft "Environmental Assessment for Water Company Drought Plans- supplementary guidance".

A4.2 Eller Beck T1

A4.2.1 Reach introduction

Eller Beck T1 is potentially impacted by an Embsay Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.1**. The reach includes part of the following river waterbody:

- Haw Beck from Source to Eller beck (GB104027063060).

A4.2.2 Reach setting

Eller Beck T1, located on main EAR **Figure 4.1,** comprises a 2.9km stretch of Embsay Beck and Haw Beck from Embsay Reservoir outflow to the confluence of Haw Beck with Eller Beck (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 8.1km^2 along the length of the reach. Eller Beck 1 (see **Section A4.3** below) is downstream.

A4.2.3 River flow regime

During the implementation of North West Area drought options, storage in Embsay Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 0.80Ml/d in the statutory compensation release rate of 1.19Ml/d represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of the drought option on Eller Beck T1 is therefore assessed as **major** for both the summer/autumn period and any winter refill period while drought options remain in place.

4 Ricardo Energy & Environment (2020). YWSL Drought Plan 2022. Environmental Assessment Methodology. Report for YWSL Services Ltd. June 2020.

5 Environment Agency (2020) Water Company Drought Plan Guideline, April 2020.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Eller Beck T1. There are no flow depleted reaches[6] within Eller Beck T1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.2.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 6 September 2018 at a reservoir outflow of 2.8Ml/d.

Eller Beck T1 is a fairly straight reach which falls ~57m over 2.9km, a slope of 1.12°. Riparian tree cover is generally isolated in the upper reaches and semi-continuous through Embsay, decreasing to scattered, before increasing to semi-continuous within the lower sections of the reach. The channel measures between 1-3.5m wide, the wider sections are commonly prior to and after the channel flows through Embsay and within the downstream section of the reach. At the YWSL water baseline monitoring site, channel width is 2.73m. Few in-channel features are visible, with only a single side bar and two un-vegetated mid channel bars identified. The visible channel surface from desktop aerial survey indicates that smooth flow predominates with no areas of broken flow identified, however at the YWSL water baseline monitoring site, rippled flow dominated. Bed substrate is dominated by pebble/gravel (70%), however areas of cobble (10%), sand (15%) and boulder (5%) were also observed at the YWSL water baseline monitoring site. Where banks are vegetated it is assumed that they are composed of earth. Bank reinforcement and re-sectioning is limited along the reach, with the exception of where bridges cross the channel, it is also assumed that reinforcement of the channel banks will occur where the channel passes through Embsay. Bank erosion is frequent along the channel, particularly in the upper and mid sections of the reach. Surrounding land use is predominantly improved grassland, with some broadleaf woodland and open water (on the left bank) flanks the channel between 0.6-0.9km downstream. Suburban/urban land use is located between 0.9km and 1.5km downstream as the channel flows through Embsay, moving to improved grassland and the broadleaf woodland in the lower section of the reach.

Eller Beck T1 is likely to be dominated by both high and low energy environments, as indicated by the relatively straight planform and moderate slope in the upper reaches and the shallow gradient and presence of limited depositional and erosional features within the lower reaches. The coarse substrate likely to be present in the watercourse will provide habitat opportunities for fish and white-clawed crayfish, with discrete patches of finer substrate supporting spawning habitat for fish also considered likely to be present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter, with the reinforced banks potentially providing additional refuge opportunities. The varied tree cover may provide some refuge opportunities for otter and white-clawed crayfish and cover for fish. The presence of breeding habitat for otter is unlikely, although there is a large expanse of woodland to the south of the river that is potentially suitable links between this and the watercourse are relatively open. The macroinvertebrate composition is likely to reflect the varied presence of trees in the riparian corridor, with allochthonous energy input greatest at the lower end of the reach. The movement of sediment, fish and white-clawed crayfish may be influenced by the presence of several weirs and two culverts, of 100m and 200m, within the reach.

The drought options reduction in flow could lead to several potential impacts within Eller Beck T1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow for the duration of drought options.
- Potentially major risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bedrock outcrops and bed elements (such as larger particles) through the flow surface for duration of drought option at very low flows.
- Potentially major risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option at very low flows.

6 'Flow depleted reach' refers to the length between the abstraction and discharge point of non-consumptive licences (e.g. aquaculture, hydro-power).

- Major risk to longitudinal connectivity, also noting the presence of several weirs located within the reach and two culverts in the lower reach.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that land based sources will be largely dormant during environmental drought. During winter refill periods, overland flow processes that add fine sediment to the channel during rainfall events will increase in-channel flows and increase velocities. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Eller Beck T1 from drought options is therefore assessed as major.

A4.2.5 River water quality

One water quality monitoring location is present in Embsay Beck Above Confluence with Haw Bk (NE-49400334). The average pH between 2010-2020 was 7.96 with a maximum temperature of 16.3°C for the same period. There are no significant continuous or intermittent discharges either within Eller Beck T1 or at risk from changes in flow in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Eller Beck T1 as a result of drought options is presented in **Table A4.1**.

Table A4.1 Potential risks to water quality in Eller Beck T1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period with a single sample achieving moderate status on 05.04.2017. Some weak seasonality is apparent.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Some weak seasonality is apparent.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.039 mg/l) throughout the monitoring period however 30% of samples achieved moderate status or lower. Some weak seasonality is apparent.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Weak
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

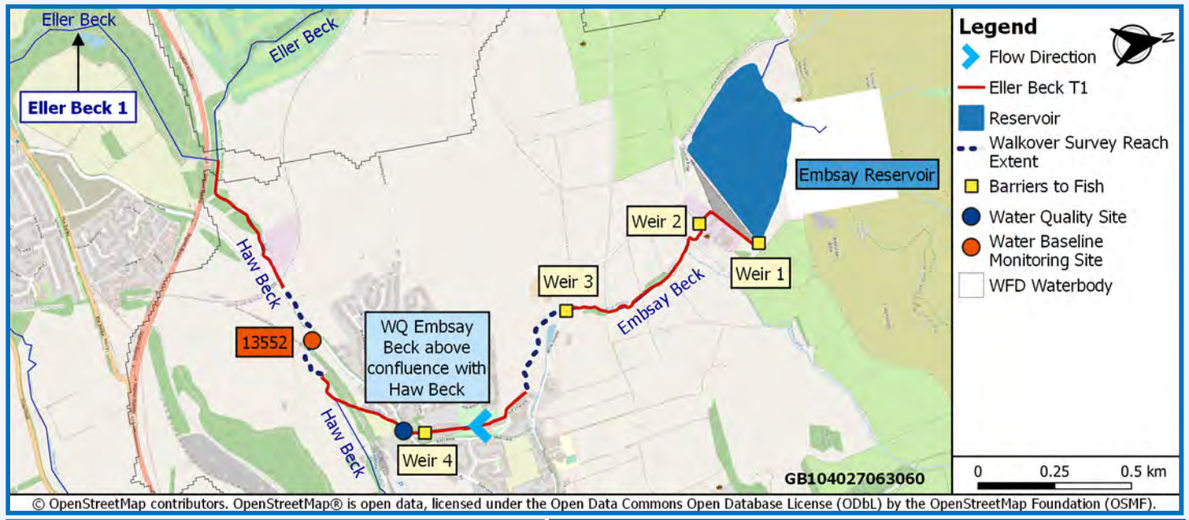
A4.2.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Eller Beck T1 as a result of drought options is presented in **Table A4.2**.

Table A4.2 Summary of potential changes in the physical environment of Eller Beck T1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Eller Beck T1.
River habitats *Major risk*	• The major reduction in flow to very low flows will change the energy, habitat availability and connectivity of the system.
Water quality *Minor risk*	• Reported water quality is mostly consistent with 'Good' status with apparent weak flow sensitivity for SRP. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting

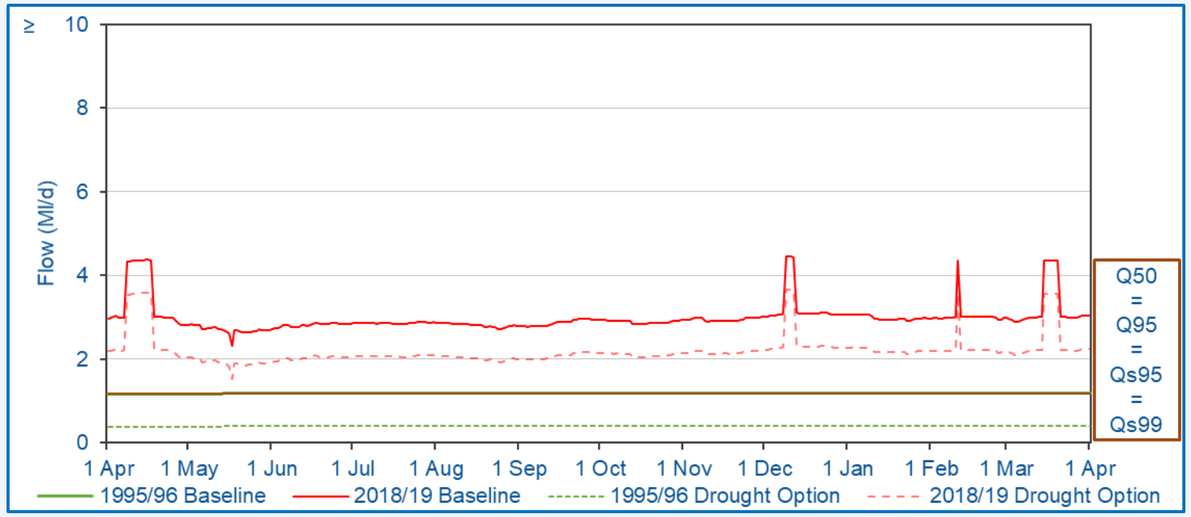


Reach Setting Information:

The superficial geology of this reach is composed predominantly of glacial till. Soil types along the reach are composed predominantly of slowly permeable, seasonally wet acid loamy and clayey soils. Surrounding land use is predominantly improved grassland, suburban/urban land use between 0.9km and 1.5km downstream as the channel flows through Embsay and improved grassland to the end of the reach.

	Supplementary Information
Catchment Area at Assessment Point	2.8km^2
Mean Slope Gradient	1.12°
Length of Reach	2.9km
Additional Catchment Area	8.1km^2
Upstream Reach	N/A
Downstream Reach	Eller Beck 1

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
$Q_{s}95$	1.19	0.39	67	Summer Major
$Q_{s}99$	1.19	0.39	67	
Q95	1.19	0.39	67	Winter Major
Q50	1.19	0.39	67	

There are no significant flow additions/ reductions associated with this reach

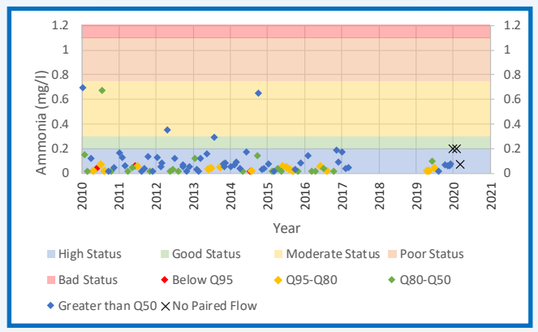
River Habitats

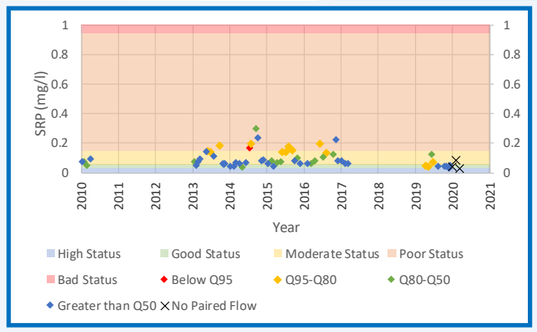
River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this river is 7.96

The maximum temperature is 16.3°C





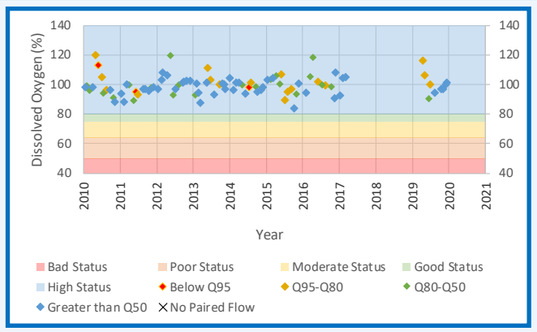


Figure A4.1

Eller Beck T1:

Physical Environment Information

A4.3 Eller Beck 1

A4.3.1 Reach introduction

Eller Beck 1 is potentially impacted by an Embsay Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.2**. The reach includes all of the main channel of the following river waterbody:

- Eller Beck from Haw Beck to River Aire (GB104027063020).

A4.3.2 Reach setting

Eller Beck 1, located on main EAR **Figure 4.1,** comprises a 3.9km stretch of the Eller Beck from the confluence with Haw Beck (Eller Beck T1, see **Section A4.2** above) to the confluence with the River Aire (**Table A2.1**).

A4.3.3 River flow regime

River flow in Eller Beck 1 is influenced by the semi-natural flows on the upstream Eller Beck and the Embsay Reservoir influenced flows of Eller Beck T1. As such some flow variability would be apparent during the implementation of North West Area drought options part-reflecting local hydrological response to rainfall conditions during the ongoing environmental drought.

Daily mean flows at the upstream end of this reach, immediately downstream of the Eller Beck T1 confluence have been estimated using the Gustard flow transposition method. This is based on catchment parameter ratios and gauged flow data from an available downstream gauge at Skipton. Prior to applying the flow transposition, adjustments to the gauged flow data and catchment parameters were made to allow for the effects of the reservoir in the upper catchment. Daily reservoir outflows were then added back on to the estimated (transposed) data series. This enabled the creation of an estimated daily flow record for the Eller Beck downstream of the Eller Beck T1 confluence covering the period 1990-2019 with moderate to high confidence.

The maximum flow reduction of flow passed forward from Eller Beck T1 during implementation of the drought options is 0.80 Ml/d. This represents a reduction of 16% and 22% in the summer Q95 and Q99 flow statistics, which is assessed as a moderate hydrological impact on this reach in summer and autumn months. The reduction in year-round Q95 and Q50 is 14% and 3.7% respectively, which is assessed as a minor hydrological impact during winter months associated with winter refill periods.

Towards the downstream end of the reach, flows are measured at the Skipton gauging station. A reduction of up to 0.80 Ml/d represents a percentage reduction of 11% and 16% in the gauged summer Q95 and Q99 flow statistics, so that the summer hydrological impact remains at moderate at the downstream end of this reach. The reduction in year round Q95 and Q50 is 10% and 2.8% respectively, which is also assessed as a minor hydrological impact during winter months.

The hydrological impact of drought options on Eller Beck 1 is therefore assessed as **moderate** for a summer/ autumn period and **minor** for any winter refill period while drought options remain in place.

There is one significant flow pressure influencing flow in Eller Beck 1, a non-consumptive abstraction licence leading to a flow depleted reach as described in **Section A4.3.3.1**. There are no significant discharges within Eller Beck 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.3.3.1 Flow depleted reaches

There is one separate licensed non-consumptive abstraction depleting flow in Eller Beck 1 for hydro-power generation.

The abstraction is for ~5m of Eller Beck 1 between the offtake and outfall, with a peak daily licensed abstraction rate of 38.88Ml/d. This abstraction is a non-consumptive large volume hydropower abstraction, without a hands-off-flow condition ('Skipton Corn Mill') with potential flow impacts. An abstraction at that rate could reduce flows in the depleted reach, during environmental drought, without or in combination with drought options, to zero. A walkover reach covering the section of the river has

been included in the schedule of monitoring for Eller Beck 1 (see main EAR Section 6). YWSL will liaise with the abstractors in advance of permit implementation to determine appropriate mitigation measures.

A4.3.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 6 September 2018 at an estimated river flow at the flow assessment point for the reach of 8.3Ml/d.

Eller Beck 1 is a fairly sinuous reach which falls ~42m over 3.9km, a slope of 0.6°. Riparian tree cover is continuous in the initial 1.2km of the reach and isolated to scattered thereafter. The channel is between 4.5-7.5m in width, with the widest sections occurring as the channel flows through Skipton, likely due to anthropogenic modification. A range of in-channel features were identified using extant aerial imagery. Six side bars (5 of which were vegetated) and 2 mid-channel bars (1 of which was vegetated) were identified. No point bars were identified. Several side bars, particularly in the channel as it passes through Skipton and at the end of the reach prior to the weir of the Environment Agency flow gauge resembled berms. The visible channel surface indicates that smooth flow predominates. Outside of Skipton, bank form and vegetation suggests that banks are predominantly composed of earth. Bank reinforcement and re-sectioning is extensive in the reach as it passes through Skipton. Sheet piling has also been identified in the last few hundred metres of the reach around the Environment Agency flow gauge. Surrounding land use is broadleaf woodland for the first 1.2km of the reach, with suburban/urban land dominant as the channel flows through Skipton (from 1.2-2.9km downstream) and improved grassland thereafter. A single pond is located on the left bank of the channel ~0.5km downstream from the start of the reach.

Eller Beck 1 is likely to be dominated by low energy flows, with a range of depositional features evident in the channel. The fine substrate present has potential to support breeding fish, with coarser substrates providing refuge and cover for fish and white-clawed crayfish considered likely to be present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter, with the reinforced banks potentially providing additional refuge opportunities. The varied tree cover may provide some refuge opportunities for otter and white-clawed crayfish and cover for fish. Breeding habitat for otter is potentially present, with extensive woodland surrounding the watercourse in the upper reaches. The macroinvertebrate composition is likely to reflect the varied presence of trees in the riparian corridor, with allochthonous energy input greatest at the upper end of the reach. The movement of sediment, fish and white-clawed crayfish may be influenced by the presence of a number of weirs.

The drought options reduction in flow could lead to several potential impacts within Eller Beck 1:

- Moderate risk of changes in the energy of the system associated with up to 22% reduction in flow for periods of time during the duration of drought options.
- Potentially minor risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bedrock outcrops and bed elements (such as larger particles) through the flow surface for periods of time during the duration of drought option, noting the retention of an overall variable flow pattern.
- Potentially minor risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time during the duration of drought option, with few changes to the range and abundance of flow types.
- Minor risk to longitudinal connectivity from six noted weirs for periods of time during the duration of drought option, noting the retention of an overall variable flow pattern.
- Minor risk of changes in sediment dynamics for periods of time during the duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Eller Beck 1 from drought options is therefore assessed as minor.

A4.3.5 River water quality

Two water quality monitoring points are present in Eller Beck 1. For this assessment the second sample in the reach, Eller Beck at Confluence with River Aire (NE-49400308), was used due to data quality. The average pH between 2010-2020 was 8.1 with a maximum temperature of 17.6˚C for the same period. There are no significant continuous discharges into Eller Beck 1. There is one frequently spilling CSO potential presenting an environmental risk in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Eller Beck 1 as a result of drought options is presented in **Table A4.3**.

Table A4.3 Potential risks to water quality in Eller Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period with four samples exceeding 'moderate' status (0.75 mg/l). Some moderate seasonality is apparent.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Some moderate seasonality is apparent.	Orthophosphate concentrations were infrequently consistent with 'Good' WFD status (0.057 mg/l) throughout the monitoring period with 75% of samples achieving moderate status (0.151 mg/l) or lower. Strong seasonality is apparent.
Flow sensitivity (diffuse pollution)	None apparent	Weak	Strong
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	Risk of short term acute, infrequent, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) locally downstream of one listed CSO during rainfall events.		None
Other point source pressures presenting risk	None	None	None
Summary	Moderate risk from drought options associated with CSO discharge	Moderate risk from drought options associated with CSO discharge	Moderate risk from drought options associated with change in dilution of diffuse pollution pressures.

A4.3.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Eller Beck 1 as a result of drought options is presented in **Table A4.4**.

Table A4.4 Summary of potential changes in the physical environment of Eller Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Moderate impacts (summer/autumn)* *Minor impacts (winter)*	• Reductions of up to 22% in summer/autumn river flows throughout the reach.
Flow depleted reaches *Major risk*	• ~5m flow depleted reach with potential for periods of time with zero flow without mitigation
River habitats *Minor risk*	• The moderate summer/autumn and minor winter reduction in flow will present moderate changes to the energy of the system • Potential minor risk of reduction in total wetted aquatic habitat in the reach, and minor risk of changes in available habitat for different species requirements – noting a significant variety of wetted habitats are present. • Minor risk to longitudinal connectivity • Minor risk of change in sediment dynamics.
Water quality *Moderate risk*	• Risk of short term acute, infrequent, temporary water quality pressures locally downstream of one listed CSO during rainfall events. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented. • Reported water quality for ammonia and DO% is mostly within 'Good' status excluding SRP which typically achieves 'moderate' status. SRP also demonstrates strong flow sensitivity.

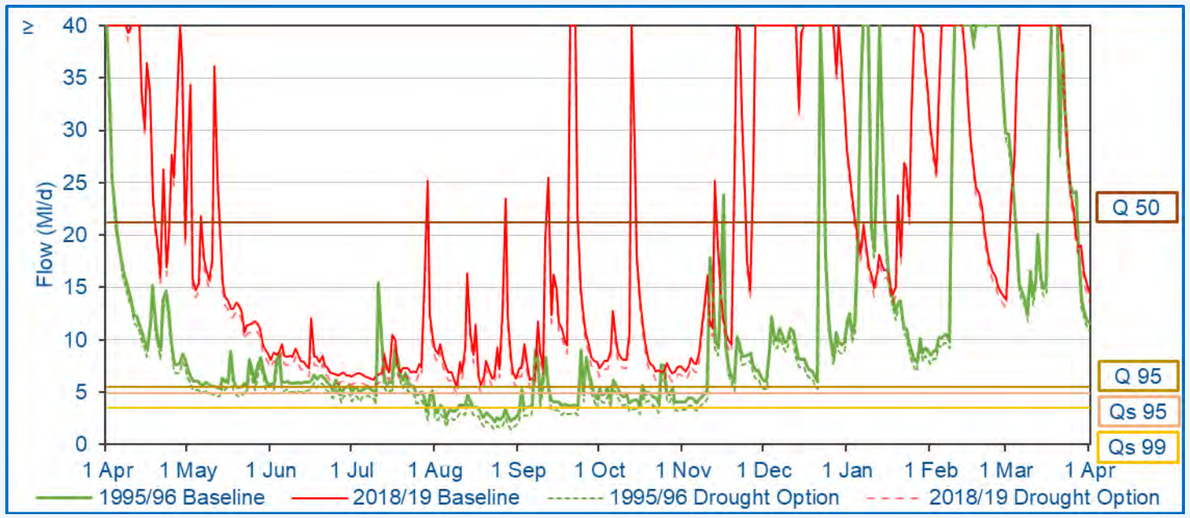
Reach Setting

Reach Setting Information:

The superficial geology is composed of alluvium along with glacial tills surrounding the reach. Extensive river terrace deposits and alluvium are located around the confluence with the River Aire. Soil types along the reach are composed predominantly of slowly permeable, seasonally wet acid loamy and clayey soils with some loamy and clayey floodplain soils around the confluence with the River Aire .Suburban/urban land is dominant as the channel flows through Skipton (1.2-2km downstream)

	Supplementary Information
Catchment Area at Assessment Point	23.5km^2
Mean Slope Gradient	0.6°
Length of Reach	3.9km
Additional Catchment Area	9.8km^2
Upstream Reach	Eller Beck T1
Downstream Reach	N/A

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	4.9	4.1	16	Summer Moderate
Q_s99	3.5	2.7	22	
Q95	5.5	4.7	14	Winter Minor
Q50	21.2	20.4	3.7	

Significant Flow Additions/Reductions	Flow Rate (Ml/d)	Abstraction / Discharge
Skipton Corn Mill, Skipton NE/027/0015/001	38.88	Abstraction

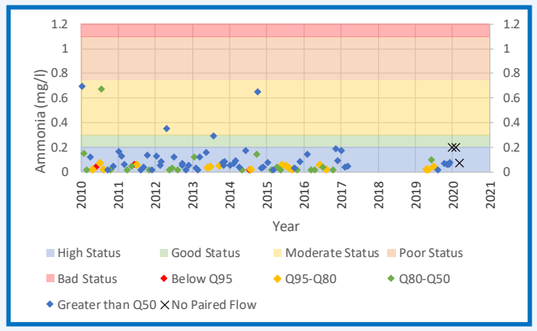
River Habitats

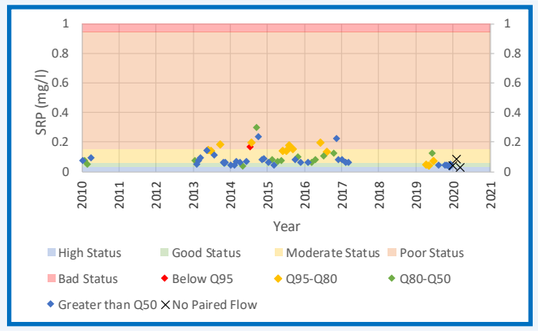
River Water Quality

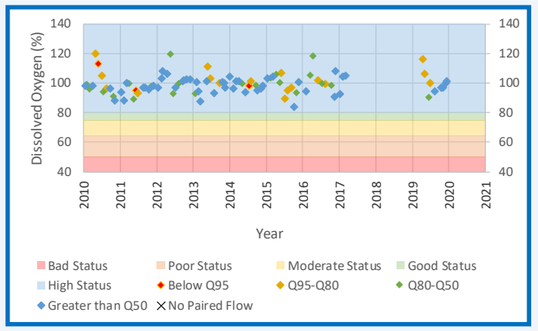
Significant Water Quality Pressures	Permit Conditions
Carleton Road Skipton CSO YWUCD2/103 1	Intermittent discharge

The average pH in this river is 8.1

The average temperature is 17.6°C







YorkshireWater

RICARDO

Figure A4.2

Eller Beck 1

Physical Environment Information

A4.4 Silsden Beck 1

A4.4.1 Reach introduction

Silsden Beck 1 is potentially impacted by a Silsden Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.3**. The reach includes all of the main channel of the following river waterbody:

- Silsden Beck from Source to River Aire (GB104027062990)

A4.4.2 Reach setting

Silsden Beck 1, located on main EAR **Figure 4.2,** comprises a 3km stretch of the Silsden Beck from Silsden Reservoir to the confluence with the River Aire (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 6.0km^2 along the length of the reach.

A4.4.3 River flow regime

During the implementation of North West Area drought options, storage in Silsden Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 1.61Ml/d in the statutory compensation release rate of 2.41Ml/d represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of the drought permit on Silsden Beck 1 is therefore assessed as a **major** hydrological impact at any time of year.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Silsden Beck 1. There are no flow depleted reaches within Silsden Beck 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.4.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 27 September 2018 at an estimated river flow at the flow assessment point for the reach of 2.7Ml/d.

Silsden Beck 1 is fairly sinuous reach which falls ~79m over 3.0km, a slope of 1.5°. Riparian tree cover ranges from semi-continuous in the upper reaches prior to Silsden and scattered to isolated after Silsden. Only the mid and lower sections of the channel are visible due to tree cover in the upper section (prior to Silsden). In the mid reaches through Silsden the channel is 9-10m wide, decreasing downstream after Silsden from 5m to 3m. This reduction in width appears to be linked to reducing anthropogenic modification towards the end of the reach. In the mid and lower sections of the reach 8 side bars (3 of which were vegetated), 3 unvegetated mid-channel bars and 4 unvegetated point bars were identified. The channel surface indicates predominant smooth flow, although 13 areas of broken flow were identified (these areas attributed to riffles). Vegetation and bank form suggests that banks are composed of earth. Extensive bank reinforcement and re-sectioning was identified in the channel as it flows through Silsden. Surrounding land use is mixture of improved grassland and broadleaf woodland in the first 0.5km, suburban/urban land use between 0.5km and 2.0km downstream as the channel passes through Silsden and improved grassland and some rough pasture until the end of the reach.

In the absence of RHS information for Silsden Beck 1, only limited conclusions can be drawn as to habitat availability. The reach is likely to be dominated by low energy environments, as indicated by the presence of depositional features in the reach and the indicated flow structure, however high energy environments are present. The coarse substrates likely to be present in the reach will provide habitat opportunities for fish and white-clawed crayfish with the riffles likely to be present supporting spawning

habitat for fish. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter and the presence of reinforcement may provide additional habitat opportunities for both species. The semi-continuous occurrence of trees in the riparian corridor of the upper section of the reach will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is potentially present in the reach, with an area of woodland present to the south of the reservoir. The regular occurrence of trees in the upper section of the reach will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is likely to be influenced by the presence of a couple of weirs.

The drought options reduction in flow could lead to several potential impacts within Silsden Beck 1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow for periods of time during the duration of drought option.
- Potentially moderate risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bedrock outcrops and bed elements (such as larger particles) through the flow surface for periods of time during the duration of drought option.
- Potentially moderate risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time during the duration of drought option, with few changes to the range and abundance of flow types.
- Major risk to longitudinal connectivity from three in-channel structure for periods of time during the duration of drought option.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Silsden Beck 1 from drought options is therefore assessed as major.

A4.4.5 River water quality

One water quality monitoring point is present in Silsden Beck 1. For this assessment the first sample in the reach, Silsden Beck (NE-49400835), was used due to its position in the reach and its data quality. The average pH between 2010-2020 was 8.2 with a maximum temperature of 17.1°C for the same period. There are no significant continuous discharges or intermittent discharges either within Silsden Beck 1 or at risk from changes in flow in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Silsden Beck 1 as a result of drought options is presented in **Table A4.5**.

Table A4.5 Potential risks to water quality in Silsden Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period with 3 samples achieving 'moderate' status (0.75 mg/l). Some weak seasonality is apparent.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Some weak seasonality is apparent.	Orthophosphate concentrations were not consistent with 'Good' WFD status (0.051 mg/l) throughout the monitoring period with all samples exceeding this status. Some seasonality was apparent.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Weak
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

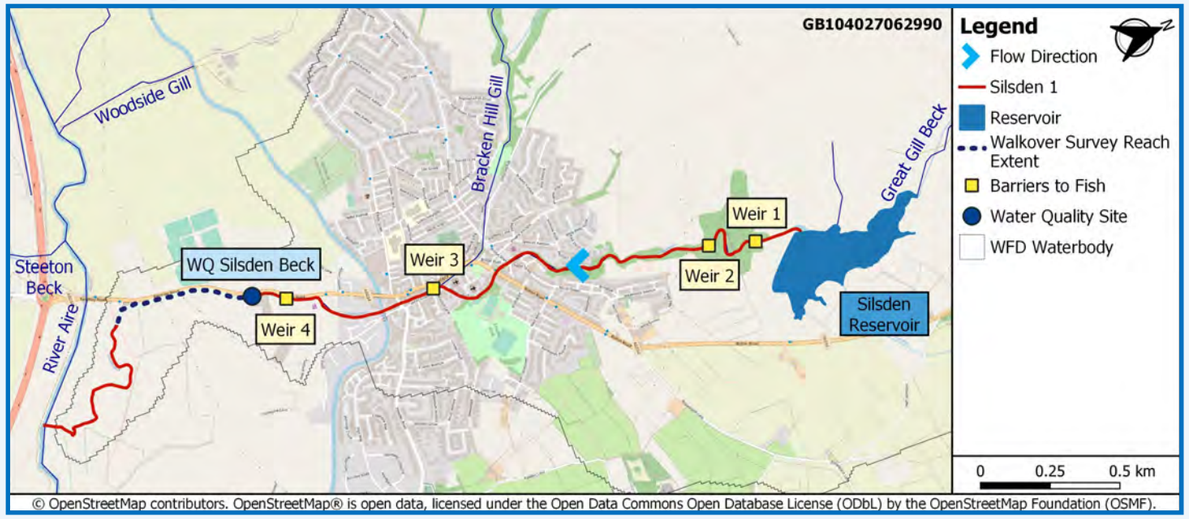
A4.4.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Silsden Beck 1 as a result of drought options is presented in **Table A4.6**.

Table A4.6 Summary of potential changes in the physical environment of Silsden Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Silsden Beck 1.
River habitats *Major risk*	• The major reduction in flow will change the energy of the system • Potential moderate risk of reduction in total wetted aquatic habitat in the reach, and moderate risk of changes in available habitat for different species requirements – noting a significant variety of wetted habitats are present. • Major risk to longitudinal connectivity • Moderate risk of change in sediment dynamics.
Water quality *Minor risk*	• Reported water quality is consistent with 'Good' status and no more than weak flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting

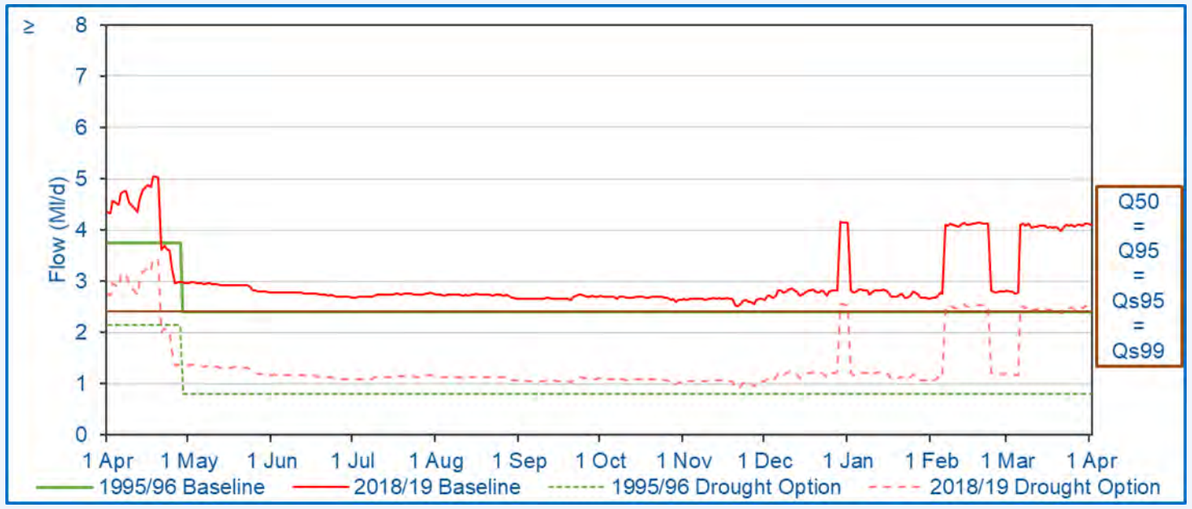


Reach Setting Information:

The superficial geology is predominantly alluvium with extensive alluvial fan deposits and alluvium at the end of the reach around the confluence with the River Aire. Soil types in the reach are composed predominantly of slowly permeable, seasonally wet acid loamy and clayey soils with some loamy and clayey floodplain soils around the confluence with the River Aire. Suburban/urban land use is observed between 0.5km and 2.0km downstream as the channel passes through Silsden.

	Supplementary Information
Catchment Area at Assessment Point	7.6km^2
Mean Slope Gradient	1.5^o
Length of Reach	3.0km
Additional Catchment Area	6.0km^2
Upstream Reach	N/A
Downstream Reach	N/A

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	2.41	0.80	67	Summer Major
Q_s99	2.41	0.80	67	
Q95	2.41	0.80	67	Winter Major
Q50	2.41	0.80	67	

There are no significant flow additions/ reductions associated with this reach

River Habitats

River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this river is 8.2

The maximum temperature is 17.1^{o}C

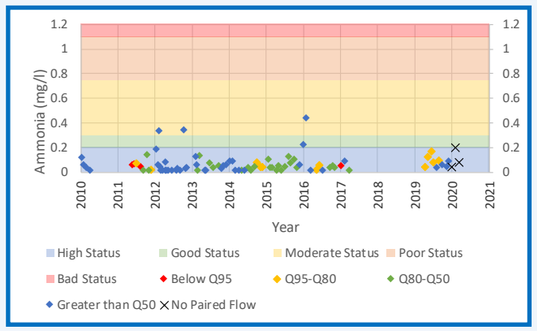
YorkshireWater

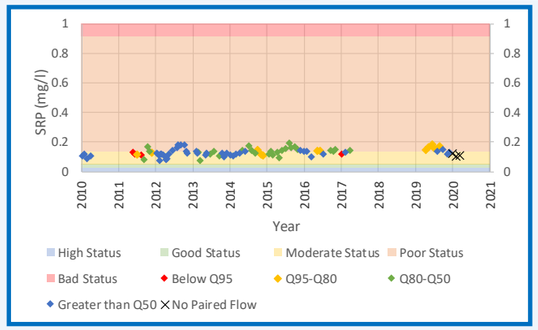
RICARDO

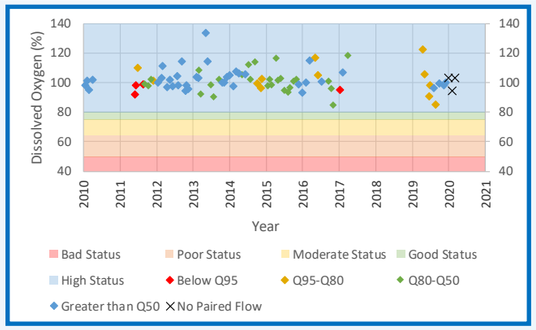
Figure A4.3

Silsden Beck 1

Physical Environment Information







A4.5 Bridgehouse Beck T1

A4.5.1 Reach introduction

Bridgehouse Beck T1 is potentially impacted by a Leeshaw Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.4**. The reach includes part of the following river waterbody:

- Bridgehouse Beck from Source to River Worth (GB104027064200).

A4.5.2 Reach setting

Bridgehouse Beck T1, located on main EAR **Figure 4.2,** comprises a 2.0km stretch of Moorhouse Beck from Leeshaw Reservoir to the confluence with Bridgehouse Beck (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 2.7km^2 along the length of the reach. Bridgehouse Beck 1 (see **Section A4.7** below) is downstream.

A4.5.3 River flow regime

During the implementation of North West Area drought options, storage in Leeshaw Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 1.84Ml/d in the statutory compensation release rate of 2.75Ml/d, when regional reservoir storage is below the regional Drought Control Line for four consecutive weeks or more, represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of the drought permit on Bridgehouse Beck T1 is therefore assessed as a **major** hydrological impact at any time of year.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Bridgehouse Beck T1. There are no flow depleted reaches within Bridgehouse Beck T1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.5.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 4 August 2018 at a reservoir outflow of 2.9Ml/d.

Bridgehouse Beck T1 is a fairly sinuous reach which falls ~40m over 2.0km, a slope of 1.1°. Riparian tree cover varies between no tree cover in the upper sections of the reach to scattered and semi-continuous in the mid and lower sections of the reach. Surrounding land use is predominantly rough pasture and improved grassland for most of the reach trending to suburban/urban land use as the reach flows through the Oxenhope.

The channel width varies from ~1.5m in the upper sections of the reach to 2.5m in the lower sections of the reach. At the YWSL water baseline monitoring site, channel widths are 2.3m. With the exception of some boulders protruding from the surface no other in-channel features were identified. Bed substrate was dominated by cobbles (40%) and pebble/gravel (40%), however areas of boulder (10%) and sand (10%) were also observed at the YWSL water baseline monitoring site. Desktop study of aerial imagery indicates the visible channel surface indicates that smooth flow predominates, although there are some areas of broken flow (with at least 17 areas of broken flow identified). At the YWSL water baseline monitoring site, riffle flow dominated. Where banks are vegetated it is assumed that they are composed of earth. Bank reinforcement and re-sectioning is limited in the reach, occurring on the left bank ~0.3km downstream around a house. Banks are also likely to be modified as the channel flows through Oxenhope.

Bridgehouse Beck T1 is likely to support both high and low energy flows, as indicated by the sinuous planform of the watercourse. The larger coarse substrates and protruding boulders will provide habitat opportunities for fish and white-clawed crayfish, with discrete patches of finer substrate supporting spawning habitat for fish also considered likely to be present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter and the presence of reinforcement, albeit limited, may provide additional habitat opportunities for both species. The regular occurrence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is not considered likely to be present in the reach due to an absence of extensive areas of woodland. The regular occurrence of riparian trees will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is likely to be influenced by the presence of a number of weirs.

The drought options reduction in flow could lead to several potential impacts within Bridgehouse Beck T1:

- Major of changes in the energy of the system associated with up to 67% reduction in flow for duration of drought options.
- Potentially minor risk of reduction in wetted aquatic habitat (wetted width reduction) due to channel shape in deep V-shaped valley.
- Potentially moderate risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option, with retention of dominant habitat types.
- Moderate risk to longitudinal connectivity due to steep nature of channel and from five in-channel structures.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Bridgehouse Beck T1 from drought options is therefore assessed as moderate.

A4.5.5 River water quality

There are no water quality monitoring sites in Bridgehouse Beck T1. As such the first monitoring point in the downstream reach (Bridgehouse Beck 1), Bridgehouse Beck Above Oxenhope Sw Final (NE-49400075) has been used. The average pH between 2010-2020 was 7.7 with a maximum temperature of 15.6°C for the same period. There are no significant continuous or intermittent discharges either within Bridgehouse Beck T1 or at risk from changes in flow in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Bridgehouse Beck T1 as a result of drought options is presented in **Table A4.7**.

Table A4.7 Potential risks to water quality in Bridgehouse Beck T1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period. Some weak seasonality was apparent.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Some moderate seasonality was apparent.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.028 mg/l) throughout the monitoring period however 17% of samples were 'Moderate' (0.087 mg/l) or lower. Some seasonality was apparent.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Weak
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

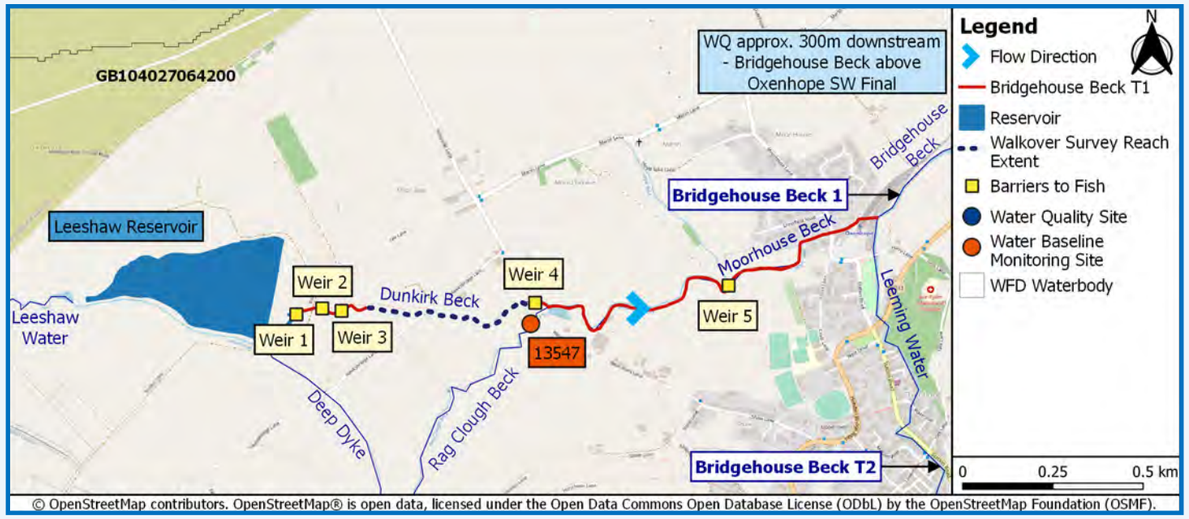
A4.5.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Bridgehouse Beck T1 as a result of drought options is presented in **Table A4.8**.

Table A4.8 Summary of potential changes in the physical environment of Bridgehouse Beck T1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Bridgehouse Beck T1.
River habitats *Moderate risk*	• The major reduction in flow will change the energy of the system • Potential minor risk of reduction in total wetted aquatic habitat in the reach, and moderate risk of changes in available habitat for different species requirements – noting that dominant flow types will be retained. • Moderate risk to longitudinal connectivity • Minor risk of change in sediment dynamics.
Water quality *Minor risk*	• No water quality data directly for the reach, but local reported water quality is predominantly consistent with 'Good' status and with no apparent associations between reducing flow and poorer water quality. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting

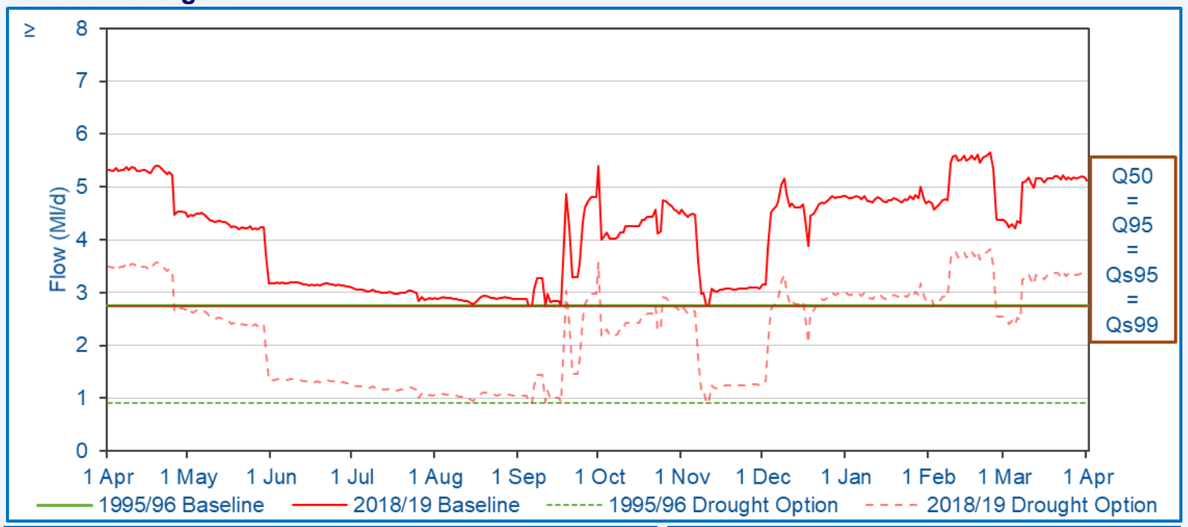


Reach Setting Information:

The superficial geology is composed of alluvium along the channel path and surrounded by glacial till. Soil types along the reach are composed predominantly of freely draining, slightly acid loamy soils. There is some suburban/urban land usage as the reach passes through Oxenhope.

	Supplementary Information
Catchment Area at Assessment Point	3.7km^2
Mean Slope Gradient	1.1°
Length of Reach	2.0km
Additional Catchment Area	2.7km^2
Upstream Reach	N/A
Downstream Reach	Bridgehouse Beck 1

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	2.75	0.91	67	Summer Major
Q_s99	2.75	0.91	67	
Q95	2.75	0.91	67	Winter Major
Q50	2.75	0.91	67	

There are no significant flow additions/ reductions associated with this reach

River Habitats

River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this river is 7.7

The maximum temperature is 15.6°C

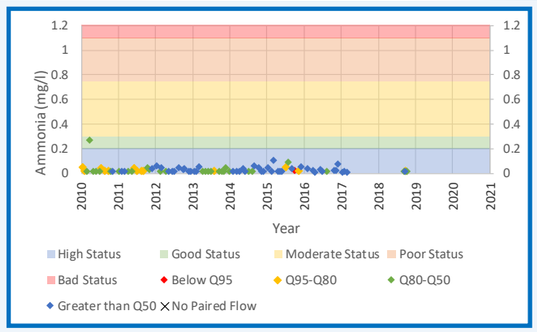
YorkshireWater

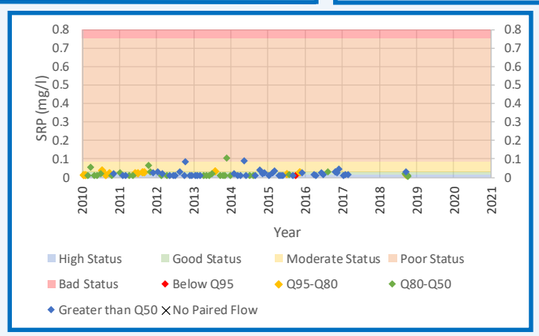
RICARDO

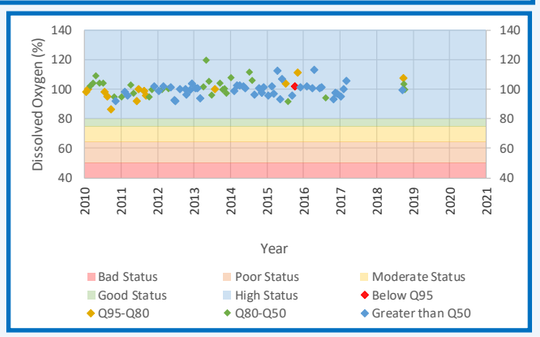
Figure A4.4

Bridgehouse Beck T1

Physical Environment Information







A4.6 Bridgehouse Beck T2

A4.6.1 Reach introduction

Bridgehouse Beck T2 is potentially impacted by a Leeming Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.5**. The reach includes part of the following river waterbodies:

- Bridgehouse Beck from Source to River Worth (GB104027064200).

A4.6.2 Reach setting

Bridgehouse Beck T2, located on main EAR **Figure 4.2,** comprises a 1.7km stretch of Leeming Water from Leeming Reservoir to the confluence with the Moorhouse Beck (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 3.9km^2 along the length of the reach. Bridgehouse Beck 1 (see **Section A4.7** below) is downstream.

A4.6.3 River flow regime

During the implementation of North West Area drought options, storage in Leeming Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 2.18Ml/d in the statutory compensation release rate of 3.25Ml/d, when regional reservoir storage is below the regional Drought Control Line for four consecutive weeks or more, represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of the drought permit on Bridgehouse Beck T2 is therefore assessed as a **major** hydrological impact at any time of year.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Bridgehouse Beck T2. There are no flow depleted reaches within Bridgehouse Beck T2. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.6.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 4 August 2018 at a reservoir outflow of 3.8Ml/d.

Bridgehouse Beck T2 is a fairly sinuous reach which falls ~42m over 1.7km, a slope of 1.4°. Riparian tree cover is generally semi-continuous along the reach. Where the channel is visible through tree cover, the channel is between ~3-5m wide. At the YWSL baseline monitoring site, channel width is 2.93m. In the visible sections of the reach 3 side bars were identified (all of these were vegetated), no in-channel depositional features were observed at the YWSL baseline monitoring site. Desktop study of aerial imagery indicates the visible channel surface indicates that smooth flow predominates, although there are some areas of broken flow (with at least 6 areas of broken flow identified). At the YWSL baseline monitoring site, flow was dominated by riffles. Bed substrate is dominated by cobbles (40%), however areas of pebble/gravel (30%), boulders (20%), sand (5%) and silt/clay (5%) were also observed. Where banks are vegetated it is assumed that they are composed of earth. Bank reinforcement and re-sectioning appear to be common in the lower sections of the reach as it flows through Oxenhope. Surrounding land use is predominantly rough pasture and suburban/urban land use, particularly as the channel flows through the Oxenhope. There are two ponds on the right side of the reach at ~0.2km and ~0.5km downstream respectively. There is also a ponded section of the reach (possibly due to a mill) located ~0.24km downstream.

Bridgehouse Beck T2 is likely to support high and low energy flows, with depositional features present and the flow structure indicating a dominance of smooth flows with broken flow present. The larger coarse substrates and protruding boulders will provide habitat opportunities for fish and white-clawed

crayfish (*Austropotamobius pallipes*), with discrete patches of finer substrate supporting spawning habitat for fish also considered likely to be present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter and the presence of reinforcement may provide additional habitat opportunities for both species. The semi-continuous occurrence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is not considered likely to be present in the reach as the only area of woodland suitable for this, does not contain sufficient understory vegetation to conceal breeding otter. The regular occurrence of riparian trees will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is likely to be influenced by the presence of a number of weirs in the reach.

The drought options reduction in flow could lead to several potential impacts within Bridgehouse Beck T2:

- Major of changes in the energy of the system associated with up to 67% reduction in flow for duration of drought options.
- Potentially moderate risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bed elements (such as larger particles) through the flow surface for periods of time during the duration of drought option.
- Potentially moderate risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time during the duration of drought option, with few changes to the range and abundance of flow types.
- Major risk to longitudinal connectivity from five in-channel structure for periods of time during the duration of drought option.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Bridgehouse Beck T2 from drought options is therefore assessed as major.

A4.6.5 River water quality

There are no water quality monitoring sites in Bridgehouse Beck T2. As such the first monitoring point in the downstream reach (Bridgehouse Beck 1), Bridgehouse Beck Above Oxenhope Sw Final (NE-49400075) has been used. The average pH between 2010-2020 was 7.7 with a maximum temperature of 15.6^{o}C for the same period. There are no significant continuous or intermittent discharges either within Bridgehouse Beck T2 or at risk from changes in flow in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Bridgehouse Beck T2 as a result of drought options is presented in **Table A4.8**.

Table A4.8 Potential risks to water quality in Bridgehouse Beck T2 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period. Some weak seasonality was apparent.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Some moderate seasonality was apparent.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.028 mg/l) throughout the monitoring period however 17% of samples were 'Moderate' (0.087 mg/l) or lower. Some seasonality was apparent.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	None apparent
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

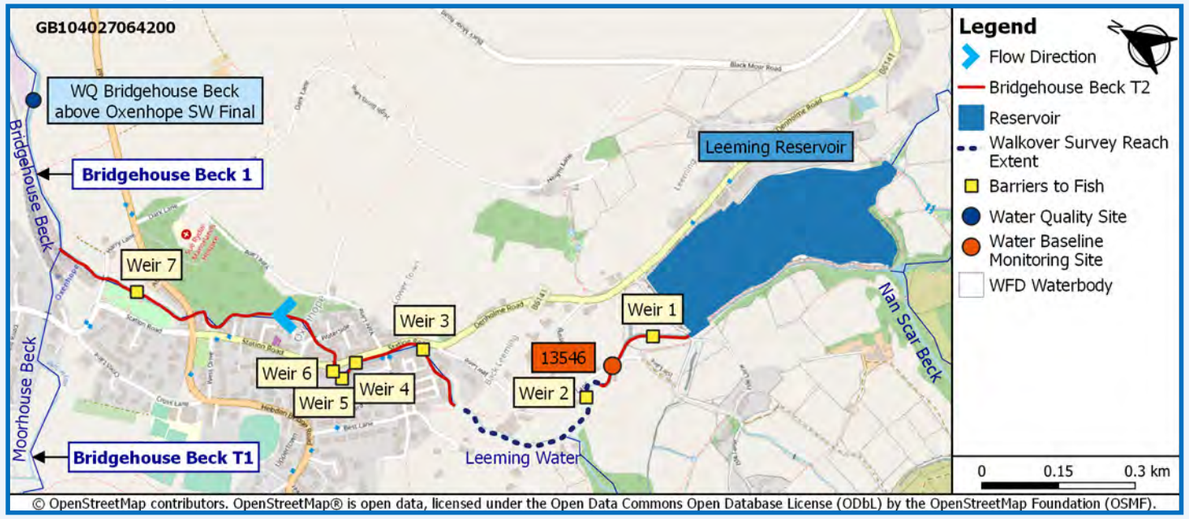
A4.6.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Bridgehouse Beck T2 as a result of drought options is presented in **Table A4.10**.

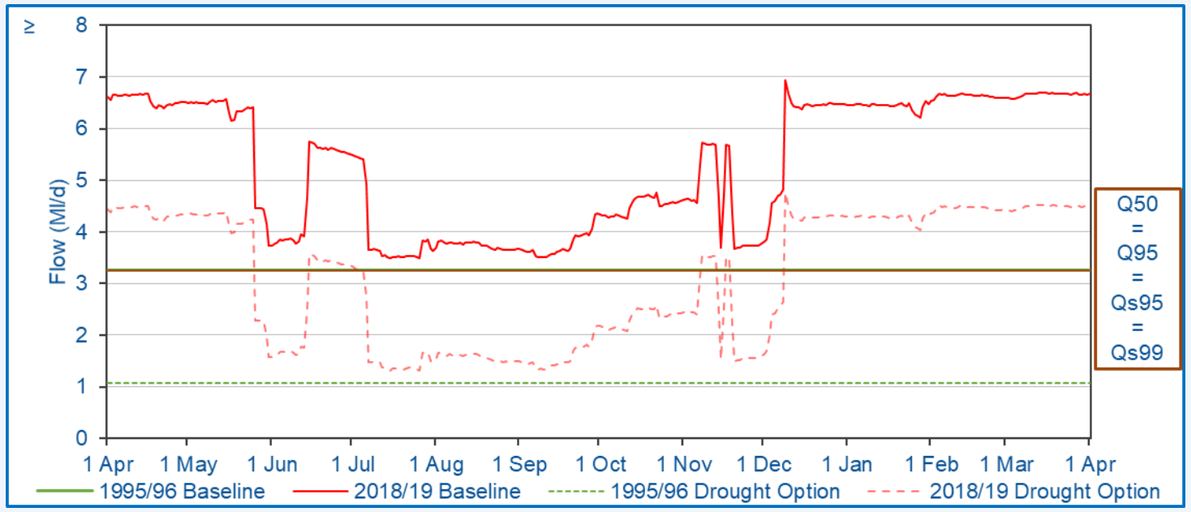
Table A4.10 Summary of potential changes in the physical environment of Bridgehouse Beck T2 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Bridgehouse Beck T2.
River habitats *Major risk*	• The major reduction in flow will change the energy of the system • Potential moderate risk of reduction in total wetted aquatic habitat in the reach, and moderate risk of changes in available habitat for different species requirements – noting that dominant flow types will be retained. • Major risk to longitudinal connectivity • Moderate risk of change in sediment dynamics.
Water quality *Minor risk*	• No water quality data directly for the reach, but local reported water quality is predominantly consistent with 'Good' status and with no apparent associations between reducing flow and poorer water quality. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting



River Flow Regime



Reach Setting Information:

The superficial geology is composed of alluvium along the channel path and surrounded by glacial till. Soil types along the reach are composed predominantly of slowly permeable, seasonally wet acid loamy and clayey soils. Surrounding land use is predominantly rough pasture and suburban/urban land use, particularly as the channel flows through the Oxenhope.

	Supplementary Information
Catchment Area at Assessment Point	4.5km^2
Mean Slope Gradient	1.4°
Length of Reach	1.7km
Additional Catchment Area	3.9km^2
Upstream Reach	N/A
Downstream Reach	Bridgehouse Beck 1

-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	3.25	1.07	67	Summer Major
Q_s99	3.25	1.07	67	
Q95	3.25	1.07	67	Winter Major
Q50	3.25	1.07	67	

There are no significant flow additions/ reductions associated with this reach

River Habitats

River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this river is 7.7

The maximum temperature is 15.6°C

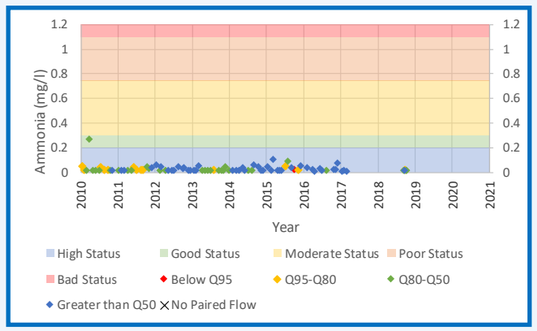
YorkshireWater

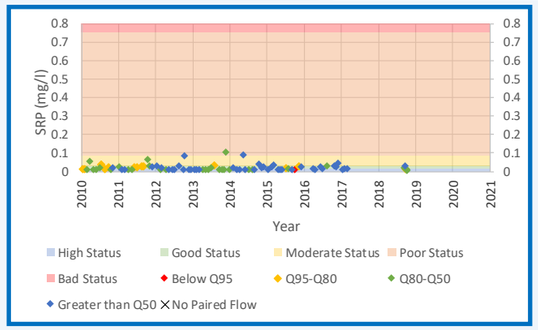
RICARDO

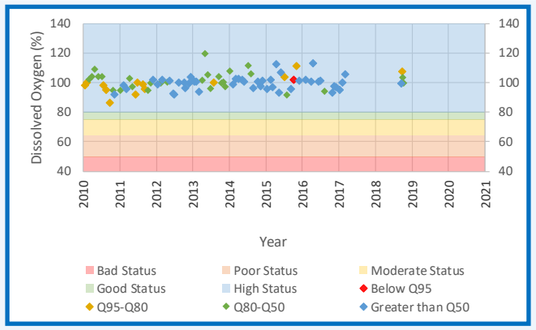
Figure A4.5

Bridgehouse Beck T2

Physical Environment Information







A4.7 Bridgehouse Beck 1

A4.7.1 Reach introduction

Bridgehouse Beck 1 is potentially impacted by both the Leeming Reservoir and Leeshaw Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.6**. The reach includes part of the following river waterbody:

- Bridgehouse Beck from Source to River Worth (GB104027064200).

A4.7.2 Reach setting

Bridgehouse Beck 1, located on main EAR **Figure 4.2,** comprises a 3.2km stretch of the Bridgehouse Beck from the confluence of Leeming Water and Moorhouse Beck to its confluence with the River Worth (**Table A2.1**). This reach is affected by the combined impacts of the Leeming Reservoir and Leeshaw Reservoir drought permits. Worth 2 (see **Section A4.9** below) is downstream.

A4.7.3 River flow regime

River flow in Bridgehouse Beck 1 is influenced by the Leeshaw Reservoir influenced flows of Bridgehouse Beck T1 and Leeming Reservoir influenced flows of Bridgehouse Beck T2. As such limited flow variability would be apparent during the implementation of North West Area drought options part-reflecting local hydrological response to rainfall conditions during the ongoing environmental drought.

Daily mean flows at the upstream end of this reach, immediately downstream of the Bridgehouse Beck T1 and Bridgehouse Beck T2 confluence have been estimated using the Gustard flow transposition method. There is no gauged flow data available for Bridgehouse Beck, so flows at the upstream end of this reach have been estimated using the Gustard flow transposition method, based on catchment parameter ratios and gauged flow data from an available downstream gauge at Keighley on the River Worth. Prior to applying the flow transposition, adjustments to the gauged flow data and catchment parameters were made to allow for the effects of the reservoir in the upper catchment. Daily reservoir outflows were then added back on to the estimated (transposed) data series. This enabled the creation of an estimated daily flow record for Bridgehouse Beck 1 downstream of the Bridgehouse Beck T1 and Bridgehouse Beck T2 confluence covering the period 1990-2019 with moderate confidence.

The maximum flow reduction flow passed forward from Bridgehouse Beck T1 and T2 during implementation of the drought options is 4.02 Ml/d. This represents a reduction of 52% and 59% in the summer Q95 and Q99 flow statistics, which is assessed as a major hydrological impact on this reach in summer and autumn months. The reduction in year-round Q95 and Q50 is 49% and 26% respectively, which is assessed as a major hydrological impact during winter months associated with winter refill periods.

The hydrological impact of drought options on Bridgehouse Beck 1 is therefore assessed as **major** for both a summer/ autumn period and any winter refill period while drought options remain in place.

There is one significant flow pressure influencing flow in Bridgehouse Beck 1, a water company discharge. There are no significant abstractions or flow depleted reaches within Bridgehouse Beck 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.7.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 30 August 2018 at an estimated river flow at the flow assessment point for the reach of 8.2Ml/d.

Bridgehouse Beck 1 is a fairly sinuous reach with relatively straight sections throughout the reach. The reach falls ~41m over 3.2km, a slope of 0.7°. Riparian tree cover is scattered to semi-continuous along the reach. The channel is 4 to 7m in width. In the visible sections of the reach 5 side bars were identified (4 of these were vegetated). Boulders were noted protruding through the flow in the reach. The visible channel surface indicates that smooth flow predominates, although there are some areas of broken flow. Where banks are vegetated it is assumed that they are composed of earth. Bank reinforcement

and re-sectioning is common in the mid sections of the reach as the channel flows through Haworth. Surrounding land use is predominantly rough pasture and improved grassland with suburban/urban land use dominating as the channel flows through Haworth.

Bridgehouse Beck 1 is likely to support high and low energy flows, with depositional features present and the flow structure indicating a dominance of smooth flows with broken flow present. The larger coarse substrates and protruding boulders will provide habitat opportunities for fish and white-clawed crayfish (Austropotamobius pallipes), with discrete patches of finer substrate supporting spawning habitat for fish also considered likely to be present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter and the presence of reinforcement may provide additional habitat opportunities for both species. The semi-continuous occurrence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is not considered likely to be present in the reach. The regular occurrence of riparian trees will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is likely to be influenced by the presence of a number of weirs and culverts.

The drought options reduction in flow could lead to several potential impacts within Bridgehouse Beck 1:

- Major risk of changes in the energy of the system associated with up to 59% reduction in flow for periods of time during the duration of drought option.
- Potentially moderate risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bed elements (such as larger particles) through the flow surface for periods of time during the duration of drought option, noting the retention of an overall variable flow pattern.
- Potentially moderate risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time during the duration of drought option, with changes to the range and abundance of flow types.
- Moderate risk to longitudinal connectivity from four noted weirs for periods of time during the duration of drought option, noting the retention of an overall variable flow pattern.
- Minor risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Bridgehouse Beck 1 from drought options is therefore assessed as moderate.

A4.7.5 River water quality

There are two water quality monitoring sites in Bridgehouse Beck 1. As the upstream site, Bridgehouse Beck Above Oxenhope STW Final (NE-49400075), has been used for the Bridgehouse Beck T1 and T2 assessment the next downstream site, Bridgehouse Beck Above Conf With R.Worth (NE-49400074), has been used. The average pH between 2010-2020 was 7.7 with a maximum temperature of 15.6^{o}C for the same period. Water quality modelling identifies one continuous discharge, YWSL Oxenhope WwTW, presenting a significant risk to both dissolved oxygen and total ammonia downstream from the WwTW for the remainder of the reach and the downstream reach Worth 2. There are no intermittent discharges either within Bridgehouse Beck 1 or at risk from changes in flow in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Bridgehouse Beck 1 as a result of drought options is presented in **Table A4.8**.

Table A4.11 Potential risks to water quality in Bridgehouse Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period. Some weak seasonality was apparent.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Some moderate seasonality was apparent.	Orthophosphate concentrations predominantly inconsistent with 'Good' WFD status (0.031 mg/l) throughout the monitoring period with most meeting 'Moderate' status (0.093 mg/l) or lower. Some seasonality was apparent.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Strong
WwTW presenting increased risk	Risk of medium-term chronic, regular, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) downstream of Oxenhope WwTW.		None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Moderate risk from drought options associated with reduction in dilution of WwTW	Moderate risk from drought options associated with reduction in dilution of WwTW	Moderate risk from drought options associated with change in dilution of diffuse pollution pressures.

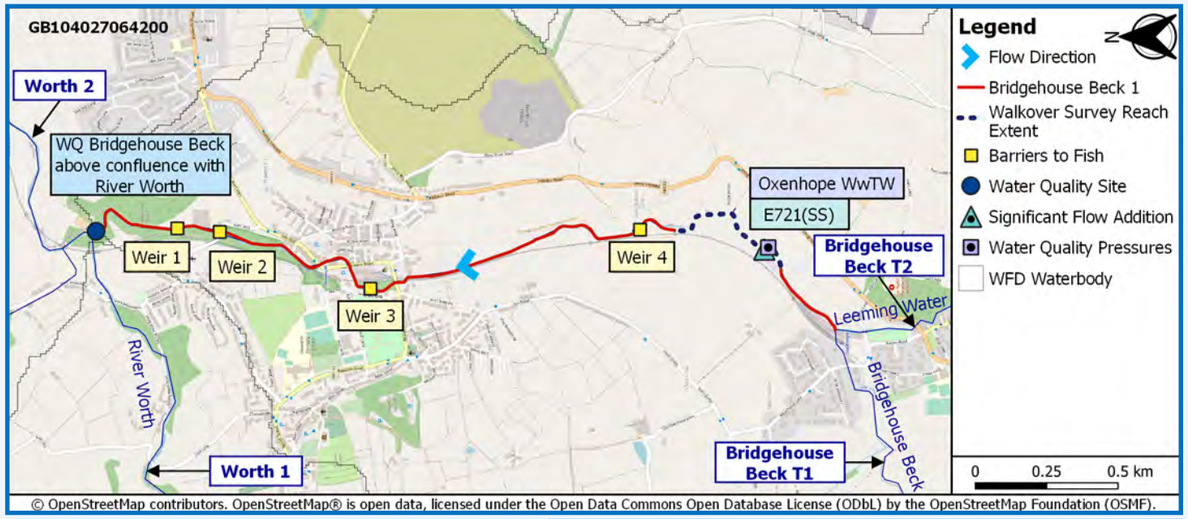
A4.7.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Bridgehouse Beck 1 as a result of drought options is presented in **Table A4.12**.

Table A4.12 Summary of potential changes in the physical environment of Bridgehouse Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 59% in river flows at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Bridgehouse Beck 1.
River habitats *Moderate risk*	• The moderate reduction in flow will change the energy of the system • Potential moderate risk of reduction in total wetted aquatic habitat in the reach, and moderate risk of changes in available habitat for different species requirements – noting a variety of wetted habitats are present. • Moderate risk to longitudinal connectivity • Minor risk of change in sediment dynamics.
Water quality *Moderate risk*	• Risk of medium-term chronic, regular, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) downstream of Oxenhope WwTW. There are no intermittent water quality pressures identified as presenting increased risk with drought options implemented. • Reported ammonia and DO % water quality is predominantly consistent with 'Good' status and with only weak flow sensitivity. SRP is predominantly attaining 'Moderate' status or lower with a strong flow sensitivity.

Reach Setting

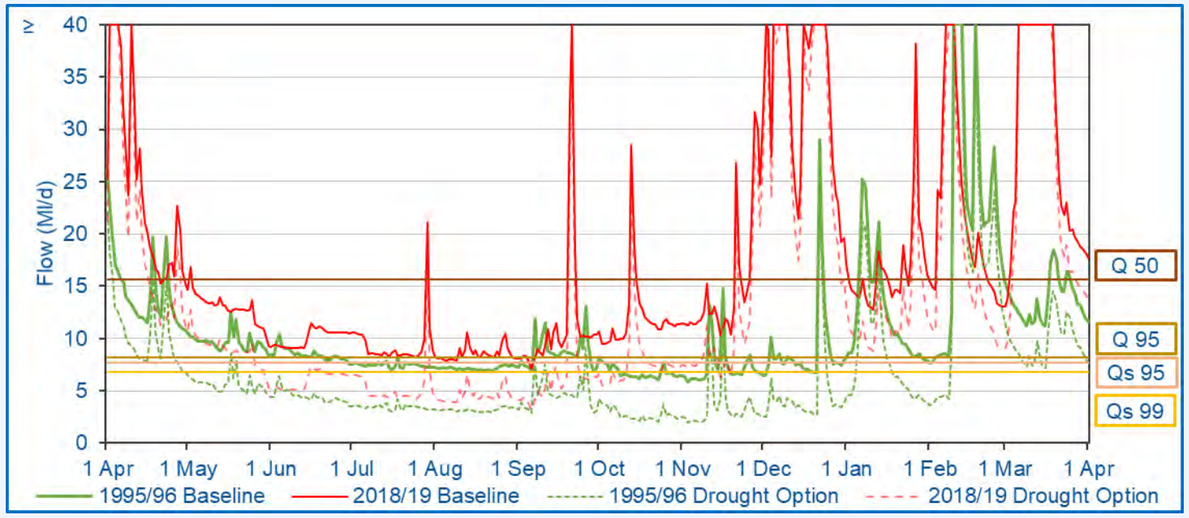


Reach Setting Information:

The superficial geology is composed of alluvium along the channel path and surrounded by glacial till. Soil types along the reach are composed predominantly of slowly permeable, seasonally wet acid loamy and clayey soils. Surrounding land use is predominantly rough pasture and improved grassland with suburban/urban land use dominating as the channel flows through Haworth.

	Supplementary Information
Catchment Area at Assessment Point	14.8km^2
Mean Slope Gradient	0.7°
Length of Reach	3.2km
Additional Catchment Area	4.3km^2
Upstream Reach	Bridgehouse Beck T1/T2
Downstream Reach	River Worth 2

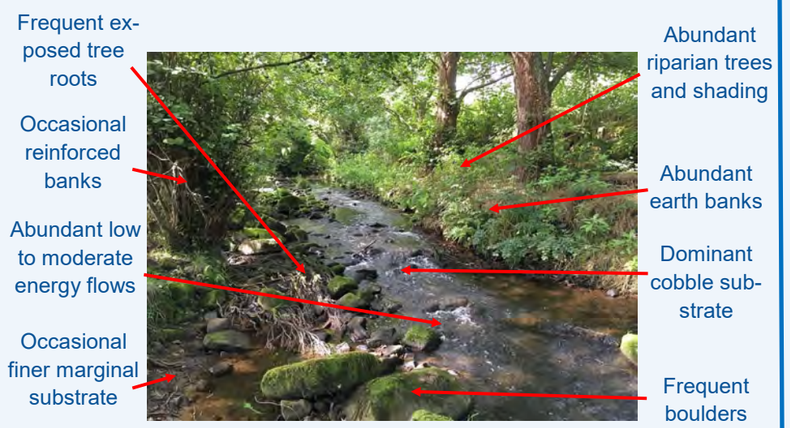
River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	7.68	3.66	52	Summer Major
Q_s99	6.83	2.81	59	
Q95	8.16	4.14	49	Winter Major
Q50	15.62	11.60	26	

Significant Flow Additions/Reductions	Flow Rate (Ml/d)	Abstraction / Discharge
Oxenhope WwTW E721(SS)	1.63	Discharge

River Habitats



River Water Quality

Significant Water Quality Pressures	Permit Conditions
Oxenhope WwTW E721 (SS)	0.91 Ml/d DWF 1.63 Ml/d Daily Max 15 mg/l Ammonia (N) 50 BOD ATU

The average pH in this river is 7.7

The maximum temperature is 15.6°C

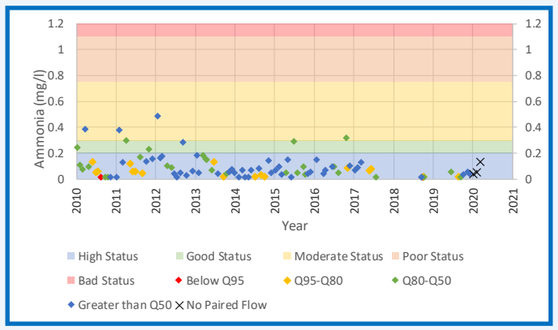
YorkshireWater

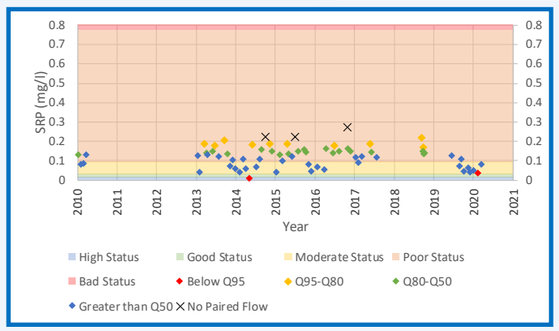
RICARDO

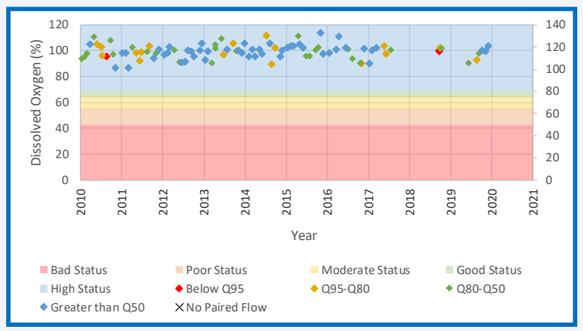
Figure A4.6

Bridgehouse Beck 1

Physical Environment Information







A4.8 Worth 1

A4.8.1 Reach introduction

Worth 1 is potentially impacted by a Springhead Weir Maintained Flow drought permit. A summary of physical environment information for this reach is provided in **Figure A4.7**. The reach includes part of the following river waterbody:

- Worth from Source to Bridgehouse Beck (GB104027064210).

A4.8.2 Reach setting

Worth 1, located on main EAR **Figure 4.2,** comprises a 2.0km stretch of the River Worth from Springhead Weir (below its confluence with Sladen Beck) to its confluence with Bridgehouse Beck (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 4.3km^2 along the length of the reach. Worth 2 (see **Section A4.9** below) is downstream.

A4.8.3 River flow regime

The minimum flow which must normally be maintained at Springhead Weir is 6.00 Ml/d, increasing to 8.00 Ml/d when Leeming and Leeshaw reservoirs are below their control lines (so that their combined compensation flow is 6.00 Ml/d). Under this drought permit, providing Leeming and Leeshaw Reservoirs are below their control lines, then the maintained flow at Springhead Weir is reduced from a reference value of 8.00 Ml/d to 4.00 Ml/d, and further reduced to 2.67 Ml/d when regional reservoir stocks are below the Drought Control Line for 4 or more consecutive weeks. The maximum flow reduction is therefore 5.33 Ml/d in this reach, a reduction of 67%.

The hydrological impact of drought options on Worth 1 is therefore assessed as **major** for both a summer/ autumn period and any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Worth 1. There are no flow depleted reaches within Worth 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.8.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 29 August 2018 at an estimated river flow at the flow assessment point for the reach of 10.0Ml/d.

Worth 1 is a fairly sinuous reach which falls ~20m over 2.0km, a slope of 0.6°. Riparian tree cover is scattered to continuous over the entire reach. Where the channel is visible, channel widths have been measured ~5m. With the exception of exposed boulders few in-channel features are visible. Bed substrate upstream is dominated by cobbles.

Visible channel surfaces indicate that smooth flow predominates, although broken flow is frequent, particularly towards the end of the reach. Rippled flow dominated upstream. A riffle-pool sequence is assumed to present in Worth 1. Vegetation types and bank erosion suggests that banks are composed of earth. Surrounding land use is predominantly improved grassland with some rough pasture. Suburban/urban land use increases slightly towards the end of the reach prior to the confluence with Bridgehouse Beck.

The reach comprises both high and low energy environments, as indicated by the shallow gradient and sinuous planform. Flow variation is likely to be present in the more sinuous parts of the channel. However, few depositional features are evident from aerial photography, so it is likely some depositional features may be present in Worth 1. The presence of boulders and cobbles will provide habitat opportunities for fish and white-clawed crayfish. Discrete habitats suitable for spawning fish are likely to be present also, with riffles potentially present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter. The regular occurrence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide

sheltering opportunities. Breeding habitat for otter is not considered likely to be present in the reach due to an absence of extensive areas of woodland. The regular occurrence of riparian trees will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish is likely to be influenced by the presence of a couple of weirs in the reach.

The drought options reduction in flow could lead to several potential impacts within Worth 1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow for periods of time during the duration of drought option.
- Potentially major risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, and protrusion of bed elements (such as larger particles) through the flow surface for periods of time during the duration of drought option.
- Potentially major risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time duration of drought option, with changes to the range and abundance of flow types.
- Major risk to longitudinal connectivity from three weirs and at boulder dams for periods of time during the duration of the drought option.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in flow depth and velocity. This will lead to increased potential for the deposition of any fine sediment in transport. There may be increased fine grained deposition between the weirs within the reach. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Worth 1 from drought options is therefore assessed as major.

A4.8.5 River water quality

There is one water quality monitoring sites in Worth 1. As such the location, River Worth Above Conf Bridgehouse Beck (NE-49400825) has been used. The average pH between 2010-2020 was 7.8 with a maximum temperature of 16.7°C for the same period. There are no significant continuous or intermittent discharges either within Worth 1 or at risk from changes in flow in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Worth 1 as a result of drought options is presented in **Table A4.13**.

Table A4.13 Potential risks to water quality in Worth 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period. Slight seasonality was apparent.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Slight seasonality was apparent.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.029 mg/l) throughout the monitoring period however 41% of samples were below this status. Some seasonality was apparent with notable peaks in June/ August. It should be noted there is limited data for orthophoslate at this location.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Strong (limited data)
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Moderate risk from drought options associated with change in dilution of diffuse pollution pressures.

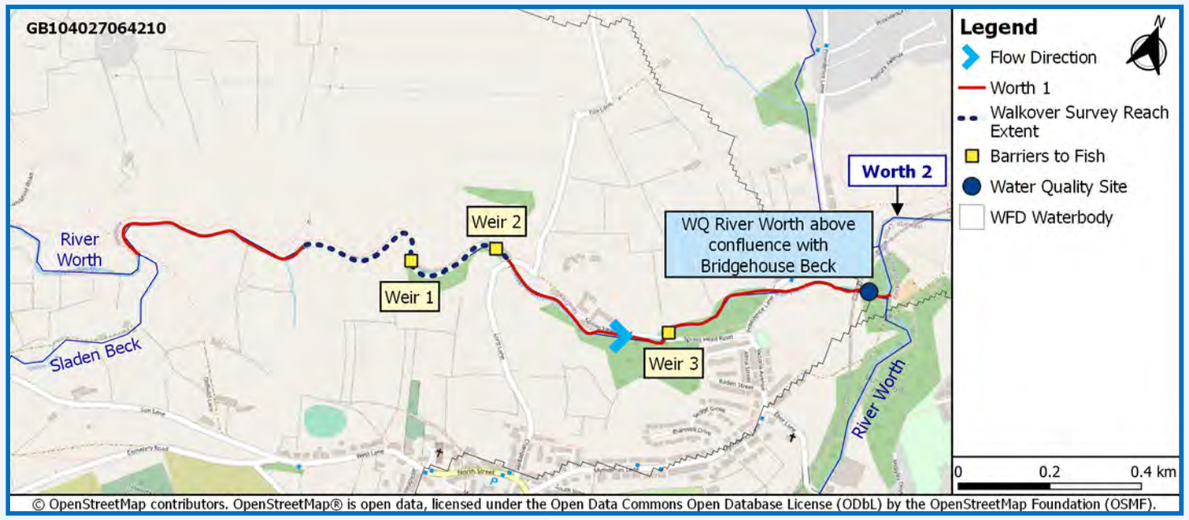
A4.8.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Worth 1 as a result of drought options is presented in **Table A4.14**.

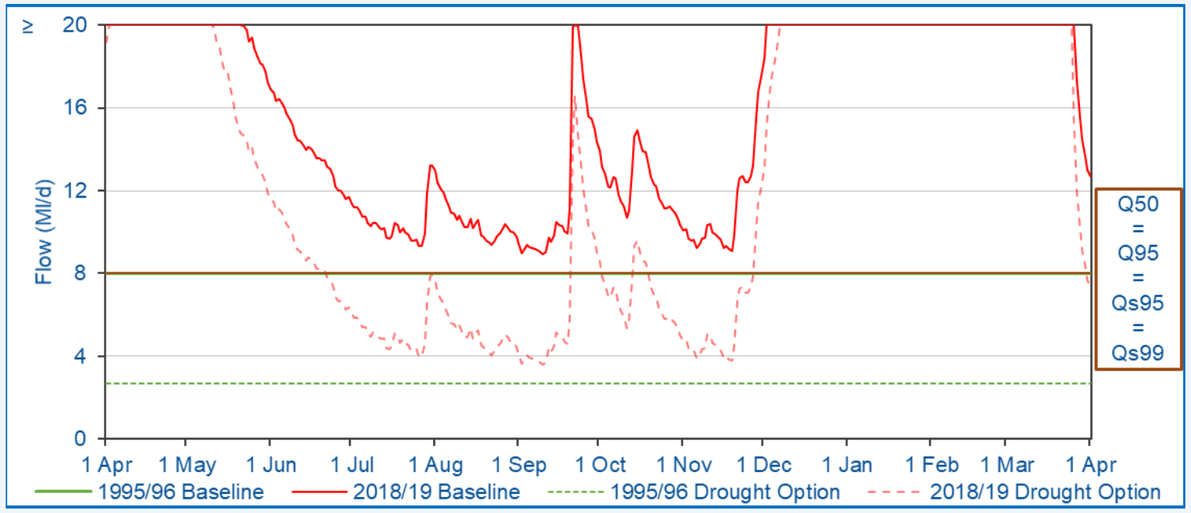
Table A4.14 Summary of potential changes in the physical environment of Worth 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Worth 1.
River habitats *Major risk*	• The major reduction in flow will change the energy of the system • Potential major risk of reduction in total wetted aquatic habitat in the reach, and major risk of changes in available habitat for different species requirements – noting a significant variety of wetted habitats are present. • Major risk to longitudinal connectivity • Moderate risk of change in sediment dynamics.
Water quality *Moderate risk*	• Reported ammonia and DO % water quality is predominantly consistent with 'Good' status and with no apparent flow sensitivity. SRP is predominantly attaining 'Moderate' status or lower with a strong flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting



River Flow Regime



Reach Setting Information:

The superficial geology of the reach is predominantly glacial till with alluvium underlying the reach and scattered glaciofluvial deposits. Soil types along the reach are composed predominantly of slowly permeable, seasonally wet acid loamy and clayey soils. Surrounding land use is predominantly improved grassland with some rough pasture. Suburban/urban land use increases slightly towards the end of the reach prior to the confluence with Bridgehouse Beck.

	Supplementary Information
Catchment Area at Assessment Point	19.5km^2
Mean Slope Gradient	0.6°
Length of Reach	2.0km
Additional Catchment Area	4.3km^2
Upstream Reach	Bridgehouse Beck 1
Downstream Reach	River Worth 2

-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	8.00	2.67	67	Summer Major
Q_s99	8.00	2.67	67	
Q95	8.00	2.67	67	Winter Major
Q50	8.00	2.67	67	

There are no significant flow additions/ reductions associated with this reach

River Habitats

River Water Quality

Significant Water Quality Pressures	Permit Conditions
Oxenhope WwTW E721 (SS) (continued risk from discharge in Bridgehouse Beck 1)	0.91 Ml/d DWF 1.63 Ml/d Daily Max 15 mg/l Ammonia (N) 50 BOD ATU

The average pH in this river is 7.8

The maximum temperature is 16.7

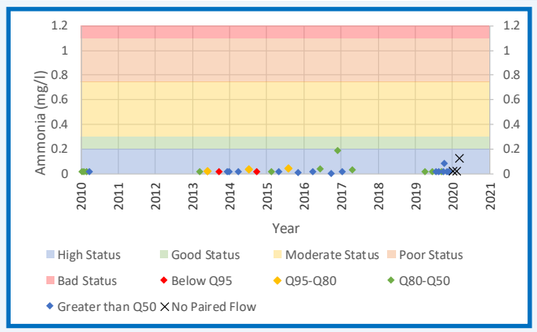
YorkshireWater

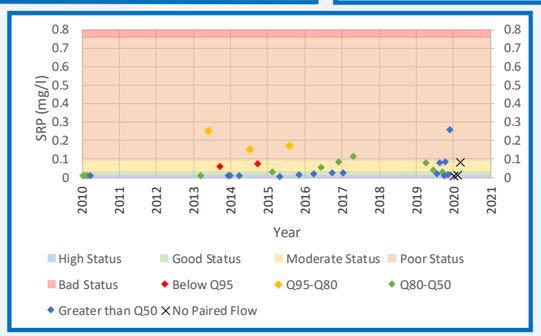
RICARDO

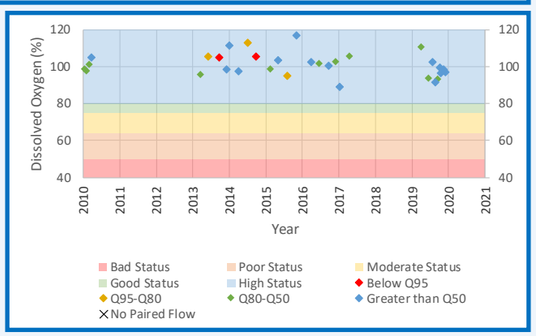
Figure A4.7

River Worth 1

Physical Environment Information







A4.9 Worth 2

A4.9.1 Reach introduction

Worth 2 is potentially impacted by the Springhead Weir Maintained Flow, Leeming Reservoir and Leeshaw Reservoir drought permits. A summary of physical environment information for this reach is provided in **Figure A4.8**. The reach includes part of the following river waterbody:

- Worth from Bridgehouse Beck to River Aire (GB104027062891).

A4.9.2 Reach setting

Worth 2, located on main EAR **Figure 4.2,** comprises a 7.2km stretch of the River Worth from the confluence with Bridgehouse Beck to the confluence with the River Aire (**Table A2.1**). This reach is affected by the combined impacts of the Springhead Weir Maintained Flow, Leeming Reservoir and Leeshaw Reservoir drought permits.

A4.9.3 River flow regime

River flow in Worth 2 is influenced by the Leeshaw Reservoir and Leeshaw Reservoir influenced flows of Bridgehouse Beck 1 and Spring Head Weir Maintained flow influenced flows of Worth 1. As such limited flow variability would be apparent during the implementation of North West Area drought options part-reflecting local hydrological response to rainfall conditions during the ongoing environmental drought.

Daily mean flows at the upstream end of this reach, immediately downstream of the Bridgehouse Beck 1 and Worth 1 confluence have been estimated using the Gustard flow transposition method. This is based on catchment parameter ratios and gauged flow data from an available downstream gauge at Keighley on the River Worth. Prior to applying the flow transposition, adjustments to the gauged flow data and catchment parameters were made to allow for the effects of the reservoirs and intake in the upper catchment. Daily reservoir outflows and maintained flows were then added back on to the estimated (transposed) data series. This enabled the creation of an estimated daily flow record for Worth 2 downstream of the Bridgehouse Beck 1 confluence covering the period 1990-2019 with moderate confidence.

The maximum combined flow reduction on the River Worth downstream of the Bridgehouse Beck 1 confluence, with all three drought permits in place, is therefore 9.35 Ml/d. Based on the estimated flow statistics for this reach, this represents a reduction of 51% and 58% in the summer Q95 and Q99 flow statistics, which is assessed as a major hydrological impact on this reach in summer and autumn months. The reduction in year-round Q95 and Q50 is 48% and 27% respectively, which is assessed as a major hydrological impact during winter months associated with winter refill periods.

The hydrological impact of drought options on Worth 2 is therefore assessed as **major** for a summer/ autumn period and **major** for any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Worth 2. There are no flow depleted reaches within Worth 2. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.9.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 31 August 2018 at an estimated river flow at the flow assessment point for the reach of 20.3Ml/d.

Worth 2 is a fairly sinuous reach which falls ~73m over 4.7km, a slope of 0.58°. Riparian tree cover is scattered to semi-continuous along the reach. The channel is between 4-7m in width. A range of in-channel features were identified from extant aerial imagery with 14 side bars (8 of which were vegetated), 5 mid-channel bars (3 of which were vegetated) and 1 point bar. Boulders were noted protruding through the flow throughout the reach. The visible channel surface indicates that smooth flow predominates, although 31 areas of broken flow were identified along the reach (it is likely that

these are riffles). Where banks are vegetated it is assumed that they are composed of earth. Bank reinforcement and re-sectioning is common in the mid and lower sections of the reach as the channel flows through Keighley. Surrounding land use is predominantly rough pasture and improved grassland for the initial 1.6km of the reach, with suburban/urban land use increasing as the channel flows through Keighley. There are also numerous ponds identified flanking the reach along its length.

Worth 2 is likely to support high and low energy flows, with depositional features present and the flow structure indicating a dominance of smooth flows with broken flow present. The larger coarse substrates and protruding boulders will provide habitat opportunities for fish and white-clawed crayfish (*Austropotamobius pallipes*), with discrete patches of finer substrate supporting spawning habitat for fish also considered likely to be present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter and the presence of reinforcement may provide additional habitat opportunities for both species. The semi-continuous occurrence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is not considered likely to be present in the reach. The regular occurrence of riparian trees will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is likely to be influenced by the presence of a number of weirs and culverts.

The reduction in flow could lead to several potential impacts within Worth 2:

- Major risk of changes in the energy of the system associated with up to 58% reduction in flow for periods of time during the duration of drought option.
- Potentially moderate risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars) and protrusion of bed elements (such as larger particles) through the flow surface for periods of time during the duration of drought option.
- Potentially moderate risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time during the duration of drought option, with changes to the range and abundance of flow types.
- Major risk to longitudinal connectivity from 16 noted in-channel structures for periods of time during the duration of drought option.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Worth 2 from drought options is therefore assessed as major.

A4.9.5 River water quality

There is one water quality monitoring sites in Worth 2. As such the location, River Worth Below Keighley (NE-49400828) has been used. The average pH between 2010-2020 was 8.0 with a maximum temperature of 17.7^{o}C for the same period. Water quality modelling identifies one continuous discharge, YWSL Oxenhope WwTW discharging in upstream Bridgehouse Beck 1, presenting a significant risk to both dissolved oxygen and total ammonia downstream in Worth 2. There is one frequently spilling CSO potential presenting an environmental risk in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Worth 2 as a result of drought options is presented in **Table A4.15**.

Table A4.15 Potential risks to water quality in Worth 2 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period with a single sample falling below this standard. Some seasonality was apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Strong seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were predominantly inconsistent with 'Good' WFD status (0.042 mg/l) throughout the monitoring period with 62% of samples falling below this standard. Some seasonality was apparent with notable peaks in June/ August.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Strong
WwTW presenting increased risk	Continued risk of medium-term chronic, regular, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) downstream of Oxenhope WwTW in Bridgehouse Beck 1.		None
Intermittent pressures presenting risk	Risk of short term acute, infrequent, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) locally downstream of one listed CSO during rainfall events.		None
Other point source pressures presenting risk	None	None	None
Summary	Moderate risk from drought options associated with CSO discharge and reduction in dilution of WwTW	Moderate risk from drought options associated with CSO discharge and reduction in dilution of WwTW	Moderate risk from drought options associated with change in dilution of diffuse pollution pressures.

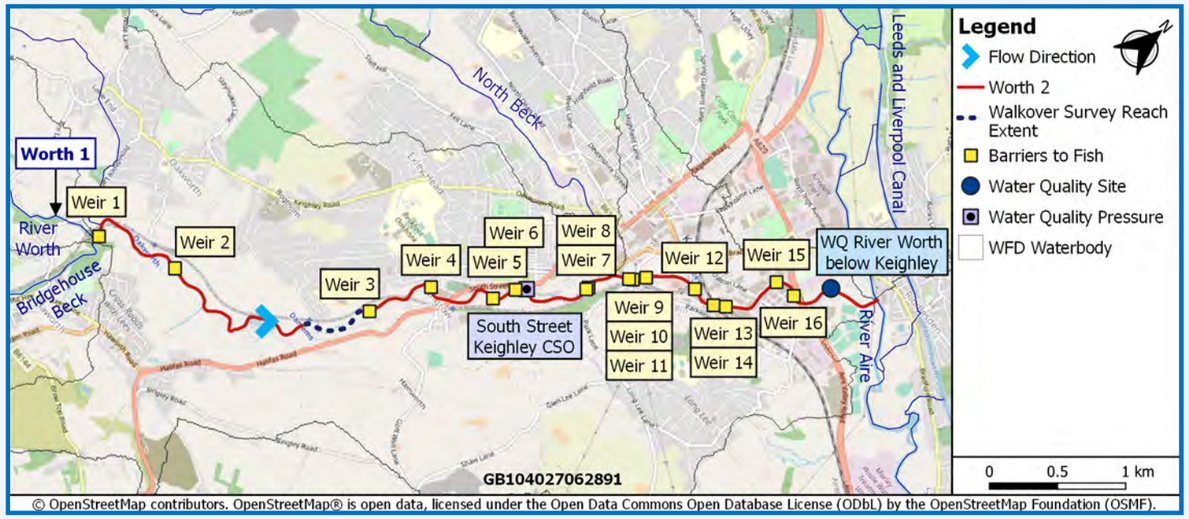
A4.9.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Worth 2 as a result of drought options is presented in **Table A4.16**.

Table A4.16 Summary of potential changes in the physical environment of Worth 2 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 58% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Worth 2.
River habitats *Major risk*	• The major reduction in flow will change the energy of the system • Potential moderate risk of reduction in total wetted aquatic habitat in the reach, and moderate risk of changes in available habitat for different species requirements – noting a significant variety of wetted habitats are present. • Major risk to longitudinal connectivity • Moderate risk of change in sediment dynamics.
Water quality *Moderate risk*	• Continued risk of medium-term chronic, regular, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) downstream of Oxenhope WwTW (which discharges to Bridgehouse Beck 1). • Risk of short term acute, infrequent, temporary water quality pressures locally downstream of one listed CSO during rainfall events. • Reported ammonia and DO % water quality is predominantly consistent with 'Good' status and with only weak flow sensitivity. SRP is predominantly attaining 'Moderate' status or lower with a strong flow sensitivity

Reach Setting

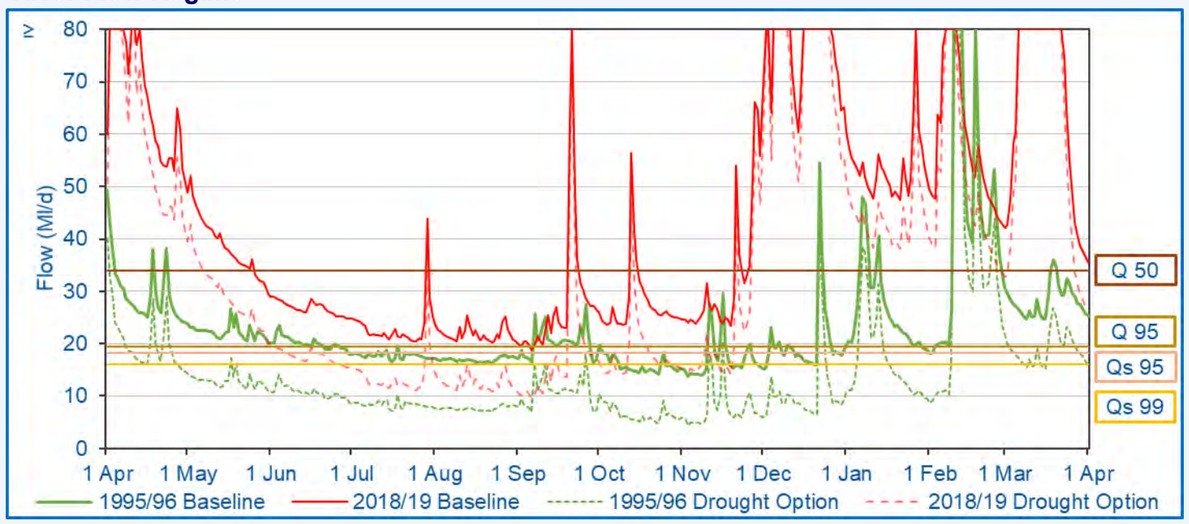


Reach Setting Information:

The superficial geology is composed of alluvium along the channel path and surrounded by glacial till. Extensive alluvial fan deposits are located around the confluence with the River Aire at Keighley. Soil types along the reach are composed predominantly of slowly permeable, seasonally wet acid loamy and clayey soils with some freely draining, slightly acid loamy soils around the confluence with the River Aire. Suburban/urban land use increases as the channel flows through Keighley.

	Supplementary Information
Catchment Area at Assessment Point	42.9km^2
Mean Slope Gradient	0.58^o
Length of Reach	7.2km
Additional Catchment Area	31.1km^2
Upstream Reach	Bridgehouse Beck 1/ River Worth 2
Downstream Reach	N/A

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	18.30	8.95	51	Summer Major
Q_s99	16.14	6.78	58	
Q95	19.44	10.09	48	Winter Major
Q50	34.02	24.67	27	

There are no significant flow additions/ reductions associated with this reach

River Habitats

River Water Quality

Significant Water Quality Pressures	Permit Conditions
South Street Keighley CSO WRA8110 A1	Intermittent discharge
Oxenhope WwTW E721 (SS) (continued risk from discharge in Bridgehouse Beck 1)	0.91 Ml/d DWF 1.63 Ml/d Daily Max 15 mg/l Ammonia (N)

The average pH in this river is 8.0

The maximum temperature is 17.7^{o}C

YorkshireWater

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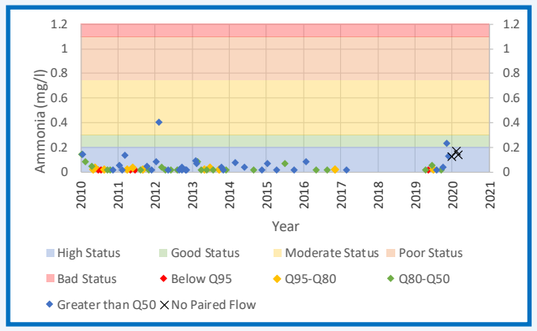
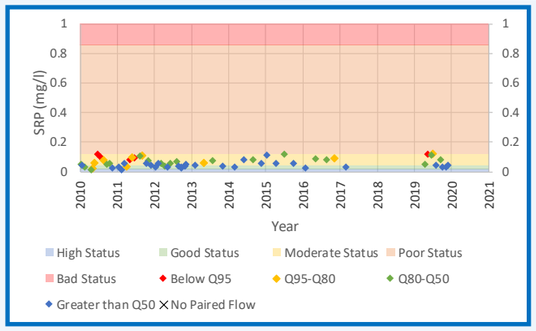
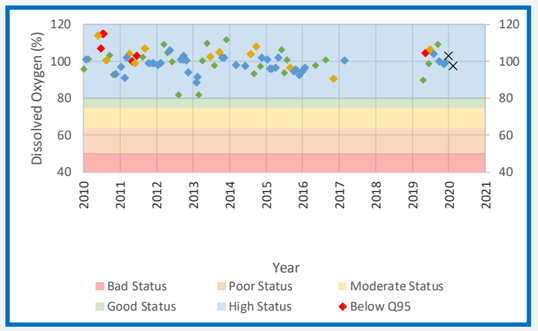
Figure A4.8

River Worth 2

Physical Environment Information







A4.10 Denholme Beck 1

A4.10.1 Reach introduction

Denholme Beck 1 is potentially impacted by a Doe Park Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.9**. The reach includes part of the following river waterbody:

- Harden Beck from Source to River Aire (GB104027062870).

A4.10.2 Reach setting

Denholme Beck 1, located on main EAR **Figure 4.2,** comprises a 1.6 km stretch of Denholme Beck from the Doe Park Reservoir outflow down to the inflow into Hewenden Reservoir (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 1.3km^2 along the length of the reach. Harden Beck 1 (see **Section A4.11** below) is downstream.

A4.10.3 River flow regime

During the implementation of North West Area drought options, storage in Doe Park Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 0.60Ml/d in the statutory compensation release rate of 1.80Ml/d represents a 33% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 33% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of drought options on Denholme Beck 1 is therefore assessed as **major** for both a summer/ autumn period and any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Denholme Beck 1. There are no flow depleted reaches in Denholme Beck 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.10.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 29 August 2018 at a reservoir outflow of 1.8Ml/d.

Denholme Beck 1 is fairly sinuous reach which falls ~20m over 1.6km, a slope of 0.7°. Riparian tree cover is scattered to isolated in the upper section of the reach, trending to continuous towards the end of the reach. The channel is between ~3-5m in width, at the YWSL water baseline monitoring site channel width is 5.16m. In-channel features were limited with a single side bar identified. Boulders were noted protruding through the flow throughout the reach with very few areas of broken flow visible. Rippled flow dominated the YWSL water baseline monitoring site. Bed substrate is dominated by pebble/gravel (45%), however areas of cobble (30%), boulder (15%) and sand (10%) were also observed at the YWSL water baseline monitoring site. Bank erosion is visible throughout the first 0.8km of the reach. Noting the vegetation and bank erosion it is likely that most banks are composed of earth. Bank reinforcement and re-sectioning has not been noted. Surrounding land use is predominantly rough pasture with broadleaf woodland dominating the final 0.4km of the channel prior to the inflow to Hewenden Reservoir.

Due to an absence of RHS information, only limited conclusions can be drawn as to habitat availability for Denholme Beck 1. The site is likely to comprise both high and low energy environments, as indicated by the sinuous planform of the watercourse and presence of erosional and depositional features. The presence of boulders in the watercourse and likely coarse substrate present will provide habitat opportunities for fish and white-clawed crayfish. Discrete habitat suitable for spawning fish is likely to be present also, with riffles potentially present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter. The regular occurrence of trees in the lower end of the

riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter could be present at the lower end of the reach, with extensive woodland with thick understory present that would be capable of concealing a natal den. The regular occurrence of riparian trees will also provide allochthonous energy into the watercourse at the lower end, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish is likely to be influenced by the presence of a weir in the reach.

The reduction in flow could lead to several potential impacts within Denholme Beck 1:

- Major risk of changes in the energy of the system associated with up to 33% reduction in flow for duration of drought option.
- Potentially moderate risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bed elements (such as larger particles) through the flow surface for duration of drought option.
- Potentially moderate risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option.
- Moderate risk to longitudinal connectivity noting one weir.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Denholme Beck 1 from drought options is therefore assessed as moderate.

A4.10.5 River water quality

There are no water quality monitoring points in Denholme Beck 1, as such the next location in the downstream reach (Harden Beck 1), Harden Beck at Harden (NE-49400457), has been used. The average pH between 2010-2020 was 7.9 with a maximum temperature of 16.9°C for the same period. There are no significant continuous or intermittent discharges into Denholme Beck 1. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Denholme Beck 1 as a result of drought options is presented in **Table A4.17**.

Table A4.17 Potential risks to water quality in Denholme Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period. Some seasonality was apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period with four below this standard. Some seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were not consistent with 'Good' WFD status (0.041 mg/l) throughout the monitoring period with all samples falling below this standard. Some seasonality was apparent.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Weak (but limited data)
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

A4.10.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Denholme Beck 1 as a result of drought options is presented in **Table A4.18**.

Table A4.18 Summary of potential changes in the physical environment of Denholme Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 33% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Denholme Beck 1.
River habitats *Moderate risk*	• The major reduction in flow will change the energy of the system • Potential moderate risk of reduction in total wetted aquatic habitat in the reach, and moderate risk of changes in available habitat for different species requirements – noting that dominant flow types will be retained. • Moderate risk to longitudinal connectivity • Moderate risk of change in sediment dynamics.
Water quality *Minor risk*	• Reported water quality is consistent with 'Good' status for dissolved oxygen and ammonia, but not phosphate and no more than weak flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

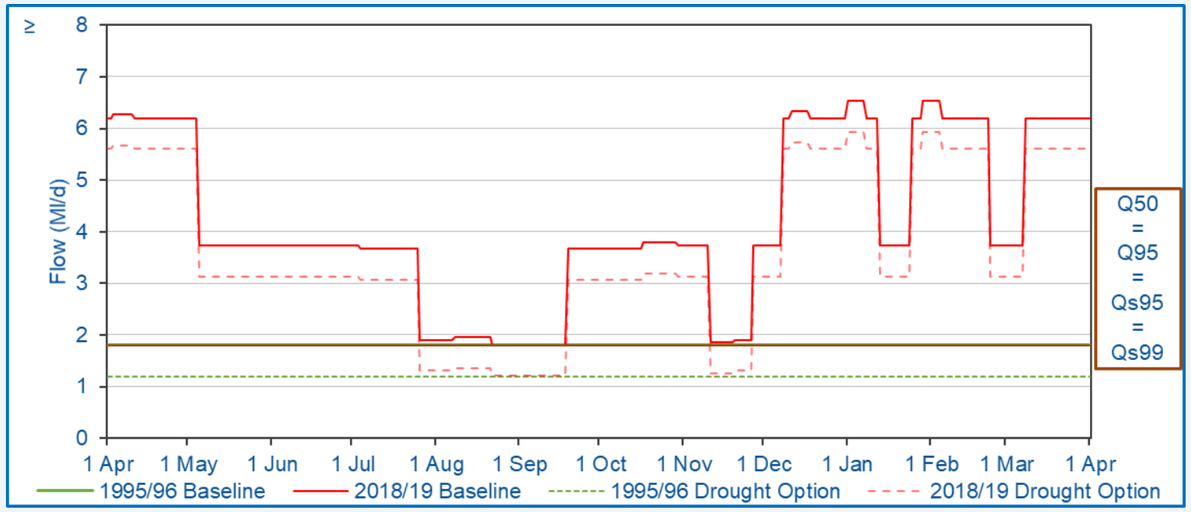
Reach Setting

Reach Setting Information:

The superficial geology is limited with only glacial till and some hummocky glacial deposits identified around the reservoir. Soils in the reservoir catchment are predominantly composed of a mixture of freely draining, slightly acid loamy soils around the reservoir and slowly permeable, wet, very acid upland soils in the remainder of the catchment. Urbanisation is very limited with a small group of houses located at ~0.3km and a farm located at ~0.8km downstream.

	Supplementary Information
Catchment Area at Assessment Point	8.0km^2
Mean Slope Gradient	0.7°
Length of Reach	1.6km
Additional Catchment Area	1.3km^2
Upstream Reach	N/A
Downstream Reach	N/A

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	1.80	1.20	33	Summer Major
Q_s99	1.80	1.20	33	
Q95	1.80	1.20	33	Winter Major
Q50	1.80	1.20	33	

There are no significant flow additions/ reductions associated with this reach

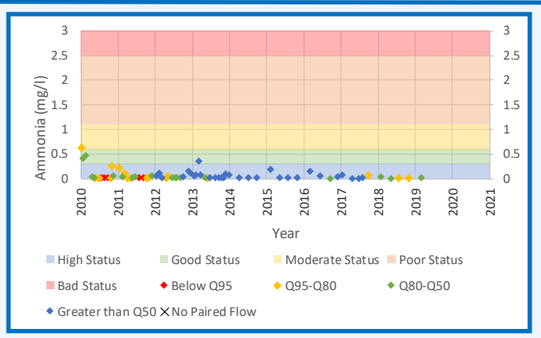
River Habitats

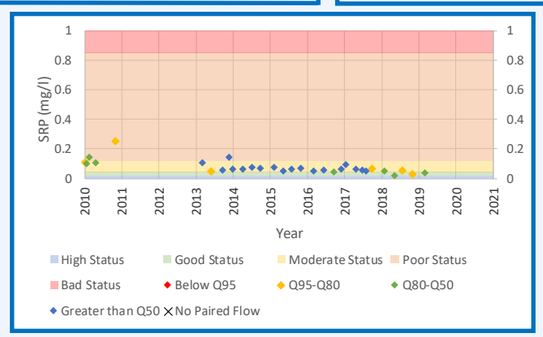
River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this river is 7.9

The maximum temperature is 16.9°C





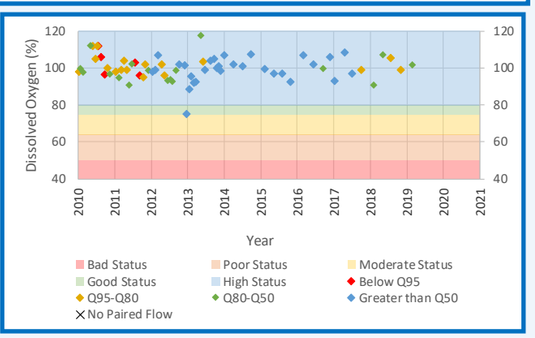


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Figure A4.9

Denholme Beck 1

Physical Environment Information

A4.11 Harden Beck 1

A4.11.1 Reach introduction

Harden Beck 1 is potentially impacted by a Hewenden Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.10**. The reach includes part of the following river waterbody:

- Harden Beck from Source to River Aire (GB104027062870).

A4.11.2 Reach setting

Harden Beck 1, located on main EAR **Figure 4.2,** comprises a 6.3km stretch of the Hewenden Beck and Harden Beck from the Hewenden Reservoir outflow down to the confluence with the River Aire (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 21.9km^2 along the length of the reach.

A4.11.3 River flow regime

During the implementation of North West Area drought options, storage in Hewenden Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 4.22Ml/d in the statutory compensation release rate of 6.3Ml/d represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of drought options on Harden Beck 1 is therefore assessed as **major** for both a summer/ autumn period and any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Harden Beck 1. There are no flow depleted reaches in Harden Beck 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.11.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 27 September 2018 at a reservoir outflow of 7.0Ml/d.

Harden Beck 1 is fairly sinuous reach which falls ~123m over 6.3km, a slope of 1.1°. Riparian tree cover ranges from scattered in the upper reaches to continuous in the mid reaches and semi-continuous in the lower reaches. The channel is only visible on extant aerial imagery for several small sections due to riparian tree cover. Channel width was measured as ~5m in the upper sections of the reach and increasing to 8-9m in the lower reaches prior to the confluence. Due to the limited visibility of the channel, few in-channel features could be identified with the exception of 3 side bars (1 of which was vegetated) and boulders protruding through the channel surface. No in-channel depositional features were observed at the RHS sites. Channel banks are steep (>45°) and are dominated by earth, however some sections observed were comprised of boulders (80% of the left bank at site 32105 within the lower reach). The upper reach has been re-sectioned and reinforced, limited bank erosion was visible in the lower section of the reach. In the few places where the channel surface was visible the flow surface was a mixture of smooth, rippled and broken flow. Bed substrate was coarse, with boulder and cobbles dominating with small amounts of silt in the upstream reaches. Surrounding land use is predominantly rough pasture and broadleaf woodland in the upper sections. The reach flows through extensive broadleaf woodland (Goitstock Wood and Crag Wood) between 1.1km and 2.9km downstream. Thereafter land use is predominantly improved grassland and rough pasture with some coniferous woodland. A golf course flanks the right bank of the channel during the last 1.0km of the reach.

Suburban/urban land use is mostly limited to individual buildings along the reach, although the largest concentration occurs when the channel flows past Harden.

Harden Beck 1 is likely to support a mixture of high and low energy environments, as indicated by the identified flow types and presence of some depositional features. The larger coarse substrates and protruding boulders will provide habitat opportunities for fish and white-clawed crayfish, with discrete patches of finer substrate supporting spawning habitat for fish. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter and the presence of reinforcement, albeit limited, may provide additional habitat opportunities for both species. The regular occurrence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is potentially present with the extensive woodland potentially containing suitable features to support breeding otter. The regular occurrence of riparian trees will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is likely to be influenced by the presence of a number of weirs and naturally as a result of two waterfalls in the reach.

The reduction in flow could lead to several potential impacts within Harden Beck 1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow for duration of drought option.
- Potentially moderate risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bed elements (such as larger particles) through the flow surface for duration of drought option.
- Potentially moderate risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option.
- Minor risk to longitudinal connectivity noting the presence of both weirs and waterfalls in the reach.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Harden Beck 1 from drought options is therefore assessed as moderate.

A4.11.5 River water quality

There are 3 water quality monitoring points in Harden Beck 1, as such the location with the highest data quality, Harden Beck at Harden (NE-49400457), has been used. The average pH between 2010-2020 was 7.9 with a maximum temperature of 16.9^{o}C for the same period. Water quality modelling identifies one continuous discharge, YWSL Harecroft WwTW, presenting a significant risk to both dissolved oxygen and total ammonia downstream from the WwTW for the remainder of the reach. There are no intermittent discharges either within Harden Beck 1 or at risk from changes in flow in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential

risks to water quality in Harden Beck 1 as a result of drought options is presented in **Table A4.19**.

Table A4.19 Potential risks to water quality in Harden Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period. Some seasonality was apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period with four below this standard. Some seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.085 mg/l) throughout the monitoring period with 21% of samples falling below this standard. Some seasonality was apparent.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	None apparent
WwTW presenting increased risk	Risk of medium-term chronic, regular, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) downstream of Harecroft WwTW.		None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Moderate risk from drought options associated with reduction in dilution of WwTW	Moderate risk from drought options associated with reduction in dilution of WwTW	Minor risk from drought options

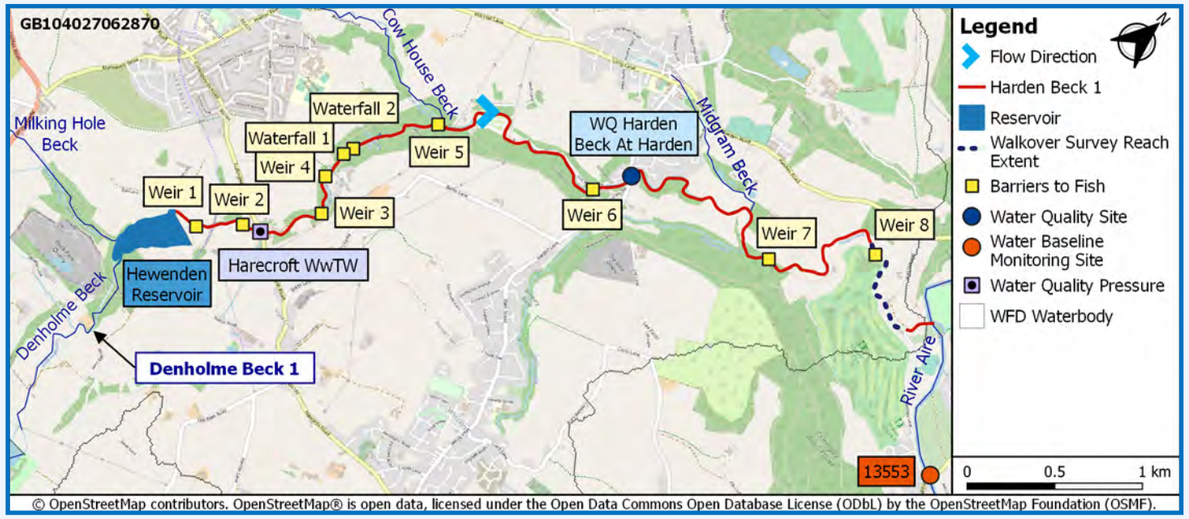
A4.11.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Harden Beck 1 as a result of drought options is presented in **Table A4.20**.

Table A4.20 Summary of potential changes in the physical environment of Harden Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Harden Beck 1.
River habitats *Moderate risk*	• The major reduction in flow will change the energy of the system • Potential moderate risk of reduction in total wetted aquatic habitat in the reach, and moderate risk of changes in available habitat for different species requirements – noting that dominant flow types will be retained. • Minor risk to longitudinal connectivity • Moderate risk of change in sediment dynamics.
Water quality *Moderate risk*	• Risk of medium-term chronic, regular, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) downstream of Harecroft WwTW. There are no intermittent water quality pressures identified as presenting increased risk with drought options implemented. • Reported results are predominantly consistent with 'Good' status and with only weak flow sensitivity.

Reach Setting

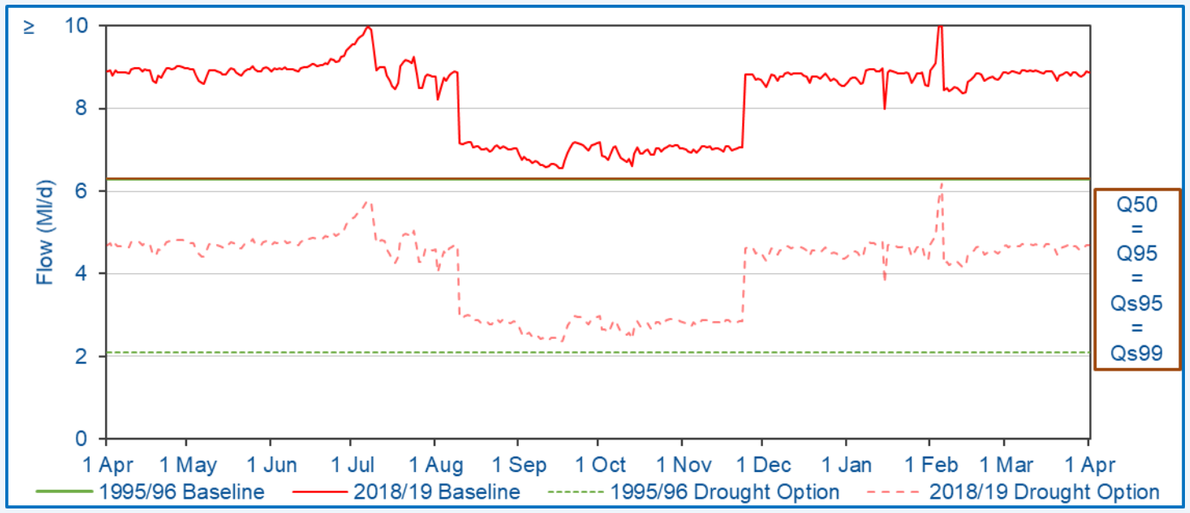


Reach Setting Information:

The superficial geology is composed of alluvium in the lower sections of the channel and surrounded by glacial till with some scattered hummocky glacial deposits. River terrace deposits are present prior to the confluence with the River Aire. Soil types are composed of freely draining, slightly acid loamy soils in the upper section of the reach and slowly permeable, seasonally wet acid loamy and clayey soils to the confluence with the River Aire. Urbanisation is limited.

	Supplementary Information
Catchment Area at Assessment Point	12.0km^2
Mean Slope Gradient	1.1°
Length of Reach	6.3km
Additional Catchment Area	21.9km^2
Upstream Reach	N/A
Downstream Reach	N/A

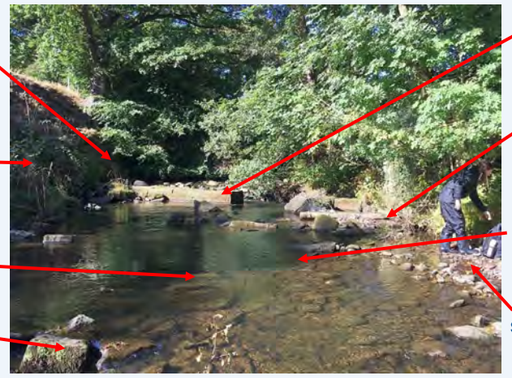
River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	6.30	2.08	67	Summer Major
Q_s99	6.30	2.08	67	
Q95	6.30	2.08	67	Winter Major
Q50	6.30	2.08	67	

There are no significant flow additions/ reductions associated with this reach

River Habitats

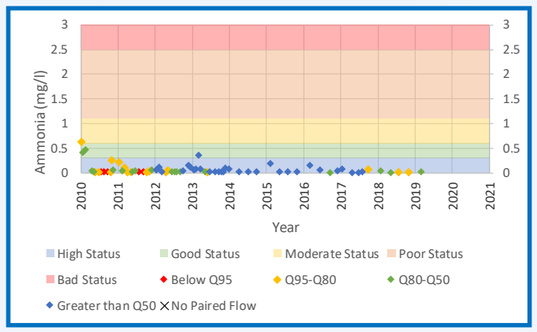


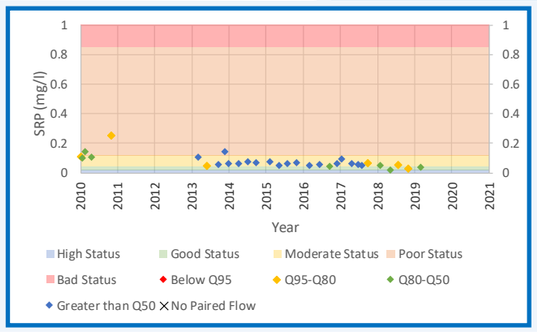
River Water Quality

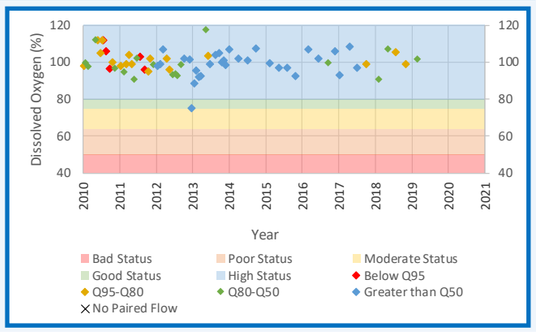
Significant Water Quality Pressures	Permit Conditions
Harecroft WwTW E717	0.02 Ml/d

The average pH in this river was 7.9

The maximum temperature was 16.9°C







YorkshireWater

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Figure A4.10

Harden Beck 1

Physical Environment Information

A4.12 Loadpit Beck 1

A4.12.1 Reach introduction

Loadpit Beck 1 is potentially impacted by an Eldwick Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.11**. The reach includes part of the following river waterbody:

- River Aire (River Worth to Gill Beck) (GB104027063034).

A4.12.2 Reach setting

Loadpit Beck 1, located on main EAR **Figure 4.2,** comprises a 3.4 km stretch of the Loadpit Beck from the Eldwick Reservoir outflow down to the confluence with the River Aire (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 5.3km^2 along the length of the reach. Aire 1 (see **Section A4.16** below) is downstream.

A4.12.3 River flow regime

During the implementation of North West Area drought options, storage in Eldwick Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 0.67Ml/d in the statutory compensation release rate of 1.0Ml/d represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of drought options on Loadpit Beck 1 is therefore assessed as **major** for both a summer/autumn period and any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Loadpit Beck 1. There are no flow depleted reaches in Loadpit Beck 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.12.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 28 September 2018 at a reservoir outflow of 1.2Ml/d.

Loadpit Beck 1 is fairly straight reach which falls ~125m over 3.4km, a slope of 2.1°. Riparian tree cover is semi-continuous to continuous along the reach. Channel width is measured at ~2m in the upstream reaches and 7m in the lower reaches. Upstream the bed substrate is dominated by pebbles/gravels (65%), however areas of cobble (15%), sand (15%) and boulders (5%), with coarser bedload comprised largely of cobbles and boulders, observed downstream. Exposed boulders were observed in the channel (70%). Rippled flow dominated the upper reaches, with rippled, chute and smooth flows as well as small areas of free flow, observed in the downstream reaches. Within the RHS survey, 2 pools and 6 riffles were observed, as well as three unvegetated point bars. Banks are steep and largely comprised of earth, however areas of brick, boulder and cobbles were also observed. At the RHS site, poaching was observed on the right bank (10%). Reinforcement of the channel banks was observed at the RHS site and is likely to occur further where the channel is near urban areas, particularly between 0.7-1.3km downstream as the channel flows through the outskirts of Eldwick. Surrounding land use is mixture of rough pasture and improved grassland in the upper sections of the reach, with suburban/urban land use between 0.7-1.3km downstream as the channel flows through Eldwick, and predominantly broadleaf woodland for the remaining 2.1km of the reach. Some suburban/urban land use is present on the left bank immediately prior to the confluence with the River Aire.

The site is likely to be dominated by the presence of high energy environments, as indicated by the relatively straight planform and gradient of the watercourse, however low energy environments are likely

to also be present. The coarse substrate likely to dominate the reach will provide habitat opportunities for fish and white-clawed crayfish. Discrete habitat suitable for spawning fish is likely to be present also, with riffles present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter and any reinforced banks may also provide opportunities. The extensive presence of trees in the lower end of the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter could be present in the lower reaches of the watercourse with extensive woodland present. The extensive occurrence of riparian trees will also provide allochthonous energy into the watercourse at the lower end, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish is likely to be influenced by the presence of a couple of weirs in the reach.

The reduction in flow could lead to several potential impacts within Loadpit Beck 1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow for duration of drought option.
- Potentially major risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bed elements (such as larger particles) through the flow surface for duration of drought option at very low flows.
- Potentially major risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option at very low flows.
- Major risk to longitudinal connectivity noting several weirs.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Loadpit Beck 1 from drought options is therefore assessed as major.

A4.12.5 River water quality

There is one water quality monitoring point in Loadpit Beck 1, as such, Loadpit Beck at Confluence with River Aire (NE-49400555), has been used. It should be noted the data it highly limited for this reach. The average pH between 2010-2020 was 7.8 with a maximum temperature of 16.6^{o}C for the same period. There are no significant continuous or intermittent discharges into Loadpit Beck 1. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Loadpit Beck 1 as a result of drought options is presented in **Table A4.21**.

Table A4.21 Potential risks to water quality in Loadpit Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were consistent with 'Good' WFD status (0.6 mg/l) throughout the monitoring period. Data is too limited to identify seasonality.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Weak seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.053 mg/l) throughout the monitoring period. Data is too limited to identify seasonality.
Flow sensitivity (diffuse pollution)	None apparent – limited data	None apparent – limited data	None apparent – limited data
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

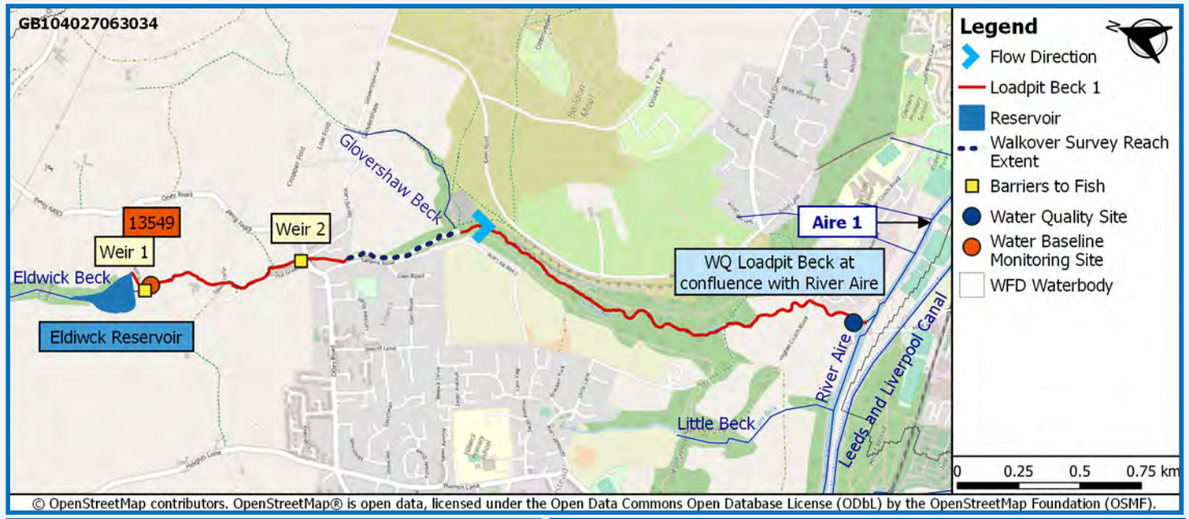
A4.12.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Loadpit Beck 1 as a result of drought options is presented in **Table A4.22**.

Table A4.22 Summary of potential changes in the physical environment of Loadpit Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Loadpit Beck 1.
River habitats *Major risk*	• The major reduction in flow to very low flows will change the energy, habitat availability and connectivity of the system.
Water quality *Minor risk*	• Reported water quality is consistent with 'Good' status and no apparent flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting

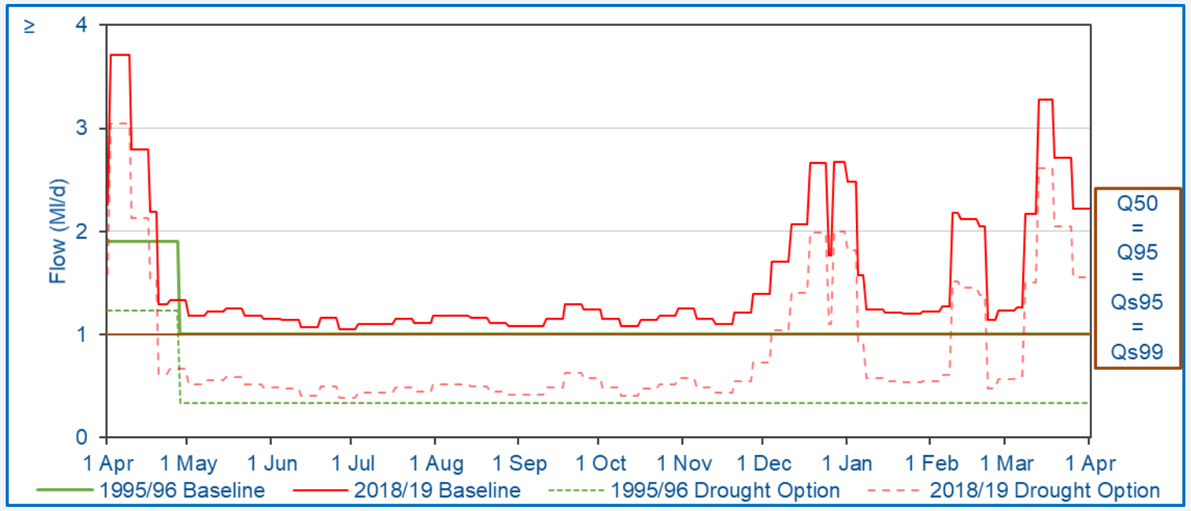


Reach Setting Information:

The superficial geology is composed of glacial till with some scattered hummocky glacial deposits around the confluence with the River Aire. Soil types in the reach are composed of slowly permeable, seasonally wet acid loamy and clayey soils. Urbanisation is very limited throughout the reach with the reach passing through Eldwick and a small urban development on the left bank prior to the confluence with the River Aire.

	Supplementary Information
Catchment Area at Assessment Point	3.5km^2
Mean Slope Gradient	2.1°
Length of Reach	3.4km
Additional Catchment Area	5.3km^2
Upstream Reach	N/A
Downstream Reach	River Aire 2

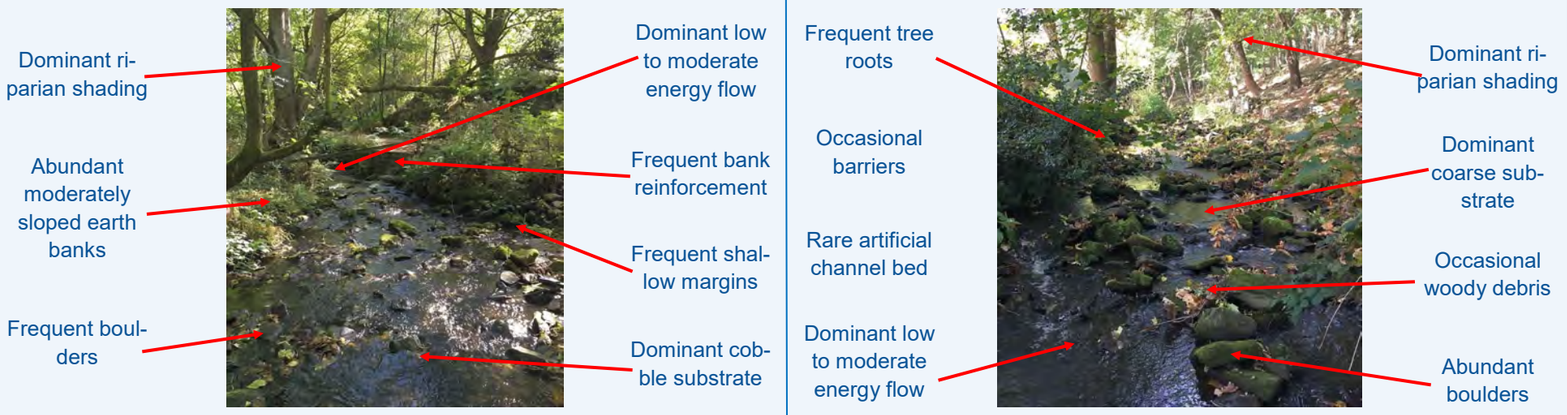
River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	1.00	0.33	67	Summer Major
Q_s99	1.00	0.33	67	
Q95	1.00	0.33	67	Winter Major
Q50	1.00	0.33	67	

There are no significant flow additions/ reductions associated with this reach

River Habitats

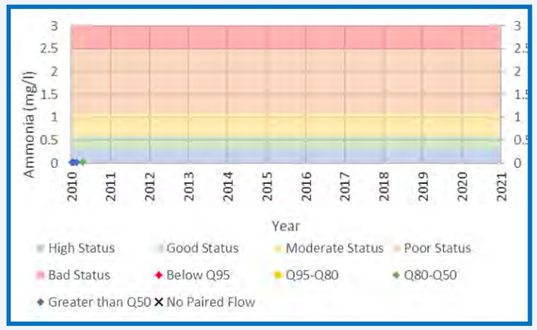


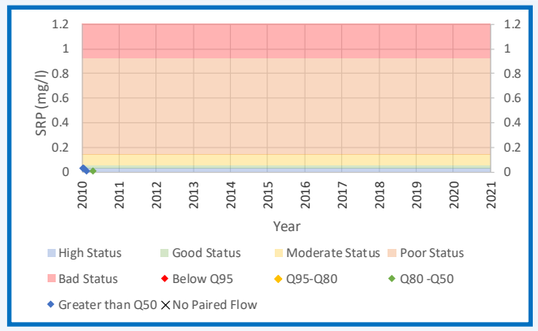
River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this river was 7.8

The maximum temperature was 16.6°C





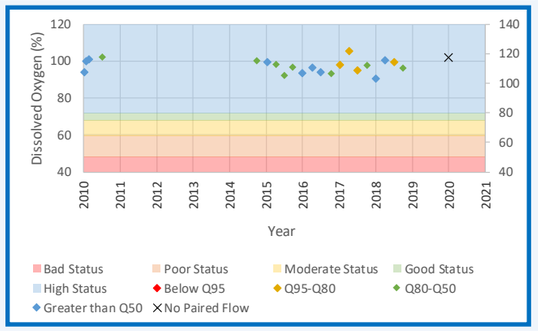


Figure A4.11
Loadpit Beck 1
Physical Environment Information

A4.13 Gill Beck 1

A4.13.1 Reach introduction

Gill Beck 1 is potentially impacted by a Weecher Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.12**. The reach includes part of the following river waterbody:

- Gill Beck (Baildon) from Source to River Aire (GB104027062940).

A4.13.2 Reach setting

Gill Beck 1, located on main EAR **Figure 4.2,** comprises a 2.4 km stretch of the Gill Beck from the Weecher Reservoir outflow down to the confluence with the Jum Beck (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 5.8km^2 along the length of the reach. Gill Beck 2 (see **Section A4.14** below) is downstream.

A4.13.3 River flow regime

During the implementation of North West Area drought options, storage in Weecher Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 0.29Ml/d in the statutory compensation release rate of 0.43Ml/d represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of drought options on Gill Beck 1 is therefore assessed as **major** for both a summer/autumn period and any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Gill Beck 1. There are no flow depleted reaches in Gill Beck 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.13.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 30 August 2018 at a reservoir outflow of 0.4Ml/d.

Gill Beck 1 is fairly sinuous reach which falls ~131m over 2.4km, a slope of 3.1°. Riparian tree cover ranges from no tree cover to isolated cover in the upper sections of the reach to continuous in the lower section of the reach. Only the upper section of the channel is visible due to tree cover in the lower section. Where visible, the channel is very narrow, being ~0.6-1.5m wide. No in-channel features were visible and the channel surface indicates that flow is predominantly smooth. However, due to the steepness of the channel some broken flow is likely. Vegetation and bank form suggests that banks are composed of earth. No bank reinforcement was observed. Surrounding land use is mixture of moorland heath, rough pasture and improved grassland in the upper sections of the reach, broadleaf woodland in the lower sections of the reach.

Gill Beck 1 is likely to be dominated by high energy environments, as indicated by the steep gradient of the watercourse, although low energy environments are also likely to be present. The coarse substrate likely to be present in the watercourse will provide habitat opportunities for fish and white-clawed crayfish, with discrete patches of finer substrate supporting spawning habitat for fish also considered likely to be present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter. The regular occurrence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is likely to be present within the reach, with extensive woodland present in the middle part of the reach. The regular occurrence of riparian trees will also provide

allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is unlikely to be anthropogenically influenced, as there are no weirs in the reach.

The reduction in flow could lead to several potential impacts within Gill Beck 1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow for duration of drought option.
- Potentially major risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bed elements (such as larger particles) through the flow surface for duration of drought option at very low flows.
- Potentially major risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option at very low flows.
- Major risk to longitudinal connectivity due to steep nature of channel.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Gill Beck 1 from drought options is therefore assessed as major.

A4.13.5 River water quality

There is one sample point in this reach, Gill Beck at Potter Brow Bridge (NE-49405107), however the data is highly limited, as such the first location in the downstream reach (Gill Beck 2), Gill Beck (Baildon) At Otley Road Bridge (NE-49400999), has been used. The average pH between 2010-2020 was 7.8 with a maximum temperature of 15.1°C for the same period. There are no significant continuous or intermittent discharges into Gill Beck 1. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Gill Beck 1 as a result of drought options is presented in **Table A4.23**.

Table A4.23 Potential risks to water quality in Gill Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were consistent with 'Good' WFD status (0.6 mg/l) throughout the monitoring period. Some seasonality was apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (60%) throughout the monitoring period. Some seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.053 mg/l) throughout the monitoring period with two samples below this status. Some seasonality was apparent with notable peaks in June/ August.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Strong
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Moderate risk from drought options associated with change in dilution of diffuse pollution pressures.

A4.13.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Gill Beck 1 as a result of drought options is presented in **Table A4.24**.

Table A4.24 Summary of potential changes in the physical environment of Gill Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Gill Beck 1.
River habitats *Major risk*	• The major reduction in flow to very low flows will change the energy, habitat availability and connectivity of the system.
Water quality *Moderate risk*	• Reported ammonia and DO % water quality is predominantly consistent with 'Good' status and with only weak flow sensitivity. SRP is predominantly attaining 'Good' status with a strong flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

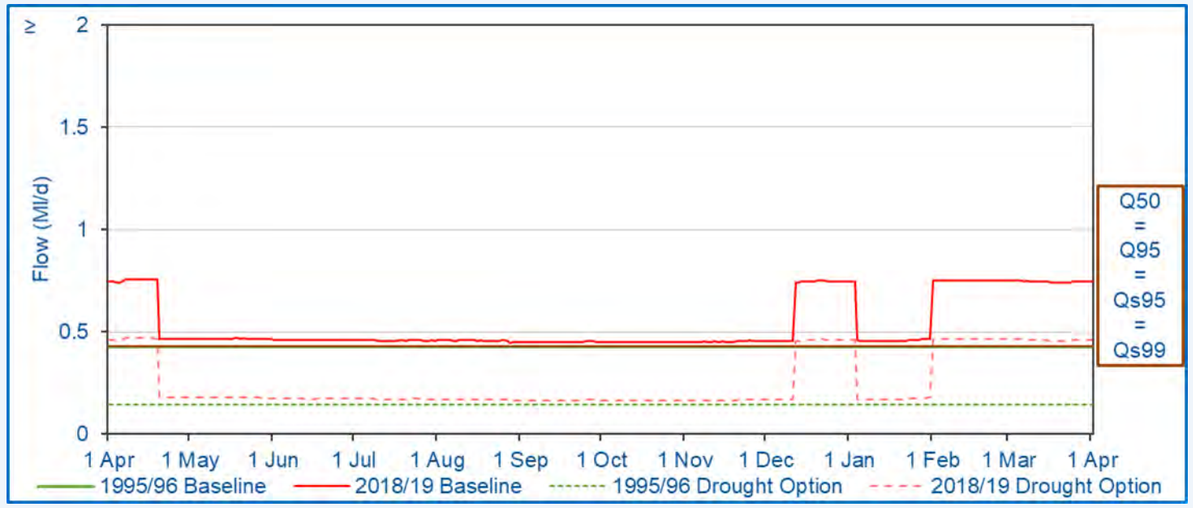
Reach Setting

Reach Setting Information:

The superficial geology is composed of glacial till with some alluvium beneath the reach and scattered hummocky glacial deposits. Soil types in the reach are composed of slowly permeable, seasonally wet acid loamy and clayey soils adjacent to the reservoir outflow and freely draining, slightly acid loamy soils to the end of the reach. There is very limited urbanisation along the reach.

	Supplementary Information
Catchment Area at Assessment Point	1.3km^2
Mean Slope Gradient	3.1°
Length of Reach	2.4km
Additional Catchment Area	5.8km^2
Upstream Reach	N/A
Downstream Reach	Gill Beck 2

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	0.43	0.14	67	Summer Major
Q_s99	0.43	0.14	67	
Q95	0.43	0.14	67	Winter Major
Q50	0.43	0.14	67	

There are no significant flow additions/ reductions associated with this reach

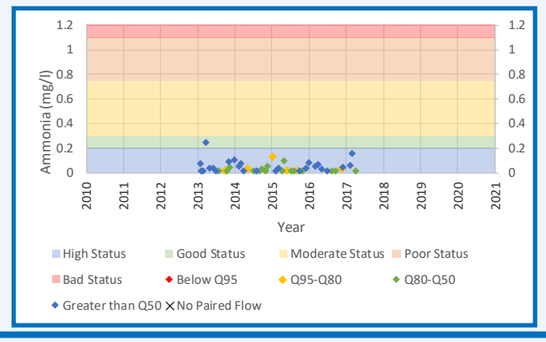
River Habitats

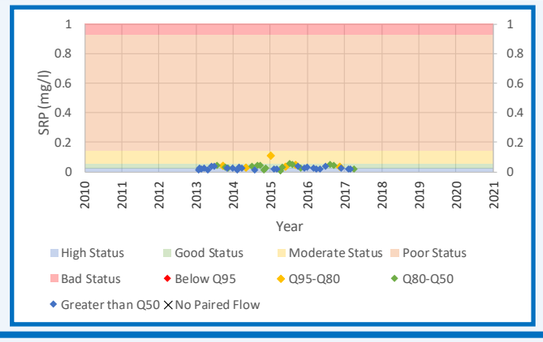
River Water Quality

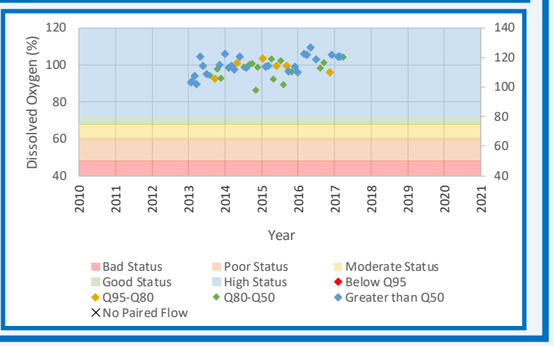
There are no significant water quality pressures associated with this reach

The average pH in this river was 7.8

The maximum temperature is 15.1°C







YorkshireWater

RICARDO

Figure A4.12

Gill Beck 1

Physical Environment Information

A4.14 Gill Beck 2

A4.14.1 Reach introduction

Gill Beck 2 is potentially impacted by a Weecher Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.13**. The reach includes part of the following river waterbody:

- Gill Beck (Baildon) from Source to River Aire (GB104027062940).

A4.14.2 Reach setting

Gill Beck 2, located on main EAR **Figure 4.2,** comprises a 4.0 km stretch of the Gill Beck from the Jum Beck confluence down to the confluence with the River Aire (**Table A2.1**). This reach is affected by the Weecher Reservoir drought permit. Aire 2 (see **Section A4.17** below) is downstream.

A4.14.3 River flow regime

River flow in Gill Beck 2 is influenced by the Weecher Reservoir influenced flows of Gill Beck 1 and the reservoir Jum Beck. As such limited flow variability would be apparent during the implementation of North West Area drought options part-reflecting local hydrological response to rainfall conditions during the ongoing environmental drought.

Daily mean flows at the upstream end of this reach, immediately downstream of the Gill Beck 1 and Jum Beck confluence have been estimated using the Gustard flow transposition method. There is no gauged flow data available for Gill Beck, so flows at the upstream end of this reach have been estimated using the Gustard flow transposition method, based on catchment parameter ratios and gauged flow data from an available downstream gauge at Armley on the River Aire. Prior to applying the flow transposition, adjustments to the gauged flow data and catchment parameters were made to allow for the effects of the reservoir in the upper catchment. Daily reservoir outflows were then added back on to the estimated (transposed) data series. Adjustments to Gill Beck catchment parameters were also made to reflect the influence of the reservoirs in the upper catchment (including a small privately owned reservoir, New Dam, which is not known to have any compensation flow and is believed to be no longer in use). Daily reservoir outflows from the Weecher Reservoir were then added back on to the estimated (transposed) data series. This enabled the creation of an estimated daily flow record for Gill Beck 2 downstream of the Gill Beck 1 and Jum Beck confluence covering the period 1990-2019 with moderate to low confidence.

The maximum flow reduction flow passed forward from Gill Beck 1 during implementation of the drought options is 0.29 Ml/d. This represents a reduction of 14% and 18% in the summer Q95 and Q99 flow statistics, which is assessed as a moderate hydrological impact on this reach in summer and autumn months. The reduction in year-round Q95 and Q50 is 13% and 3.7% respectively, which is assessed as a minor hydrological impact during winter months associated with winter refill periods.

The hydrological impact of drought options on Gill Beck 2 is therefore assessed as **moderate** for both a summer/ autumn period and any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Gill Beck 2. There are no flow depleted reached in Gill Beck 2. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.14.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 6 September 2018 at an estimated river flow at the flow assessment point of 3.2Ml/d.

Gill Beck 2 is fairly straight reach which falls ~107m over 4.0km, a slope of 1.5°. Riparian tree cover is semi-continuous to continuous along the reach. Only small sections of the channel are visible on aerial imagery. At these sections the channel is ~3m in width, at the YWSL water baseline monitoring site,

channel widths are 1.22m. Only one mid channel bar is visible and the visible channel surface indicates a mixture of smooth and broken flow. At the YWSL water baseline monitoring site, rippled flow dominated (50%). Bed substrate was dominated by cobble (35%), however areas of pebble/gravel (30%), boulder (25%) and sand (10%) were also observed at the YWSL water baseline monitoring site. Where banks are vegetated it is assumed that they are composed of earth. Bank reinforcement is observed at one location ~1.0km downstream where a caravan park flanks the left river bank. Surrounding land use is mixture of improved grassland, rough pasture and broadleaf woodland throughout much of the reach. Suburban/urban land use is limited to a caravan park on the left bank, ~1.0km downstream and an industrial complex at ~3.2km downstream. Open water is also present on the right side of the reach at ~2.8km downstream. There is scattered parkland and garden land use in the lower section of the reach, mainly from a cricket pitch and golf course.

Gill Beck 2 is likely to support a mixture of high and low energy environments, as indicated by the presence of depositional features and likely flow structure identified. The coarse substrate likely to be present in the watercourse will provide habitat opportunities for fish and white-clawed crayfish, with discrete patches of finer substrate supporting spawning habitat for fish also considered likely to be present. The soft earth banks are suitable for the creation of burrows by white-clawed crayfish and otter and the presence of reinforcement, albeit limited, may provide additional habitat opportunities for both species. The extensive presence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is likely to be present within the reach, with extensive woodland present in the upper part of the reach. The extensive presence of riparian trees will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is likely to be influenced by the presence of a single weir in the reach.

The reduction in flow could lead to several potential impacts within Gill Beck 2:

- Moderate risk of changes in the energy of the system associated with up to 18% reduction in flow for periods of time during the duration of drought option.
- Potentially major risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars) and protrusion of bed elements (such as larger particles) through the flow surface for periods of time during the duration of drought option, noting the retention of an overall variable flow pattern.
- Potentially major risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time during the duration of drought option.
- Moderate risk to longitudinal connectivity, noting one weir, for periods of time during the duration of drought option, noting the retention of an overall variable flow pattern.
- Minor risk of changes in sediment dynamics for periods of time during the duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Gill Beck 2 from drought options is therefore assessed as major.

A4.14.5 River water quality

There is one sample location in Gill Beck 2, as such Gill Beck (Baildon) At Otley Road Bridge (NE-49405107), has been used. The average pH between 2010-2020 was 7.8 with a maximum temperature of 15.1°C for the same period. There are no significant continuous or intermittent discharges into Gill Beck 2. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Gill Beck 2 as a result of drought options is presented in **Table A4.25**.

Table A4.25 Potential risks to water quality in Gill Beck 2 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were consistent with 'Good' WFD status (0.6 mg/l) throughout the monitoring period. Some seasonality was apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (60%) throughout the monitoring period. Some seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.053 mg/l) throughout the monitoring period with two samples below this status. Some seasonality was apparent with notable peaks in June/ August.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Strong
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Moderate risk from drought options associated with change in dilution of diffuse pollution pressures.

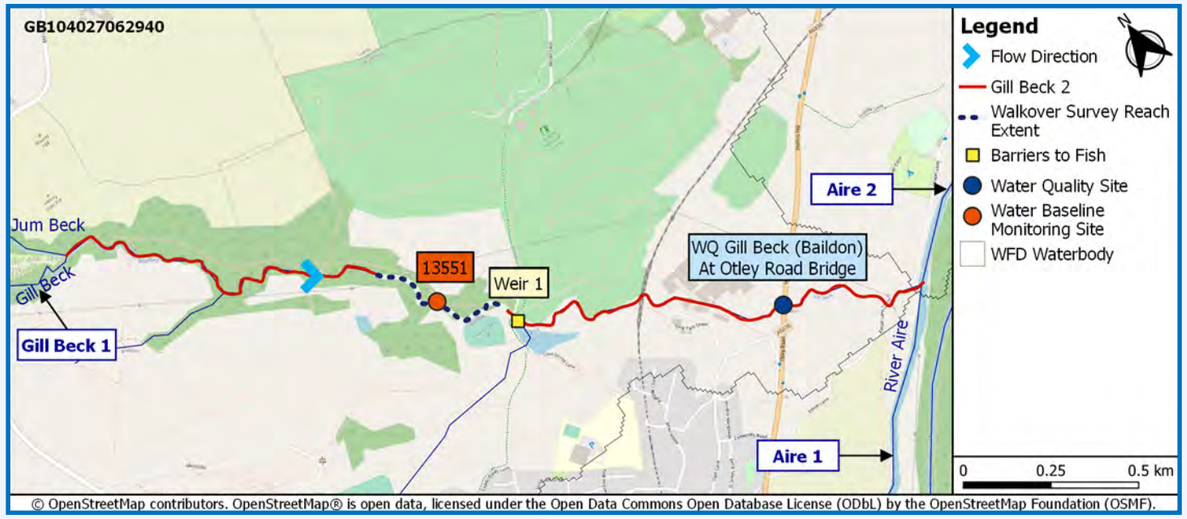
A4.14.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Gill Beck 2 as a result of drought options is presented in **Table A4.26**.

Table A4.26 Summary of potential changes in the physical environment of Gill Beck 2 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Moderate impacts (summer/autumn)* *Minor impacts (winter)*	• Reductions of up to 18% in summer/autumn river flows throughout the reach.
Flow depleted reaches *None*	• There are no flow depleted reaches within Gill Beck 2.
River habitats *Major risk*	• The moderate summer/autumn and minor winter reduction in flow will present moderate changes to the energy of the system • Potential major risk of reduction in total wetted aquatic habitat in the reach, and major risk of changes in available habitat for different species requirements – noting a significant variety of wetted habitats are present. • Moderate risk to longitudinal connectivity • Minor risk of change in sediment dynamics.
Water quality *Moderate risk*	• Reported ammonia and DO % water quality is predominantly consistent with 'Good' status and with only weak flow sensitivity. SRP is predominantly attaining 'Good' status with a strong flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting

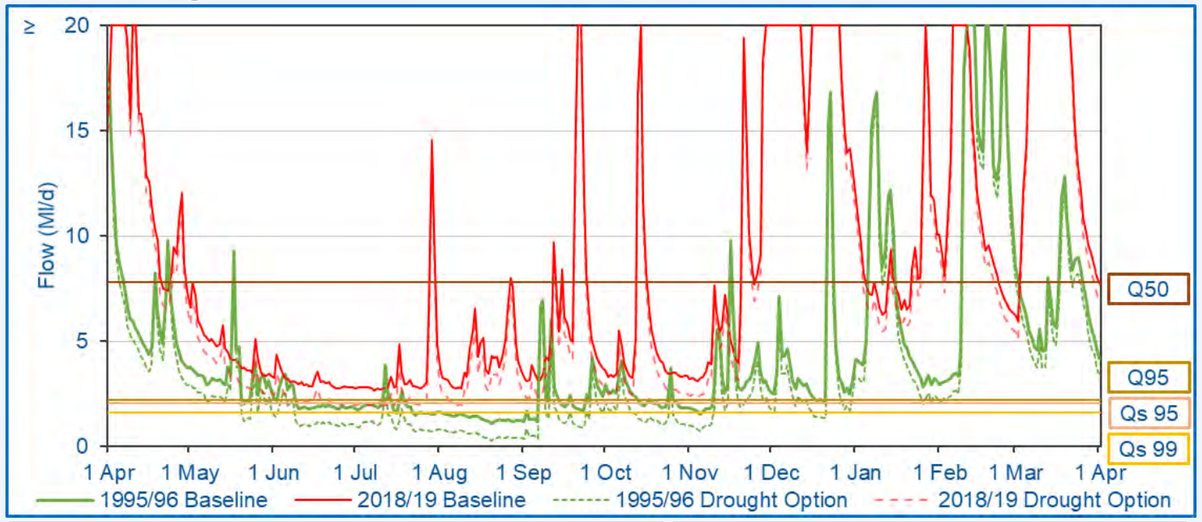


Reach Setting Information:

The superficial geology is composed of glacial till with some alluvium beneath the reach and scattered hummocky glacial deposits. Soil types in the reach are composed of freely draining, slightly acid loamy soils with slowly permeable, seasonally wet acid loamy and clayey soils around the confluence with the River Aire. Suburban/urban land use is limited to a caravan park on the left bank, ~1.0km downstream and an industrial complex at ~3.2km downstream.

	Supplementary Information
Catchment Area at Assessment Point	8.3km^2
Mean Slope Gradient	1.5°
Length of Reach	4.0km
Additional Catchment Area	5.6km^2
Upstream Reach	Gill Beck 1
Downstream Reach	River Aire 2

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	2.03	1.74	14	Summer Moderate
Q_s99	1.61	1.32	18	
Q95	2.20	1.91	13	Winter Minor
Q50	7.79	7.50	3.7	

There are no significant flow additions/ reductions associated with this reach

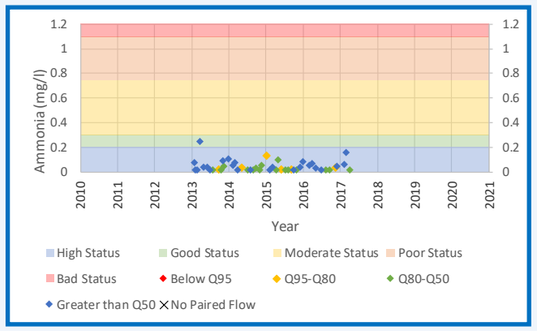
River Habitats

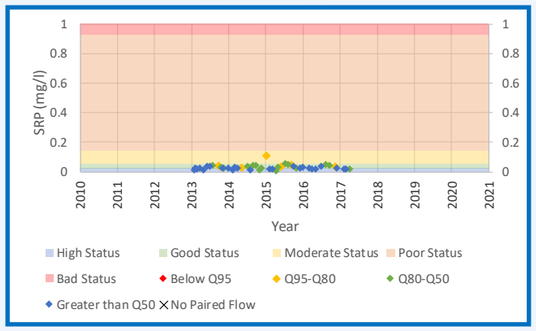
River Water Quality

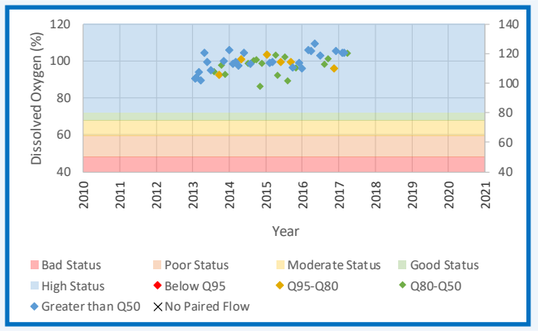
There are no significant water quality pressures associated with this reach

The average pH in this reach was between 7.8

The maximum temperature was 15.1°C







YorkshireWater

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Figure A4.13

Gill Beck 2

Physical Environment Information

A4.15 Jum Beck 1

A4.15.1 Reach introduction

Jum Beck 1 is potentially impacted by a Reva Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.14**. The reach includes part of the following river waterbody:

- Gill Beck (Baildon) from Source to River Aire (GB104027062940).

A4.15.2 Reach setting

Jum Beck 1, located on main EAR **Figure 4.2,** comprises a 1.0 km stretch of the Jum Beck from the Reva Reservoir outflow down to the inflow to the New Dam Reservoir (**Table A2.1**). The reach is dominated by reservoir outflows.

A4.15.3 River flow regime

During the implementation of North West Area drought options, storage in Reva Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 0.53Ml/d in the statutory compensation release rate of 0.79Ml/d represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of drought options on Jum Beck 1 is therefore assessed as **major** for both a summer/ autumn period and any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Jum Beck 1. There are no flow depleted reached in Jum Beck 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.15.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 6 September 2018 at a reservoir outflow of 1.0Ml/d.

Jum Beck 1 is fairly straight reach which falls ~18m over 1.0km, a slope of 1.0°. Riparian tree cover is scattered to semi-continuous along the reach. The channel is very narrow and cannot be reliably measured where visible, although width is estimated at <1m, at the YWSL water baseline monitoring site channel width is 0.42m. No in-channel features or flow types can be identified. Flow at the YWSL water baseline monitoring site was dominated by rippled flow, and bed substrate was of sand grade (85%), however areas of cobble (10%) and pebble/gravel (5%) was also observed. Due to the size of the channel it is inappropriate to suggest bank materials as such a small channel may be wholly reinforced. However, due to the size of the channel anthropogenic modification cannot be observed. Surrounding land use is predominantly improved grassland with some broadleaf woodland around the inflow to New Dam Reservoir. Suburban/urban development is limited to a farm located ~0.9km downstream on the right bank.

In the absence of RHS information for Jum Beck 1, only limited conclusions can be drawn as to habitat availability. The reach is likely to support both high and low energy flows, as is typical with watercourses with a low gradient. The habitat is likely to support features providing cover/refuge for fish, however its presence above the New Dam reservoir could inhibit the presence of species. The presence of spawning habitat in a reach such as this is considered unlikely. The bank materials, be it soft earth of reinforced, is likely to provide habitat opportunities for both otter and white-clawed crayfish. The regular occurrence of trees in the riparian corridor will provide habitat opportunities for fish, through the provision of cover, white-clawed crayfish in the root structure of any trees on the edge of the

watercourse and for otter where holt potential or voids provide sheltering opportunities. Breeding habitat for otter is only potentially present at the southern end of the reach in woodland surrounding New Dam Reservoir. The regular occurrence of riparian trees will also provide allochthonous energy into the watercourse, which will be reflected in the macroinvertebrate population composition. The movement of sediment, fish and white-clawed crayfish through the reach is unlikely to be influenced anthropogenically, due to an absence of weirs, however their access into the reach from downstream could be restricted.

The reduction in flow could lead to several potential impacts within Jum Beck 1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow for duration of drought option.
- Potentially major risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bed elements (such as larger particles) through the flow surface for duration of drought option at very low flows.
- Potentially major risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option at very low flows.
- Major risk to longitudinal connectivity.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Jum Beck 1 from drought options is therefore assessed as major.

A4.15.5 River water quality

There are no sampling locations in Jum Beck 1, as such the next downstream sampling located in Gill Beck 2, Gill Beck (Baildon) At Otley Road Bridge (NE-49400999), has been used as a representative example. The average pH between 2010-2020 was 7.8 with a maximum temperature of 15.1°C for the same period. There are no significant continuous or intermittent discharges into Jum Beck 1. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Jum Beck 1 as a result of drought options is presented in **Table A4.27**.

Table A4.27 Potential risks to water quality in Jum Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were consistent with 'Good' WFD status (0.6 mg/l) throughout the monitoring period. Some seasonality was apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (60%) throughout the monitoring period. Some seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were predominantly consistent with 'Good' WFD status (0.053 mg/l) throughout the monitoring period with two samples below this status. Some seasonality was apparent with notable peaks in June/ August.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Strong
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Moderate risk from drought options associated with change in dilution of diffuse pollution pressures.

A4.15.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Jum Beck 1 as a result of drought options is presented in **Table A4.28**.

Table A4.28 Summary of potential changes in the physical environment of Jum Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Jum Beck 1.
River habitats *Major risk*	• The major reduction in flow to very low flows will change the energy, habitat availability and connectivity of the system.
Water quality *Moderate risk*	• Reported ammonia and DO % water quality is predominantly consistent with 'Good' status and with only weak flow sensitivity. SRP is predominantly attaining 'Good' status with a strong flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

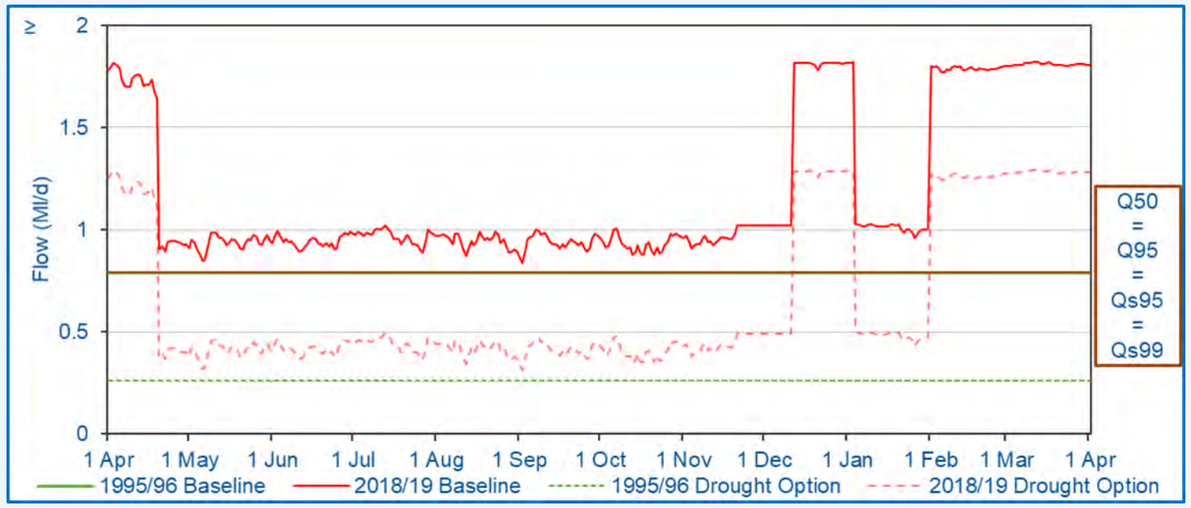
Reach Setting

Reach Setting Information:

The superficial geology around the reservoir is composed of glacial till and some hummocky glacial deposits. Soils in the reservoir catchment are predominantly composed of slowly permeable, seasonally wet, acid loamy and clayey soils. Suburban/urban development is limited to a farm located ~0.9km downstream on the right bank.

	Supplementary Information
Catchment Area at Assessment Point	Unavailable on FEH
Mean Slope Gradient	1.0°
Length of Reach	1.0km
Additional Catchment Area	Unavailable on FEH
Upstream Reach	N/A
Downstream Reach	N/A

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	0.79	0.26	67	Summer Major
Q_s99	0.79	0.26	67	
Q95	0.79	0.26	67	Winter Major
Q50	0.79	0.26	67	

There are no significant flow additions/ reductions associated with this reach

River Habitats

River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this river was 7.8

The maximum temperature was 15.1°C

YorkshireWater

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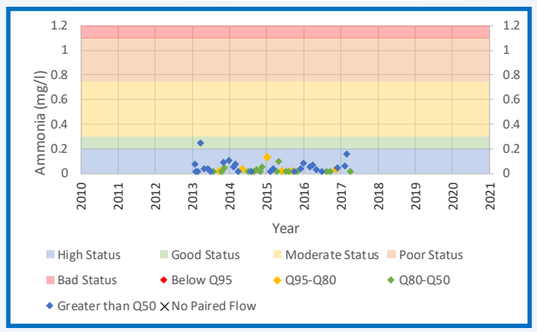
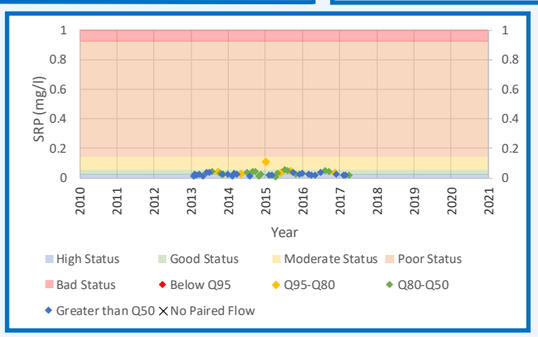
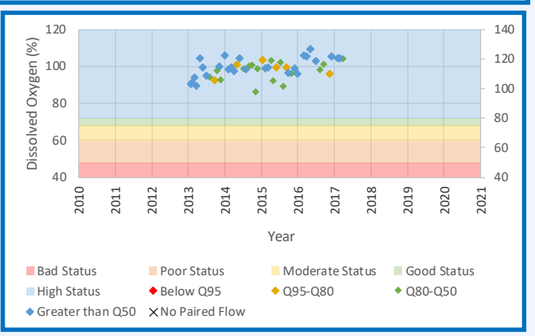
Figure A4.14

Jum Beck 1

Physical Environment Information







A4.16 Aire 1

A4.16.1 Reach introduction

Aire 1 is potentially impacted by an Eldwick Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.15**. The reach includes part of the following river waterbody:

- River Aire (River Worth to Gill Beck) (GB104027063034).

A4.16.2 Reach setting

Aire 1, located on main EAR **Figure 4.2,** comprises a 4.7 km stretch of the River Aire from the confluence with Loadpit Beck down to the confluence with Gill Beck (**Table A2.1**). This reach is affected by the drought options at Springhead Weir maintained flow, Leeming Reservoir, Leeshaw Reservoir, Hewenden Reservoir and Eldwick Reservoir. Aire 2 (see **Section A4.17** below) is downstream.

A4.16.3 River flow regime

River flow in Aire 1 is influenced by the semi-natural flows on the upstream River Aire, including the reservoir influenced flows of many tributaries. As such some flow variability would be apparent during the implementation of North West Area drought options part-reflecting local hydrological response to rainfall conditions during the ongoing environmental drought.

Daily mean flows at the upstream end of this reach, immediately downstream of the Loadpit Beck 1 confluence have been estimated using the Gustard flow transposition method. This is based on catchment parameter ratios and gauged flow data from an available downstream gauge at Armley. Prior to applying the flow transposition, adjustments to the gauged flow data were made to allow for the effects of effluent discharges from Marley WwTW and Esholt WwTW. Daily mean discharges from the WwTWs, estimated as the dry weather flow (DWF) where daily data was not available, were subtracted from the daily mean gauged flows before applying the flow transposition. Adjustments to the catchment parameters and gauged flows were also made to allow for the influence of a number of reservoirs upstream of the gauge. The Marley daily discharge was then added back to the transposed flow estimates for this reach (as the Marley WwTW is upstream of the Loadpit Beck confluence with the River Aire), along with the daily reservoir outflows from all reservoirs upstream of the River Aire/Loadpit Beck confluence. All other abstractions and discharges upstream of the Armley gauging station were below the threshold of 5% of the Q99 flow statistic, and were therefore excluded from the adjustment process. This enabled the creation of an estimated daily flow record for the River Aire downstream of the Loadpit Beck 1 confluence covering the period 1990-2019 with moderate to high confidence.

The maximum combined flow reduction on the River Aire downstream of the Loadpit Beck 1 confluence, with all seven drought permits in place, is therefore 16.64 Ml/d. Based on the estimated flow statistics for this reach, this represents a reduction of 13% and 19% in the summer Q95 and Q99 flow statistics, which is assessed as a moderate hydrological impact on this reach in summer and autumn months. The reduction in year-round Q95 and Q50 is 12% and 3.1% respectively, which is assessed as a minor hydrological impact during winter months associated with winter refill periods.

The hydrological impact of drought options on Aire 1 is therefore assessed as **moderate** for a summer/autumn period and **minor** for any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Aire 1. There are no flow depleted reached in Aire 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.16.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 27 September 2018 at estimated river flow at the flow assessment point of 323Ml/d.

Aire 1 is fairly sinuous and falls ~9m over 4.7km, a slope of 0.1°. Riparian tree cover varies along the reach from none to semi-continuous. Channel width varies throughout the reach between 19-33m, at the RHS site 3275, channel width was recorded as 30m. Extant aerial imagery shows few in-channel features with only 3 unvegetated side bars noted. Channel substrate is likely to be coarse. The domain flow type is smooth, with some areas of riffle-pool sequence. It is expected that banks are composed of a wide range of materials, both natural and artificial, particularly as the channel flows through Shipley. Surrounding land use is a mixture of suburban/urban land use as the reach flows through Shipley, improved grassland and parkland and gardens with some deciduous woodland at the end of the reach.

The reduction in flow could lead to several potential impacts within Aire 1:

River habitats have been characterised at a whole reach scale. No additional information for a representative 500m reach has been surveyed.

- Negligible risk of changes in the energy of the system associated with up to 19% reduction in flow for periods of time during the duration of drought option.
- Potentially minor risk of reduction in wetted aquatic habitat (wetted depth reduction) within steep banks for periods of time during the duration of drought option, noting the retention of an overall variable flow pattern.
- Potentially minor risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time during the duration of drought option, noting the dominance of smooth flow.
- Negligible risk to longitudinal connectivity noting the two large weirs and the retention of an overall variable flow pattern.
- Negligible risk of changes in sediment dynamics . Reductions in discharge will lead to only temporary reductions in velocity that could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are also unlikely to be affected.

The overall risk to river habitats on Aire 1 from drought options is therefore assessed as minor.

A4.16.5 River water quality

There are three sample locations in Aire 1, the third location, Aire at Buck Bridge (NE-49400710), has been used due to its data quality. The average pH between 2010-2020 was 7.9 with a maximum temperature of 20.6°C for the same period. There are three frequently spilling CSOs potential presenting an environmental risk in the reach. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Aire 1 as a result of drought options is presented in **Table A4.29**.

Table A4.29 Potential risks to water quality in Aire 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were predominantly consistent with 'Good' WFD status (0.6 mg/l) throughout the monitoring period. Two values were below this status. Strong seasonality was apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Strong seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were predominantly inconsistent with 'Good' WFD status (0.066 mg/l) with 98% of results below this status across the monitoring period. Notably 75% of results meet 'Poor' status (0.168 mg/l). Strong seasonality is apparent.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Strong
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	Risk of short term acute, infrequent, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) locally downstream of three listed CSOs during rainfall events.		None
Other point source pressures presenting risk	None	None	None
Summary	Moderate risk from drought options associated with CSO discharge	Moderate risk from drought options associated with CSO discharge	Moderate risk from drought options associated with change in dilution of diffuse pollution pressures.

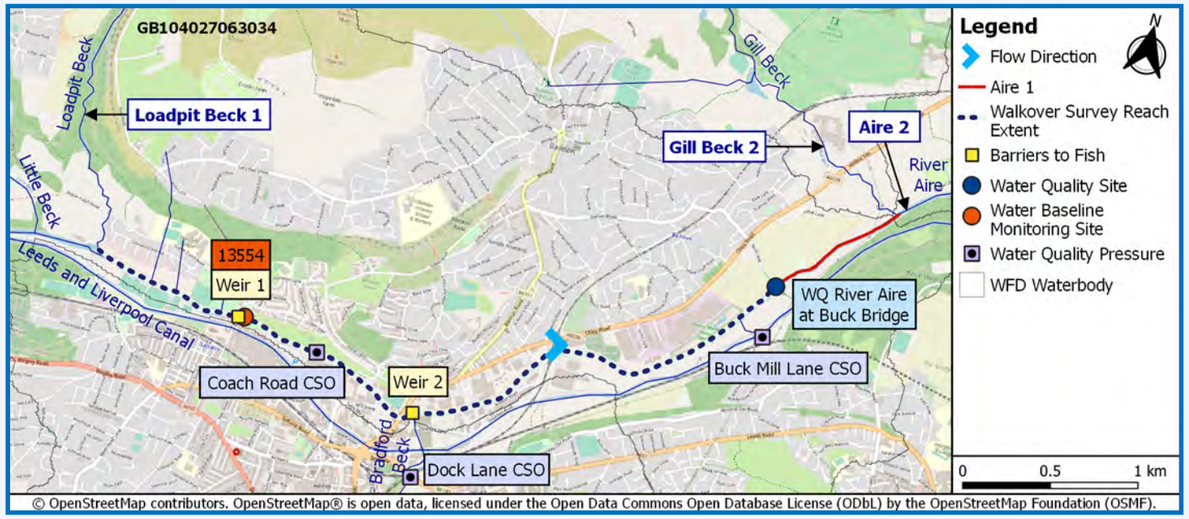
A4.16.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Aire 1 as a result of drought options is presented in **Table A4.30**.

Table A4.30 Summary of potential changes in the physical environment of Aire 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Moderate impacts (summer/autumn)* *Minor impacts (winter)*	• Reductions of up to 19% in summer/autumn river flows throughout the reach.
Flow depleted reaches *None*	• There are no flow depleted reaches within Aire 1.
River habitats *Minor risk*	• The moderate summer/autumn and minor winter reduction in flow will change the energy of the system • Potential minor risk of reduction in total wetted aquatic habitat in the reach, and minor risk of changes in available habitat for different species requirements. • Negligible risk to longitudinal connectivity • Negligible risk of change in sediment dynamics.
Water quality *Moderate risk*	• Risk of short term acute, infrequent, temporary water quality pressures locally downstream of three listed CSOs during rainfall events. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented. • Reported ammonia and DO % water quality is predominantly consistent with 'Good' status and with only weak flow sensitivity. SRP is predominantly attaining 'Poor' status with a strong flow sensitivity.

Reach Setting

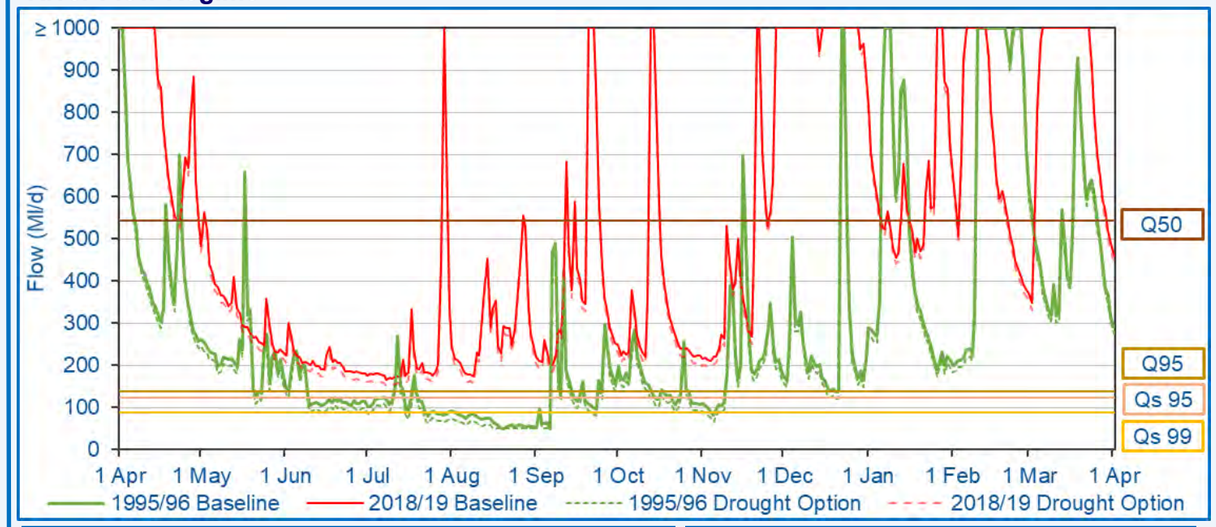


Reach Setting Information:

The superficial geology of the reach is dominated by alluvium and hummocky glacial deposits beneath the channel. Soils in the reservoir catchment are predominantly composed of loamy and clayey floodplain soils directly beneath and around the reach. Parts of the surrounding land use of along the reach is a mixture of suburban/urban land use as the reach flows through Shipley.

	Supplementary Information
Catchment Area at Assessment Point	521.1km^2
Mean Slope Gradient	0.1°
Length of Reach	4.7km
Additional Catchment Area	69.6km^2
Upstream Reach	Loadpit Beck 1
Downstream Reach	River Aire 2

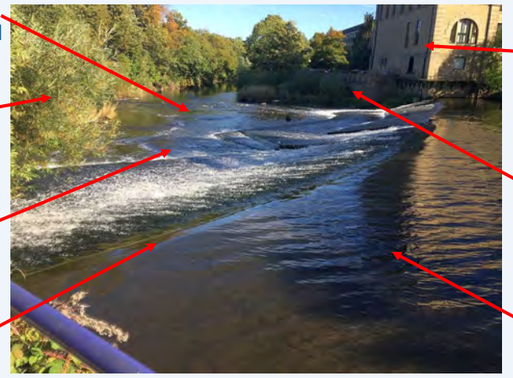
River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
$Q_{s}95$	123.37	106.72	13	Summer Moderate
$Q_{s}99$	89.02	72.37	19	
Q95	137.98	121.33	12	Winter Minor
Q50	542.99	526.34	3.1	

There are no significant flow additions/ reductions associated with this reach

River Habitats

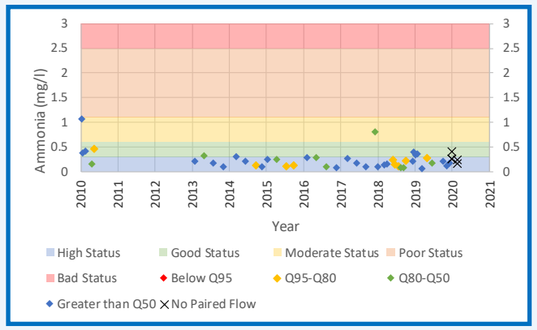


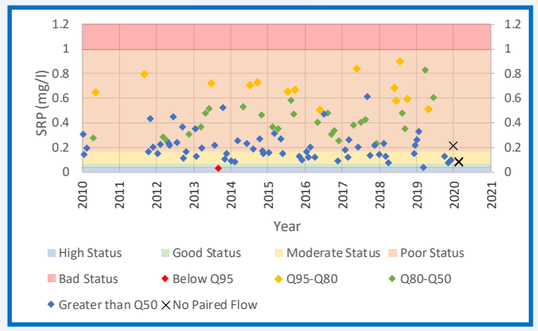
River Water Quality

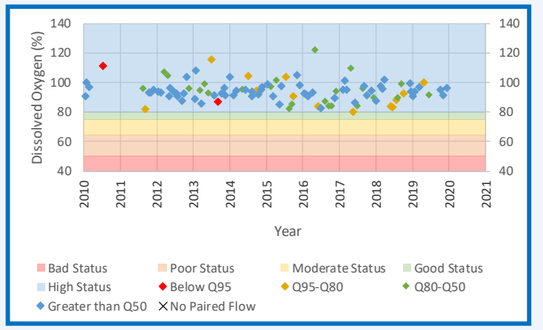
Significant Water Quality Pressures	Permit Conditions
Buck Mill Lane CSO 2788 A1	Intermittent discharge
Dock Land CSO 3720(SS) 1	Intermittent discharge
Coach Road CSO WRA8472 1	Intermittent discharge

The average pH in this river was 7.9

The maximum temperature is 20.6°C







YorkshireWater

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Figure A4.15

River Aire 1

Physical Environment Information

A4.17 Aire 2

A4.17.1 Reach introduction

Aire 2 is potentially impacted by a Weecher Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.16**. The reach includes part of the following river waterbody:

- River Aire from Gill Beck (Baildon) to River Calder (GB104027063032).

A4.17.2 Reach setting

Aire 2, located on main EAR **Figure 4.2,** comprises a 1.8 km stretch of the River Aire from the Gill Beck confluence down to the Esholt WwTW discharge (**Table A2.1**). This reach is affected by the drought options at Springhead Weir maintained flow, Leeming Reservoir, Leeshaw Reservoir, Hewenden Reservoir and Eldwick Reservoir.

A4.17.3 River flow regime

River flow in Aire 2 is influenced by the semi-natural flows on the upstream River Aire, including the reservoir influenced flows of many tributaries. As such some flow variability would be apparent during the implementation of North West Area drought options part-reflecting local hydrological response to rainfall conditions during the ongoing environmental drought.

Daily mean flows at the upstream end of this reach, immediately downstream of the Gill Beck 1 confluence have been estimated using the Gustard flow transposition method. This is based on catchment parameter ratios and gauged flow data from an available downstream gauge at Armley. Prior to applying the flow transposition, adjustments to the gauged flow data were made to allow for the effects of effluent discharges from Marley WwTW and Esholt WwTW. Daily mean discharges from the WwTWs, estimated as the dry weather flow (DWF) where daily data was not available, were subtracted from the daily mean gauged flows before applying the flow transposition. Adjustments to the catchment parameters and gauged flows were also made to allow for the influence of a number of reservoirs upstream of the gauge. The Marley daily discharge was then added back to the transposed flow estimates for this reach (as the Marley WwTW is upstream of the Loadpit Beck confluence with the River Aire), along with the daily reservoir outflows from all reservoirs upstream of the River Aire/Loadpit Beck confluence. All other abstractions and discharges upstream of the Armley gauging station were below the threshold of 5% of the Q99 flow statistic, and were therefore excluded from the adjustment process. This enabled the creation of an estimated daily flow record for the River Aire downstream of the Loadpit Beck 1 confluence covering the period 1990-2019 with moderate to high confidence.

The maximum combined flow reduction on the River Aire downstream of the Gill Beck 1 confluence, with all eight drought permits in place, is therefore 16.64 Ml/d. Based on the estimated flow statistics for this reach, this represents a reduction of 12% and 17% in the summer Q95 and Q99 flow statistics, which is assessed as a moderate hydrological impact on this reach in summer and autumn months. The reduction in year-round Q95 and Q50 is 11% and 2.8% respectively, which is assessed as a minor hydrological impact during winter months associated with winter refill periods.

The hydrological impact of drought options on Aire 2 is therefore assessed as **moderate** for a summer/autumn period and **minor** for any winter refill period while drought options remain in place.

There are no significant flow pressures, either abstractions or discharges, influencing flow in Aire 2. There are no flow depleted reached in Aire 2. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.17.4 River habitats

River habitats have been characterised at a whole reach scale. No additional information for a representative 500m reach has been surveyed.

Aire 2 is moderately sinuous and falls ~2m over 1.8km, a slope of 0.06°. Riparian tree cover varies along the reach from isolated to continuous. Channel width varies throughout the reach between 19-27m. Extant aerial imagery shows several in-channel features with 2 side bars (both of which are vegetated) and 1 un-vegetated point bar. No channel substrate could be identified on aerial imagery. Six areas of broken flow have been identified in the reach, which are likely caused by riffles. The remainder of the channel surface indicated smooth flow. Due to the vegetation present it is expected that banks are composed predominantly of earth. Bank erosion is limited in the reach. Surrounding land use is predominantly improved grassland and deciduous woodland with some suburban/urban land use, particularly at the end of the reach where Esholt STW is located.

The reduction in flow could lead to several potential impacts within Aire 2:

- Negligible risk of changes in the energy of the system associated with up to 17% reduction in flow for periods of time during the duration of drought option.
- Potentially minor risk of reduction in wetted aquatic habitat (wetted depth reduction) within steep banks for periods of time during the duration of drought option.
- Potentially minor risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for periods of time during the duration of drought option noting the retention of an overall variable flow pattern, noting the dominance of smooth flow.
- Negligible risk to longitudinal connectivity noting no weirs and the retention of an overall variable flow pattern.
- Negligible risk of changes in sediment dynamics. Reductions in discharge will lead to only temporary reductions in velocity that could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are also unlikely to be affected.

The overall risk to river habitats on Aire 2 from drought options is therefore assessed as minor.

A4.17.5 River water quality

There are no sampling locations in Aire 2, the next sample downstream of this reach, Aire at Apperley (NE-49400676), has been used. The average pH between 2010-2020 was 7.8 with a maximum temperature of 18.3°C for the same period. There are no significant continuous or intermittent discharges into Aire 2. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Aire 2 as a result of drought options is presented in **Table A4.31**.

Table A4.31 Potential risks to water quality in Aire 2 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were consistent with 'Good' WFD status (0.6 mg/l) throughout the monitoring period. Some seasonality was apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period. Some seasonality was apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations were not consistently with 'Good' WFD status (0.068 mg/l) with all results all results below this status. Strong seasonality was apparent with notable peaks in June/ August.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	Moderate
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

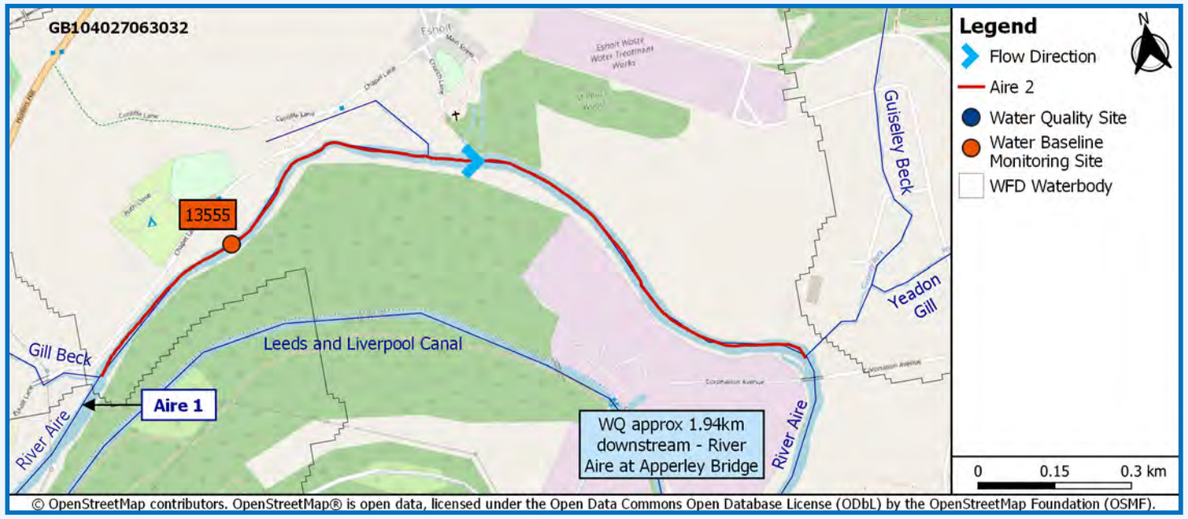
A4.17.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Aire 2 as a result of drought options is presented in **Table A4.32**.

Table A4.32 Summary of potential changes in the physical environment of Aire 2 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Moderate impacts (summer/autumn)* *Minor impacts (winter)*	• Reductions of up to 17% in summer/autumn river flows throughout the reach.
Flow depleted reaches *None*	• There are no flow depleted reaches within Aire 2.
River habitats *Minor risk*	• The moderate summer/autumn and minor winter reduction in flow will change the energy of the system • Potential minor risk of reduction in total wetted aquatic habitat in the reach, and minor risk of changes in available habitat for different species requirements. • Negligible risk to longitudinal connectivity • Negligible risk of change in sediment dynamics.
Water quality *Minor risk*	• Reported ammonia and DO % water quality is predominantly consistent with 'Good' status and with only weak flow sensitivity. SRP is predominantly attaining 'Poor' status with a moderate flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting

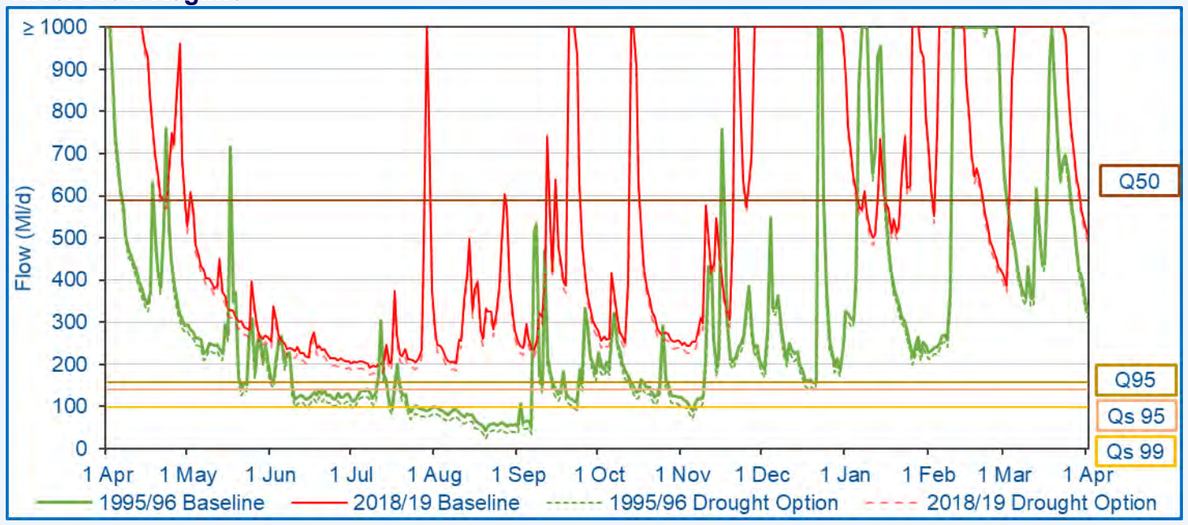


Reach Setting Information:

The superficial geology of the reach is dominated by alluvium beneath the channel with some river terrace deposits around the channel towards the end of the reach. Soils in the reservoir catchment are predominantly composed of loamy and clayey floodplain soils directly beneath and around the reach. There is some suburban/urban land use along the reach, particularly at the end of the reach where Esholt STW is located.

	Supplementary Information
Catchment Area at Assessment Point	604.6km^2
Mean Slope Gradient	0.06°
Length of Reach	1.8km
Additional Catchment Area	1.6km^2
Upstream Reach	River Aire 1/ Gill Beck 2
Downstream Reach	N/A

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	139.77	123.12	12	Summer Moderate
Q_s99	97.89	81.24	17	
Q95	157.43	140.78	11	Winter Minor
Q50	589.04	572.39	2.9	

There are no significant flow additions/ reductions associated with this reach

River Habitats

No walkover survey was carried out during the onset of drought in 2018. This will be include in the EMP.

River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this reach was 7.8

The maximum temperature was 18.3°C

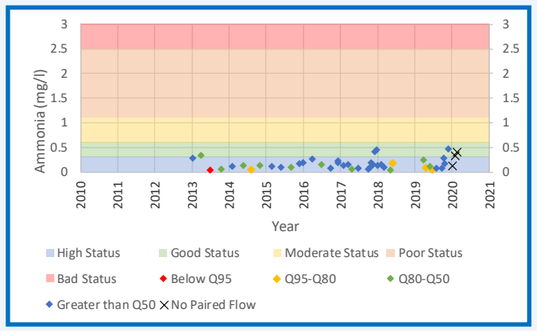
YorkshireWater

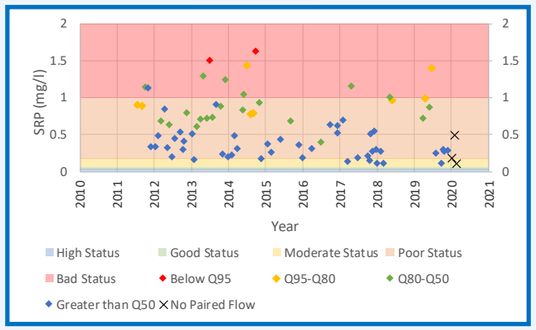
RICARDO

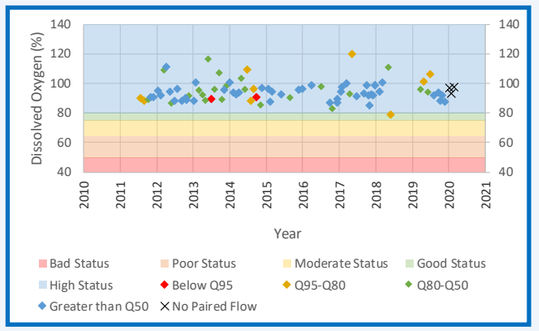
Figure A4.16

River Aire 2

Physical Environment Information







A4.18 Dibb 1

A4.18.1 Reach introduction

Dibb 1 is potentially impacted by a Grimwith Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.17**. The reach includes part of the following river waterbody:

- Barden Beck and River Dibb (GB104027064120).

A4.18.2 Reach setting

Dibb 1, located on main EAR **Figure 4.1,** comprises a 5.15 km stretch of the River Dibb from the Grimwith Reservoir outflow down to the confluence with the River Wharfe (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 9.1km^2 along the length of the reach.

A4.18.3 River flow regime

In addition to the compensation releases of Grimwith Reservoir, YWSL is also required to release a regulating flow from Grimwith Reservoir to support their abstractions from the River Wharfe at low flows. YWSL has a drought option to temporarily suspend part of the regulating flow and a further option to increase the annual volume abstracted from the River Wharfe at Lobwood. An assessment of the combined impact of the River Wharfe and Grimwith Reservoir options is included in the River Wharfe Environmental Assessment Report (see Appendix A Section A3.3).

At times without regulation release from Grimwith Reservoir the compensation flow reduction would lead to significant reductions in flow in the River Dibb. During the spring period of 20 April to 10 May, a reduction of 5.2 Ml/d (the maximum spring reduction under this drought option) therefore represents a reduction of up to 67% in the flow at the top of this reach, and this is assessed as a major hydrological impact. Similarly, during the summer period of 11 May to 11 October, the maximum reduction of 2.55 Ml/d also represents a 67% reduction in flows and is also assessed as a major impact.

During the autumn and winter refill periods, there is likely to be higher flow accretion along the length of the reach so that the percentage reduction in flows will be less at the lower end of the reach. However, at the upstream end of this reach it is assumed that flow would still consist of compensation releases only during the implementation of this drought permit. The maximum flow reduction of 4.98 Ml/d during the autumn period of 12 October to 31 October, or of 10.12 Ml/d during the winter period of 1 November to 19 April, therefore, still represents a 67% reduction in flows and is also assessed as a major impact during both of these periods.

The hydrological impact of drought options on Dibb 1 is therefore assessed as **major** for both a summer/ autumn period and any winter refill period while drought options remain in place and for the duration of period without regulation releases from Grimwith Reservoir.

Other that the regulation release from Grimwith Reservoir, there are no significant flow pressures, either abstractions or discharges, influencing flow in Dibb 1. There are no flow depleted reaches in Dibb 1. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.18.4 River habitats

River habitats have been characterised at a whole reach scale. No additional information for a representative 500m reach has been surveyed.

Dibb 1 is a fairly sinuous and abuts the valley sides in some locations. The reach falls ~111m over 5.15km, a slope of 1.23°. Riparian tree cover is generally continuous throughout the reach, tree cover was continuous at RHS Survey ID 39734 and 38134. The channel measures between 7-11m wide. As tree cover blocks the view of the reach, few in-channel features are visible. One side bar was observed near the start of the reach, and two vegetated mid-channel bars were observed within the reach. Two vegetated point bars were observed at RHS site 218.

The visible channel surface indicates that smooth flow predominates, however due to the steep gradient and sinuosity of the channel, flow variation is expected. Flow variation was observed at all of the RHS sites. At Survey ID 218, rippled flow dominated, however almost laminar flow was also observed (20%). At site 39734, rippled flow dominated (50%), however areas of unbroken standing waves (30%), broken waves (10%) and chaotic flow (10%) were also observed. At RHS Survey ID 38134, 70% of flow observed was unbroken standing waves, however areas of broken waves (10%), chaotic flow (10%) and rippled flow (10%) were also observed.

Bed substrate cannot be observed from aerial imagery, however, given the location, coarse substrate is expected. This is confirmed by the RHS data, cobbles and boulders dominated. However, there were also areas of bedrock. Exposed boulders and bedrock were also observed at the RHS sites. Where banks are vegetated it is assumed that they are composed of earth, this is confirmed by the RHS sites. However small areas of bedrock and brick were also recorded. Banks are steep at all RHS sites (>45°). The channel is reinforced near the outfall of the reservoir, however downstream, no further modifications could be observed. Survey ID 218 and 38134 recorded reinforced banks. Surrounding land use is predominantly farmland, however areas of plantation and woodland were also observed.

Dibb 1 is likely to be dominated by high energy environments, as indicated slope. Two vegetated point bars were observed at RHS site 218, which will increase habitat diversity. The coarse substrate present in the watercourse will provide habitat opportunities for fish and white-clawed crayfish, with discrete patches of finer substrate supporting spawning habitat for fish also considered likely to be present. The earth banks are suitable for the creation of burrows by white-clawed crayfish and otter. The occasional nature of tree cover will provide some habitat opportunities for fish, white-clawed crayfish and otter, there is potential for the available tree cover to provide suitable breeding habitat for otter. The occasional presence of trees in the riparian corridor will also provide some allochthonous energy input, which will be reflected in the macroinvertebrate composition.

The reduction in flow could lead to several potential impacts within Dibb 1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow at times without regulation release. Major risk particularly throughout the mid May to mid October period when seasonal compensation flows lowest and exacerbating the pattern of flow variability resulting from the presence/absence of regulation releases.
- Potentially major risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bed elements (such as larger particles) through the flow surface particularly throughout the ‘summer’ (mid May to mid October period when seasonal compensation flows lowest, moderate risk during the ‘spring’ (mid April to mid May) and ‘autumn’ (mid October to mid November) periods when river flows would be higher. Minor risk during the ‘winter’ (mid November to mid April) period when wetted habitat would more closely resemble the spring and autumn conditions without drought options.
- Potentially major risk of change in available aquatic habitat (flow velocity reduction and depth reduction) at times without regulation release from Grimwith Reservoir for duration of drought option.
- Major risk to longitudinal connectivity noting three weirs, particularly the two located low in the reach close to the River Wharfe confluence.
- Minor risk of changes in sediment dynamics for duration of drought option due to the variable pattern of flow dependent on the pattern of regulation release from Grimwith Reservoir.

The overall risk to river habitats on Dibb 1 from drought options is therefore assessed as major.

A4.18.5 River water quality

There are two sampling locations in Dibb 1, however the most upstream location, River Dibb at Dibbles Bridge (NE-49700222), has limited data, as such, the next sample downstream, River Dibb At Hartlington Bridge (NE-49400676), has been used. The average pH between 2010-2020 was 7.8 with a maximum temperature of 17.3°C for the same period. There are no significant continuous or intermittent discharges into Dibb 1. See Annex 2 for a full list of discharges considered in the

assessment. A summary description of the potential risks to water quality in Dibb 1 as a result of drought options is presented in **Table A4.33**.

Table A4.33 Potential risks to water quality in Dibb 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations were consistent with 'Good' WFD status (0.3 mg/l) throughout the monitoring period.	Dissolved oxygen saturation (%) values were consistent with 'Good' WFD status (75%) throughout the monitoring period.	Orthophosphate concentrations were consistent with 'Good' WFD status (0.033 mg/l) throughout the monitoring period.
Flow sensitivity (diffuse pollution)	None apparent	None apparent	None apparent
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

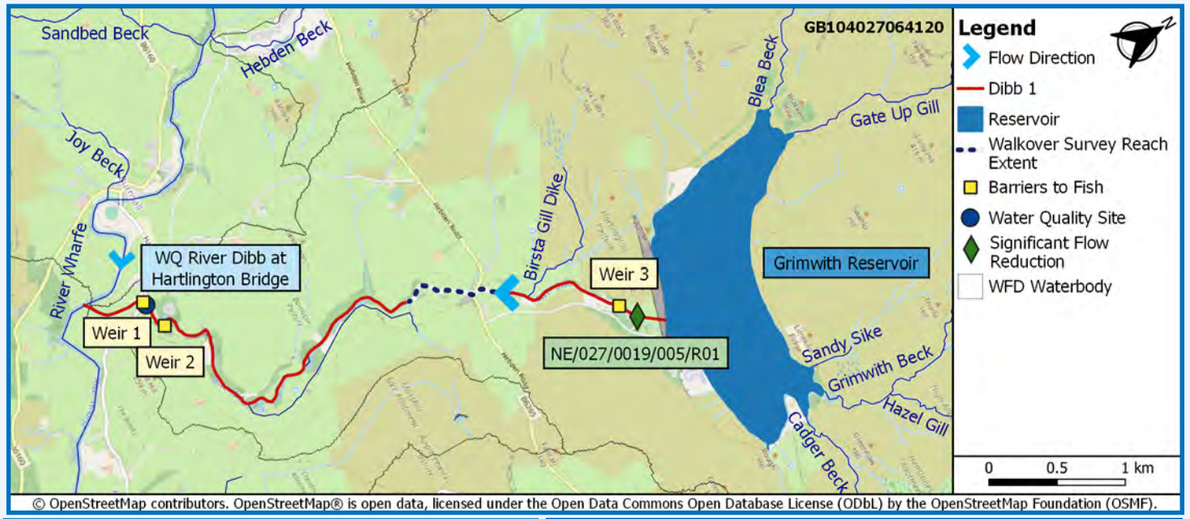
A4.18.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Dibb 1 as a result of drought options is presented in **Table A4.34**.

Table A4.34 Summary of potential changes in the physical environment of Dibb 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Dibb 1.
River habitats *Major risk (at times without regulation release from Grimwith Reservoir)*	• The major reduction in flow will change the energy of the system • Potential major risk of reduction in total wetted aquatic habitat in the reach, and major risk of changes in available habitat for different species requirements. • Major risk to longitudinal connectivity • Minor risk of change in sediment dynamics.
Water quality *Minor risk*	• Reported water quality is consistent with 'Good' status and with no apparent flow sensitivity. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting

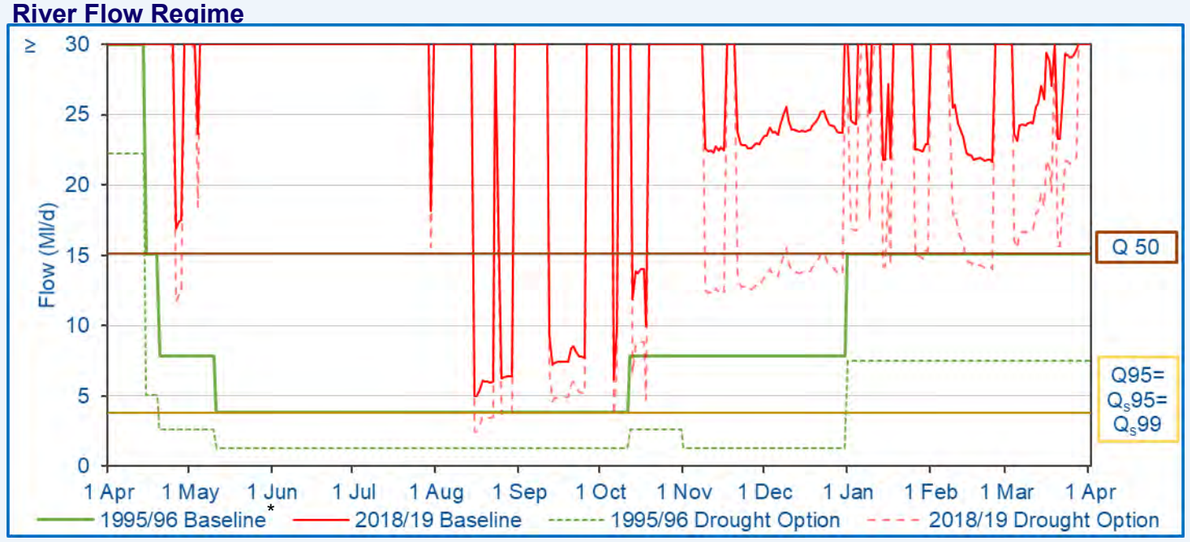


Reach Setting Information:

The bedrock geology of the upstream part of the reach is dominated by the Millstone Grit Group, and downstream is dominate by the Craven Group. The superficial geology is composed predominantly of glacial till. Soils are predominantly composed of very acidic, upland soils with a peat surface, acid loam and clay soils and slightly acid but base rich freely draining soils. At the downstream end of this reach, the River Dibb joins the River Wharfe. Urbanisation is very limited along this reach.

	Supplementary Information
Catchment Area at Assessment Point	25.8km^2
Mean Slope Gradient	1.23°
Length of Reach	5.15km
Additional Catchment Area	9.1km^2
Upstream Reach	N/A
Downstream Reach	N/A

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	3.80	1.25	67	Summer Major
Q_s99	3.80	1.25	67	
Q95	3.80	1.25	67	Winter Major
Q50	15.10	4.98	67	

* the regulation regime in 1995/96 is not available and that the line is only a representation of the compensation flow (if it had been in place at that time).

There are no significant flow additions/ reductions associated with this reach

River Habitats

No walkover survey was carried out during the onset of drought in 2018 due to the fact that the Grimwith Reservoir drought option was not needed. This will be include in the EMP.

River Water Quality

There are no significant water quality pressures associated with this reach

The average pH in this reach was 7.8

The maximum temperature was 17.3°C

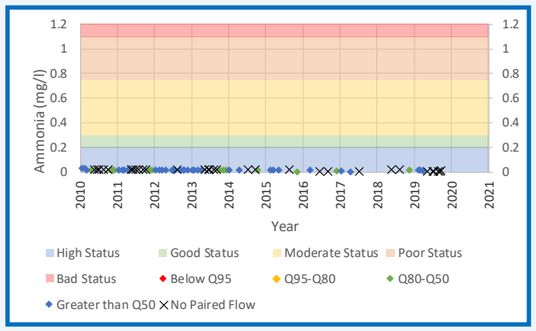
YorkshireWater

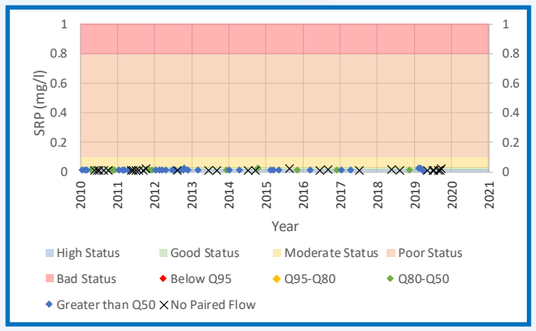
RICARDO

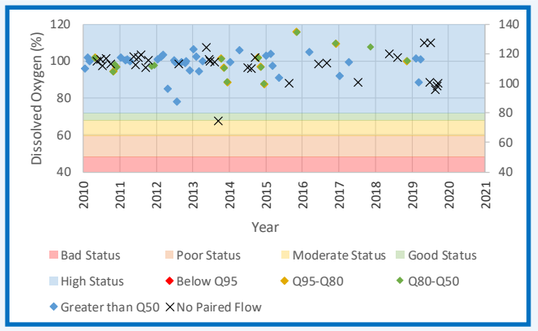
Figure A4.17

River Dibb 1

Physical Environment Information







A4.19 Carr Beck 1

A4.19.1 Reach introduction

Carr Beck 1 is potentially impacted by a Carr Bottom Reservoir drought permit. A summary of physical environment information for this reach is provided in **Figure A4.18**. The reach includes part of the following river waterbody:

- Wharfe Middle and Washburn (GB104027064258).

A4.19.2 Reach setting

Carr Beck 1, located on main EAR **Figure 4.2,** comprises 5.1 km stretch of the Carr Beck and Mickle Ing Beck from the Carr Bottom Reservoir outflow down to the confluence with the River Wharfe (**Table A2.1**). The reach is dominated by reservoir outflows with an additional catchment area of 7.0km^2 along the length of the reach.

A4.19.3 River flow regime

During the implementation of North West Area drought options, storage in Carr Bottom Reservoir is likely to be below top water level and therefore the reservoir compensation flow represents a high proportion of the flow in this reach. A reduction of up to 0.06Ml/d in the statutory compensation release rate of 0.09Ml/d represents a 67% reduction in the flow at the upstream end of the reach, regardless of the time of year. During a winter refill period when catchment flows are generally increasing, there may be some limited flow accretion along the reach so that the percentage flow reduction is less at the lower end of the reach. However, the flow reduction at the top of the reach will remain at 67% until the reservoir reaches top water level and begins to spill again.

The hydrological impact of drought options on Carr Beck 1 is therefore assessed as **major** for both a summer/ autumn period and any winter refill period while drought options remain in place.

There is one potentially significant flow pressure influencing flow in Carr Beck 1, a golf club spray irrigation licence for 0.024Ml/d daily maximum with multiple abstraction locations. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

A4.19.4 River habitats

River habitats have been characterised at a whole reach scale and with additional information for a representative 500m reach from survey information on 11 September 2018 at a reservoir outflow of 0.086Ml/d.

Carr Beck 1 is a fairly sinuous reach which falls ~209m over 5.1km, a slope of 2.36°. The bedrock geology underlying the reach is composed of sandstones and mudstones of the Carboniferous Millstone Grit Group. Between the outflow from Carr Bottom Reservoir to ~1.6km downstream the watercourse passes over the coarse Millstone Grits of the High Moor and Doubler Stones Sandstone, Long Ridge Sandstone and the Addingham Edge Grit before flowing over mudstones of the Millstone Grit Group for the ~2.2km to the confluence with the River Wharfe. The superficial geology of the reach is characterised by glacial till and some localised hummocky glacial deposits near the River Wharfe confluence. Soil types along the reach are characterised by a small area of very acid loamy upland soils close to the reservoir with the majority of the reach characterised by seasonally wet base-rich loamy and clayey soils. Surrounding land use is characterised by upland heath and grassland near the reservoir rapidly changing to improved grassland with increasing urban land use around the confluence with the River Wharf.

The steep and sinuous nature of Carr Beck 1 indicates that the reach is typical of a low order stream and can support a variety of high energy environments. The channel is narrow along the reach and widens slightly after the confluence with Gill Beck, 400m upstream of the confluence with the River Wharfe. The banks of the channel are predominantly steep earth banks, however, on occasion, shallower banks are present which allow poaching. Images from the Low Flow survey, conducted in 2018 by the Environment agency, demonstrate that the bed is largely comprised of coarse sediments,

such as cobbles and boulders, with some silt sediment sourced from bank poaching by cattle. Arial imagery indicates that there is partial riparian tree cover along the reach which will provide some allochthonous energy input into the watercourse. A HMWB Geomorphology Assessment Survey, conducted in 2013, indicates that in the upper reach there is a series of step weirs which have a detrimental impact on sediment transfer.

The reduction in flow could lead to several potential impacts within Carr Beck 1:

- Major risk of changes in the energy of the system associated with up to 67% reduction in flow for the duration of drought options.
- Potentially major risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands) and protrusion of bedrock outcrops and bed elements (such as larger particles) through the flow surface for duration of drought option at very low flows.
- Potentially major risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option at very low flows.
- Major risk to longitudinal connectivity with the 2018 Low Flow walkover indicating that, if flows were to be reduced, pools may become disconnected and riffles could dry.
- Moderate risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that poaching in the reach will mean that there will be an ongoing source of fine sediment throughout the environmental drought. Coarse sediment dynamics are unlikely to be affected.

The overall risk to river habitats on Carr Beck 1 from drought options is therefore assessed as major.

A4.19.5 River water quality

There are no sample locations in Carr Beck 1. As such the average pH and maximum temperatures cannot be determined for this reach. In order to assess the water quality the neighbouring Gill Beck catchment has been used as a representative example due to its similarities as a catchment.

There are no significant continuous or intermittent discharges into Carr Beck 1. See Annex 2 for a full list of discharges considered in the assessment. A summary description of the potential risks to water quality in Carr Beck 1 as a result of drought options is presented in **Table A4.35**.

Table A4.35 Potential risks to water quality in Carr Beck 1 as a result of drought options

	Total ammonia	Oxygen	Phosphate
General quality	Ammonia concentrations are assumed consistent with 'Good' WFD status (0.6 mg/l) throughout the monitoring period. Some seasonality is assumed to be apparent with concentrations rising in spring and falling in autumn.	Dissolved oxygen saturation (%) values are assumed consistent with 'Good' WFD status (60%) throughout the monitoring period. Some seasonality is assumed apparent with saturation rising in late winter/spring and falling in late summer/autumn.	Orthophosphate concentrations are assumed predominantly consistent with 'Good' WFD status (0.053 mg/l). Some seasonality was apparent with notable peaks in June/ August.
Flow sensitivity (diffuse pollution)	None assumed	None assumed	Some moderate sensitivity assumed
WwTW presenting increased risk	None	None	None
Intermittent pressures presenting risk	None	None	None
Other point source pressures presenting risk	None	None	None
Summary	Minor risk from drought options	Minor risk from drought options	Minor risk from drought options

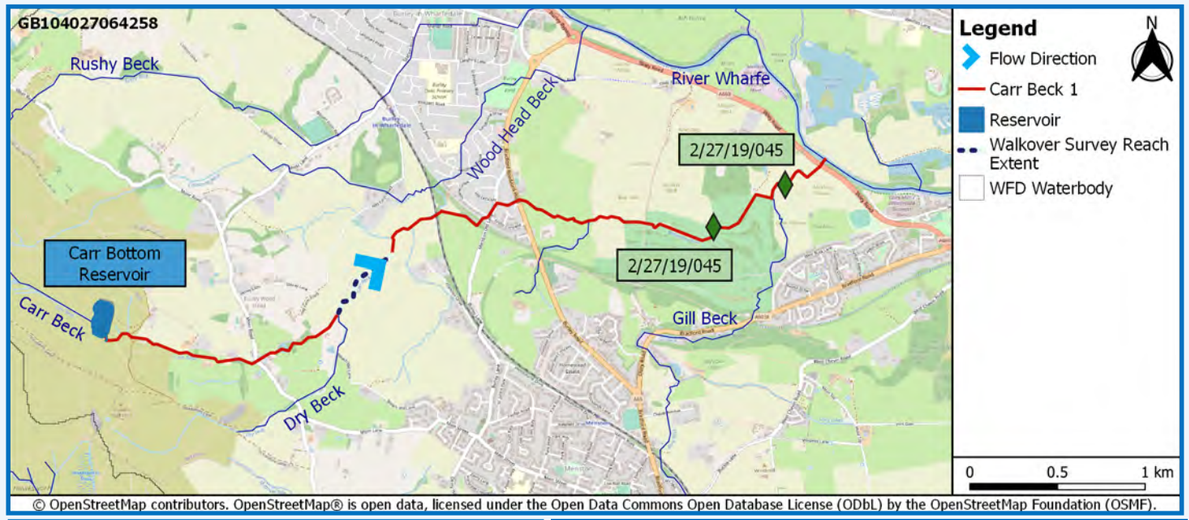
A4.19.6 Summary of potential changes in the physical environment as a result of drought options

An overall summary of potential changes in the physical environment of Carr Beck 1 as a result of drought options is presented in **Table A4.36**.

Table A4.36 Summary of potential changes in the physical environment of Carr Beck 1 as a result of drought options

Physical environment aspect reviewed	Assessment of risk from implementation of drought options
River flows *Major impacts*	• Reductions of up to 67% in river flows throughout the reach at any time of year that drought options implemented.
Flow depleted reaches *None*	• There are no flow depleted reaches within Carr Beck 1.
River habitats *Major risk*	• The major reduction in flow to very low flows will change the energy, habitat availability and connectivity of the system.
Water quality *Minor risk*	• Reported water quality is assumed consistent with 'Good' status and with moderate flow sensitivity for SRP. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented and no significant intermittent pressures presenting risk.

Reach Setting

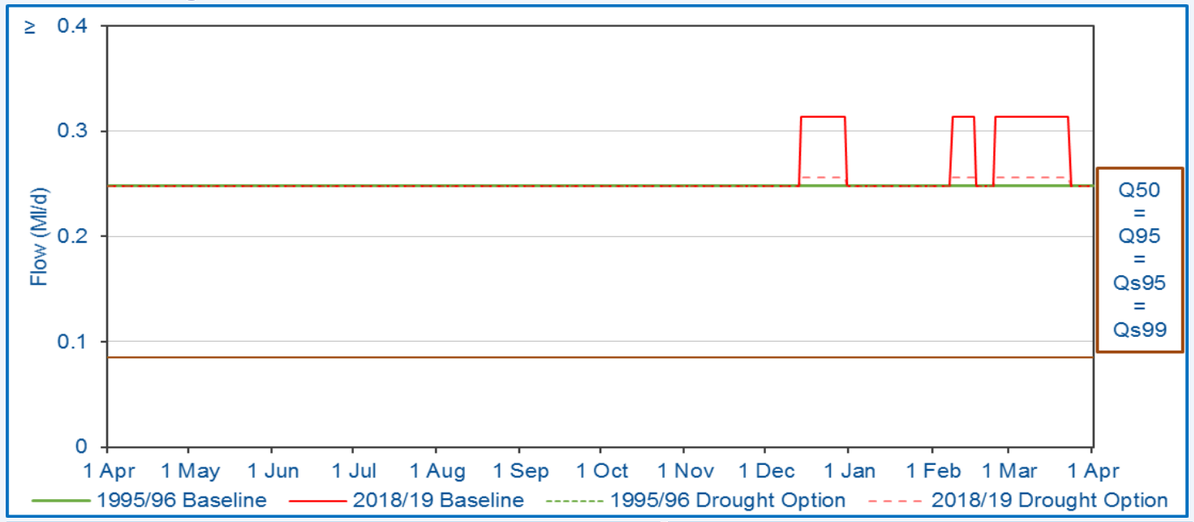


Reach Setting Information:

The bedrock geology underlying the reach is composed of sandstones and mudstones of the Carboniferous Millstone Grit Group. The superficial geology of the reach is predominantly underlain by glacial till with localised hummocky glacial deposits near the River Wharfe confluence. Soil types along the reach are characterised mostly by seasonally wet base-rich loamy and clay soils. Surrounding land use is characterised by upland heath and improved grassland and some urban land use around the Wharfe confluence.

	Supplementary Information
Catchment Area at Assessment Point	0.5km^2
Mean Slope Gradient	2.36^o
Length of Reach	5.1km
Additional Catchment Area	7.0km^2
Upstream Reach	N/A
Downstream Reach	N/A

River Flow Regime



-	Reference Conditions (Ml/d)	Drought Plan Conditions (Ml/d)	% Reduction	Impact
Q_s95	0.09	0.03	67	Summer Major
Q_s99	0.09	0.03	67	
Q95	0.09	0.03	67	Winter Major
Q50	0.09	0.03	67	

Significant Flow Additions/Reductions	Flow Rate (Ml/d)	Abstraction / Discharge
Otley Golf Course 2/27/19/045	0.025	Abstraction

River Habitats

River Water Quality

There are no significant water quality pressures associated with this reach

There are no monitoring points in this reach. In the comparable Gill Beck catchment the average pH was 7.8 with an maximum temperature of 15.1^{o}C

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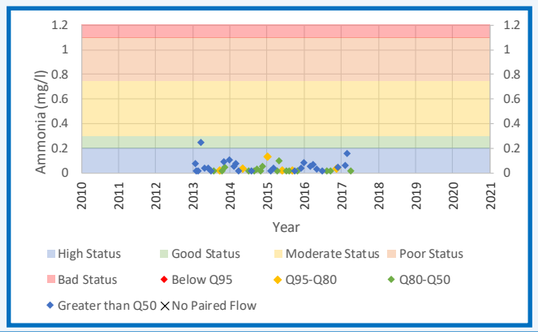
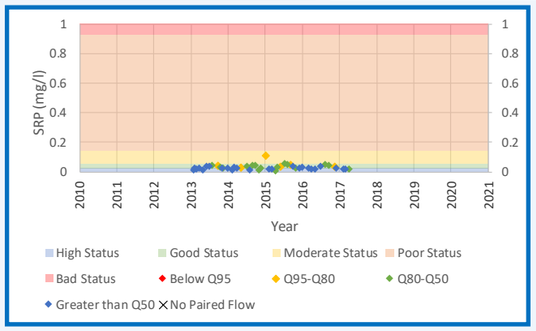
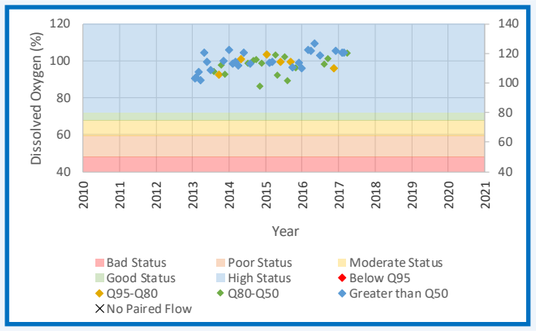
Figure A4.18

Carr Beck 1

Physical Environment Information







Annex 1 – Regulated abstractions in North West Area reaches

DP reach	Licence No.	Use Description	NGR 1	Max Annual Quantity	Max Daily Quantity
Carr Beck 1	2/27/19/045	Spray Irrigation - Direct	SE185453	3864	25
Eller Beck 1	NE/027/0015/021	Supply To A Canal For Throughflow	SD9919252038		
Eller Beck 1	NE/027/0015/001	Hydroelectric Power Generation	SD9897652042	8553600	38880
Eller Beck 1	NE/027/0015/002	Transfer Between Sources (Post Water Act 2003)	SD9920852177		
Harden Beck 1	2/27/16/099	Spray Irrigation - Direct	SE103385	3182	63.644
Worth 2	2/27/14/043	General Cooling (Existing Licences Only) (Low Loss)	SE037382	22730	91
Worth 2	2/27/14/043	General Use Relating To Secondary Category (Medium Loss)	SE037382	22730	91
Worth 2	2/27/14/088	Non-Evaporative Cooling	SE03713824	40500	216
Worth 2	NE/027/14/001	Textiles and Leather	SE070417	26780	161.38

Annex 2 – Regulated discharges in North West Area reaches

Name	Permit Reference	Outfall NGR	Significant Water Quality Pressure	Intermittent/ Continuous
Belle Isle Road/CSO	WRA8104	SE 03406 37009	No	Intermittent
Brandy Mill 34/CSO	2739	SE 06097 40305	No	Intermittent
Brook Street/CSO	WADC761	SD 98608 51732	No	Intermittent
Buck Mill Lane/CSO	2788 A1	SE 16893 38881	Yes	Intermittent
Carleton Rd Skipton/CSO	YWUCD2/103	SD 98444 50748	Yes	Intermittent
Clog Bridge/CSO	WRA9241	SE 04220 46200	No	Intermittent
Cloughs Mill/No 2 CSO	WRA8515	SE 05456 39682	No	Intermittent
Coach Road/CSO	WRA8472 1	SE 14460 38140	Yes	Intermittent
Coney Lane/CSO	WRA8639	SE 06424 40943	No	Intermittent
Damems Road/CSO	WRA8640	SE 05279 39100	No	Intermittent
Dock Lane/CSO	3720(SS) 1	SE 15160 37590	Yes	Intermittent
Embsay/CSO	WRA9313	SE 00574 53335	No	Intermittent
Fell View/CSO	WRA8309	SE 01330 53599	No	Intermittent
Gargrave Road/No 2 CSO	WRA8138	SD 98610 51740	No	Intermittent
Gilstead Lane 128/CSO	WRA8139	SE 12835 39264	No	Intermittent
Hardings Lane/CSO	NPSWQD008018 A1	SE 01396 45267	No	Intermittent
Haworth/CSO	WRA8641	SE 04800 38450	No	Intermittent
Ingrow Bridge/CSO	EPR/UP3322GR	SE 05628 39746	No	Intermittent
Ingrow Lane/CSO	3054	SE 05655 39764	No	Intermittent
Ingrow Station/CSO	2998	SE 05680 39770	No	Intermittent
Keighley Marley/STW	WRA7172 A3	SE 0869 4140	No	Intermittent
Low Mill Lane 27/CSO	WRA8453	SE 06680 41160	No	Intermittent
Mytholmes Lane/CSO	3827(SS)	SE 03605 38083	No	Intermittent
Newlands/No 2 CSO	WRA9032	SE 00613 53356	No	Intermittent
Oakworth/CSO	2998	SE 04210 38430	No	Intermittent
Old Cattle Market/CSO	WADC908	SD 98603 51380	No	Intermittent
Otley Road Baildon/CSO	EPR/TP3828GV	SE 17038 39755	No	Intermittent
Pitt Street/CSO	WRA8103	SE 06830 41148	No	Intermittent
Saltaire Road/No 2 CSO	WRA8895	SE 12817 40140	No	Intermittent
South Goods Yard/CSO	WRA8101	SE 06550 41120	No	Intermittent
South Street Keighley/CSO	WRA8110	SE 05920 40223	Yes	Intermittent
Spring Bank/CSO	WRA8642	SE 05851 39951	No	Intermittent
St John Street/CSO	WRA8129	SE 04220 46330	No	Intermittent
The Narrows/CSO	WA6075	SE 09204 38058	No	Intermittent
The Walk/CSO	WRA8105	SE 06314 40811	No	Intermittent
Whalley Lane/CSO	WRA7667	SE 0681 3485	No	Intermittent
Willow Grove/CSO	WRA9106	SE 05415 39510	No	Intermittent
Woodhouse Rd 38/CSO	WRA9105	SE 05886 40188	No	Intermittent
Woodhouse Road 36/CSO	WRA9104	SE 06007 40210	No	Intermittent
Worth Way North Beck/CSO	WRA7351	SE 06254 40787	No	Intermittent

Name	Permit Reference	Outfall NGR	Significant Water Quality Pressure	Intermittent/ Continuous
Worth Way Sun Street/CSO	WRA9103	SE 06185 40632	No	Intermittent
Appletreewick STW	1779	SE0510059700	No	Continuous
Beamsley STW	WRA6885	SE0803051870	No	Continuous
Ben Rhydding (Ilkley) WwTW	27/19/0044	SE1476547338	No	Continuous
Broughton WwTW	2907	SD9452951122	No	Continuous
Burley STW	E164	SE1859945903	No	Continuous
Burnsall Sewage Treatment Works	27/19/0081	SE0336060840	No	Continuous
Denholme (Doe Park) WWTW	2251	SE0764633956	No	Continuous
Dowley Gap (Bingley)	2502	SE1232338180	No	Continuous
Draughton WPC Works	27/19/0082	SE0458753102	No	Continuous
East Carlton	E776	SE2208442031	No	Continuous
Embsay WWTW	2583	SD9998253069	No	Continuous
Esholt STW	WRA6925	SE1897238744	No	Continuous
Flappit Spring	E715(SS)	SE0546236117	No	Continuous
Gargrave WWTW	2855	SD9462353570	No	Continuous
Grassington STW	27/19/0075	SE0061362943	No	Continuous
Grimwith	3131	SE0580463953	No	Continuous
Hallas Bridge STW	E716 (SS)	SE0770036600	No	Continuous
Harecroft STW	E717	SE0780035900	No	Continuous
Hebden STW	27/19/0083	SE0269062170	No	Continuous
Hollingwell Hill	E718(SS)	SE1067131257	No	Continuous
Ilkley STW	27/19/0045	SE1240048430	No	Continuous
Keighley (Marley) STW	WRA7172	SE0868041410	No	Continuous
Lane Head STW	C4570	SE1989240188	No	Continuous
Otley STW	27/20/0046	SE2230546377	No	Continuous
Oxenhope WWTW	E721 (SS)	SE0355035670	No	Continuous
Private	WRA7720	SE0358035740	No	Continuous
Private	WRA7610	SE0774036470	No	Continuous
Private	NPSWQD003342	SE1523741347	No	Continuous
Private	3602	SE0020054300	No	Continuous
Private	WRA7471	SE0022053850	No	Continuous
Snaygill (Skipton) WWTW	2838	SD9870749389	No	Continuous

Appendix B – Environmental Features

B1. Introduction

This appendix assesses the potential impacts on the environmental features of the North West Area river catchment during the period of implementation of associated drought options.

The North West Area reported in this appendix comprises drought permits at one maintained river flow and at ten reservoirs with compensation flows:

- Springhead Weir Maintained Flow drought permit
- Leeming Reservoir drought permit
- Leeshaw Reservoir drought permit
- Doe Park Reservoir drought permit
- Hewenden Reservoir drought permit
- Eldwick Reservoir drought permit
- Reva Reservoir drought permit
- Weecher Reservoir drought permit
- Silsden Reservoir drought permit
- Embsay Reservoir drought permit
- Grimwith Reservoir drought permit
- Carr Bottom Reservoir drought permit.

Details regarding the approaches/methodologies used for assessing susceptibility and sensitivity to drought management actions and the assessment of the impacts associated with drought management actions are presented in Sections 3.6 and 3.7 of YWSL's Drought Plan 2022 Environmental Assessment Methodology[1].

The environmental preferences within which a species can successfully exist and the relationship between populations in stressed river conditions remains subject to debate. The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty and this may be exacerbated where data are limited. This assessment has, therefore, adopted a precautionary approach, with potential impacts highlighted where doubt exists.

The assessment of environmental features is informed by the assessment of the physical environment (which includes hydrology and hydrodynamics; geomorphology; and water quality), this is summarised in Section 5 presented in full in **Appendix A**.

Points of interest referred to throughout the text are indicated in **Figures B1.1** and **B1.2**. Note that the only local wildlife sites mapped on the figures are those which were agreed with the Environment Agency in 2019 as having water dependent receptors.

This EAR has been prepared in support of a drought permit application in late summer 2022. It provides an update to the 'shelf copy' report which was produced in support of YWSL's Drought Plan 2022. Following agreement with the Environment Agency, the physical environment and environmental features assessments presented in the 'shelf copy' report have been retained for this application EAR (see main EAR Section 1.2).

This appendix is set out in the following sections:

Section B.2 Baseline and sensitivity– this includes for each reach:

[1] Ricardo Energy & Environment (2020). Yorkshire Water Drought Plan 2022. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. June 2020.

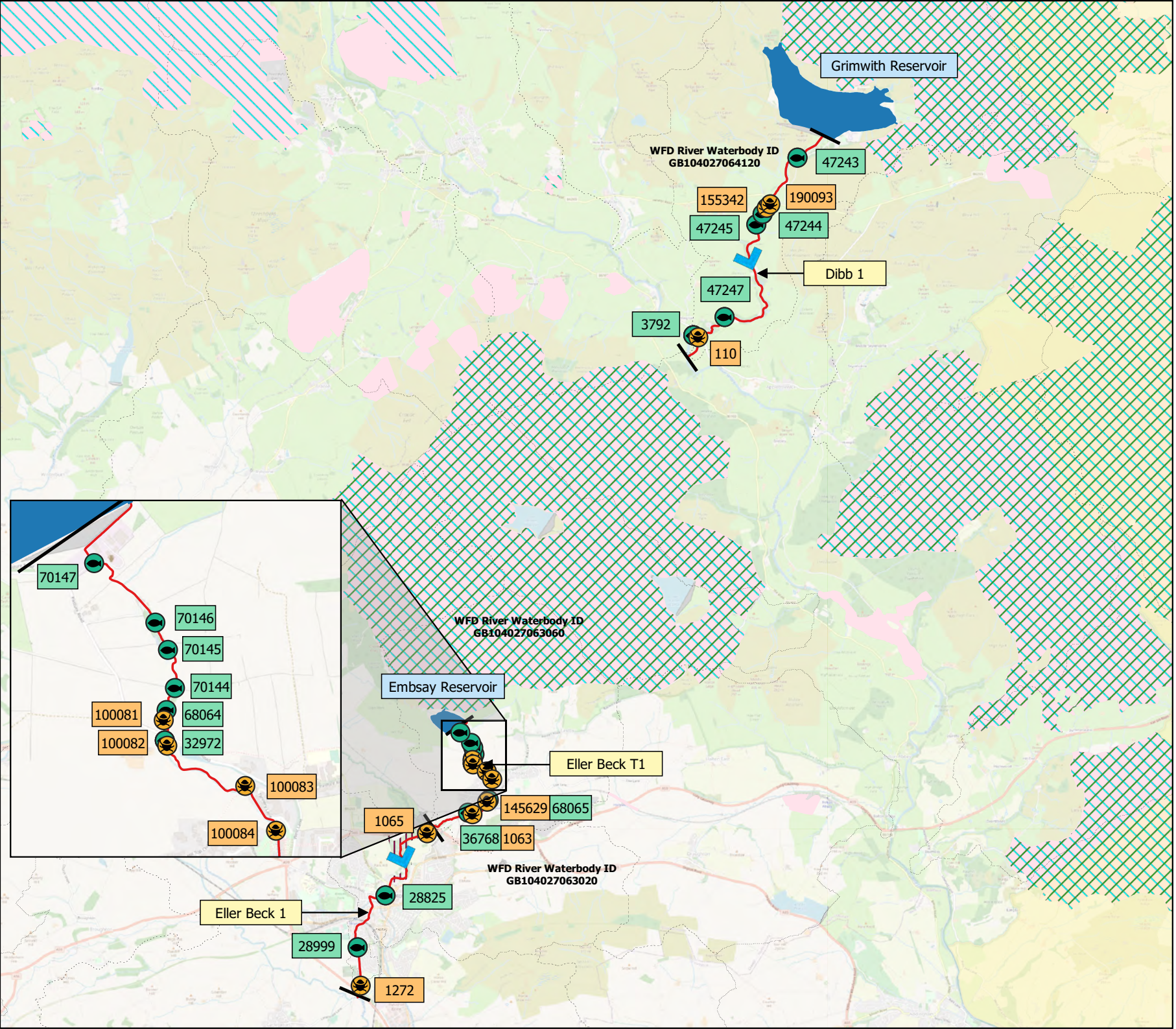
1. Statutory designated sites
2. NERC and local wildlife sites (LWS)
3. NERC and other protected species
4. WFD features
5. Invasive non-native species (INNS)
6. Landscape, navigation, recreation and heritage.

Section B.3 Environmental features screening.

Section B.4 Features assessment, monitoring and mitigation – this includes for each reach:

1. Features assessment
2. Summary of impacts.

Section B.5 Monitoring and mitigation



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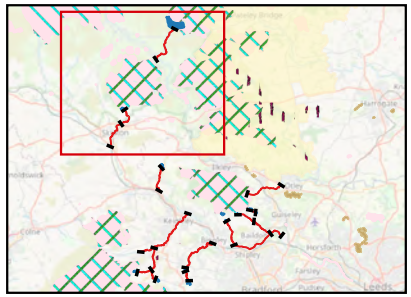
Legend

N

- River Reaches
- Reach Divides
- Reservoirs
- Flow Direction
- Macroinvertebrate Site
- Fish Site
- Areas of Outstanding Natural Beauty
- Local Wildlife Sites *
- Special Areas of Conservation
- Special Protection Areas
- Sites of Special Scientific Interest
- WFD Management Catchment



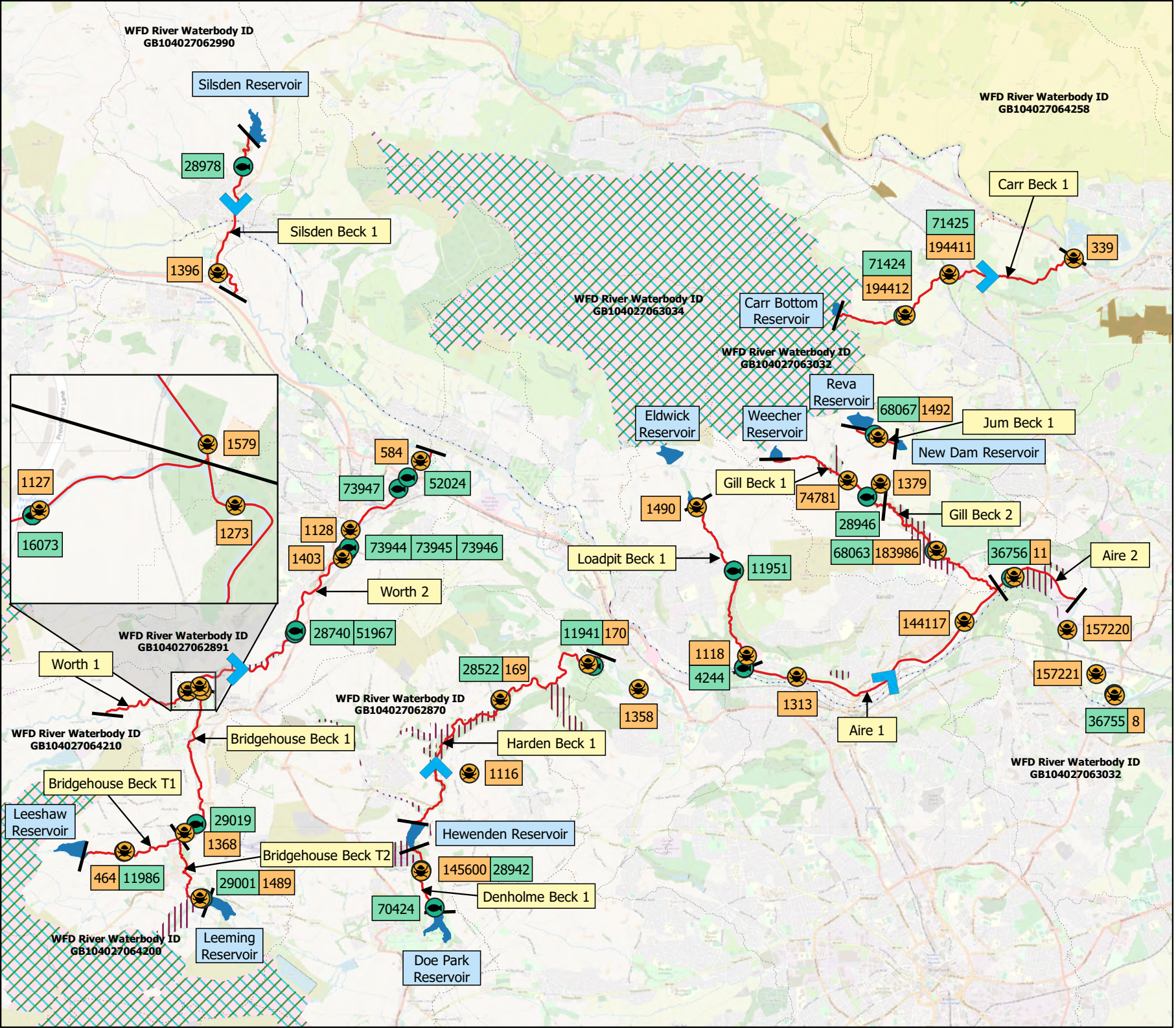
Project title:
Yorkshire Water Drought Plan
Environmental Assessment

Figure title:
North West Ecology

Figure B1.1	**Date:** August 2020
NGR: SE 01525 57666	**Scale:** 1:80000

*Only sites with water dependant receptors are mapped.

Note: All locations are approximate

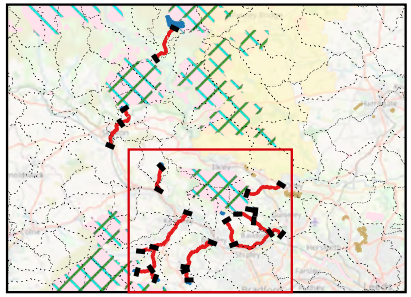


RICARDO YorkshireWater

Legend

N

- River Reaches
- Reach Divides
- Reservoirs
- Flow Direction
- Macroinvertebrate Site
- Fish Site
- Areas of Outstanding Natural Beauty
- Local Nature Reserves
- Local Wildlife Sites *
- Special Areas of Conservation
- Special Protection Areas
- Sites of Special Scientific Interest
- WFD Management Catchment



Project title:
Yorkshire Water Drought Plan Environmental Assessment

Figure title:
North West Ecology

Figure B1.2	**Date:** August 2020
NGR: SE 10122 41302	**Scale:** 1:85000

*Only sites with water dependant receptors are mapped.

Note: All locations are approximate

B2. Baseline & Sensitivity

B2.1 Eller Beck T1

B2.1.1 Statutory designated sites

Table B2.1 summarises the sites of international/national importance (SSSI, SAC, SPA, Ramsar, Marine Conservation Zone, NNR, LNR) which are in hydrological connectivity with the impacted reach.

No statutory designated sites that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.1**).

Table B2.1 Statutory designated sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
North Pennine Moors SAC	Major	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No
North Pennine Moors SPA	Major	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No
West Nidderdale, Barden and Blubberhouses Moors SSSI	Major	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No

B2.1.2 NERC and local wildlife sites

Table B2.2 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.2**).

Table B2.2 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Castle Wood LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors	Not sensitive	No

B2.1.3 NERC and other protected species

Table B2.3 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish is sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. The data shows the species has been recorded in the reach prior to 2009. Additionally, white-clawed crayfish surveys carried out by YWSL in 2016 (in Eller Beck T1) found no evidence of white-clawed crayfish, however, it is not possible to conclusively rule out their presence. As the presence of the feature cannot be ruled out within the impacted reach, a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.3 identifies the potential for impacts upon otter with Eller Beck T1, which is identified in the NERC Act Section 41 as a species of principal importance.

Review of Environment Agency records indicates the presence of otter within the Eller Beck T1. However, no information from survey findings was available and although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option.

The nationally scarce species of riffle beetle, *Riolus subviolaceus* has been identified as being present in Eller Beck T1. The species was identified in routine sampling carried out by the Environment Agency at the site Upstream Tannery in May 2010, with only one specimen present. Based on the available information this feature is considered not to be susceptible to drought option impacts and has a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including two NERC Act Section 41 fish species (brown trout and river lamprey) and two notable fish species (bullhead and brook lamprey). Baseline data for these species is detailed in **Section B2.1.4.**

Several NERC Act section 41 and notable bird species have been identified as present in water dependent habitats which rely on the impacted reach. Based on the available information these species are considered not to be susceptible to drought option impacts and **not sensitive** to the physical environment impacts identified in **Appendix A.**

Table B2.3 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipes)*	Major	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters are known to use the impacted reaches. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Invertebrate -Riffle Beetle *(Riolus subviolaceus)*	Major	This species is moderately tolerant/sensitive of pollution (WHPT scores of 6.4) and such water quality pressures are unlikely to impact the species. Therefore, impacts *on R. subviolaceus* is not considered to be of greater than low magnitude, and considering the ecological	Low	Yes
NERC Species – Fish -Brown Trout (*Salmo trutta*)	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species – Fish -Bullhead *(Cottus gobio)* -Brook lamprey *(Lampetra planeri)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is	High	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.		
NERC and Notable Species – Birds There are a number of species present across the region.	Major	The following bird species to varying extents rely on water dependent habitats. However, they are not expected to be impacted severely from implementation of the drought option against a baseline of reduced flows characteristic of drought: - Eurasian Curlew (*Numeniusarqauta)* - Swallow (*Hirundo rustica)* - Redshank (*Tringa tetanus)* - House Martin (*Delichonurbica)*	Not sensitive	No

B2.1.4 WFD Features

B2.1.4.1 Macroinvertebrates

The WFD waterbody GB104027063060 Haw Beck from Source to Eller Beck classifies as 'good' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by two Environment Agency monitoring sites, Upstream Tannery (ID 100081) and D/S Embsay (ID 145629). Upstream Tannery had baseline survey data for two seasonal samples for 2009 and 2010, and D/S Embsay had baseline survey data for two seasonal samples for 2013. In 2015 D/S Embsay only had summer baseline survey data, and only autumn baseline survey data for 2016. YSWL monitoring data was also available for survey sites located at the site D/S Embsay Village (ID YW1063). D/S Embsay Village had baseline survey data for two seasonal samples for 2015 to 2018. WHPT scores were not available at D/S Embsay Village in 2015, with only BMWP scores recorded. WHPT scores were recorded at D/S Embsay Village from 2016 to 2018, however, to allow year over year analysis only BWMP scores will be used at this site.

The WFD status of the macroinvertebrate community in Eller Beck T1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis of recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Eller Beck T1 has a medium to high sensitivity to reduced flows (**Figure B2.1**). See **Table B2.4** for guidance in interpreting raw LIFE scores.

Table B2.4 LIFE score sensitivities

LIFE score	Invertebrate community flow sensitivity
7.26 and above	High sensitivity to reduced flows
6.51 – 7.25	Medium sensitivity to reduced flows
6.5 and below	Low sensitivity to reduce flows

$WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.1**.

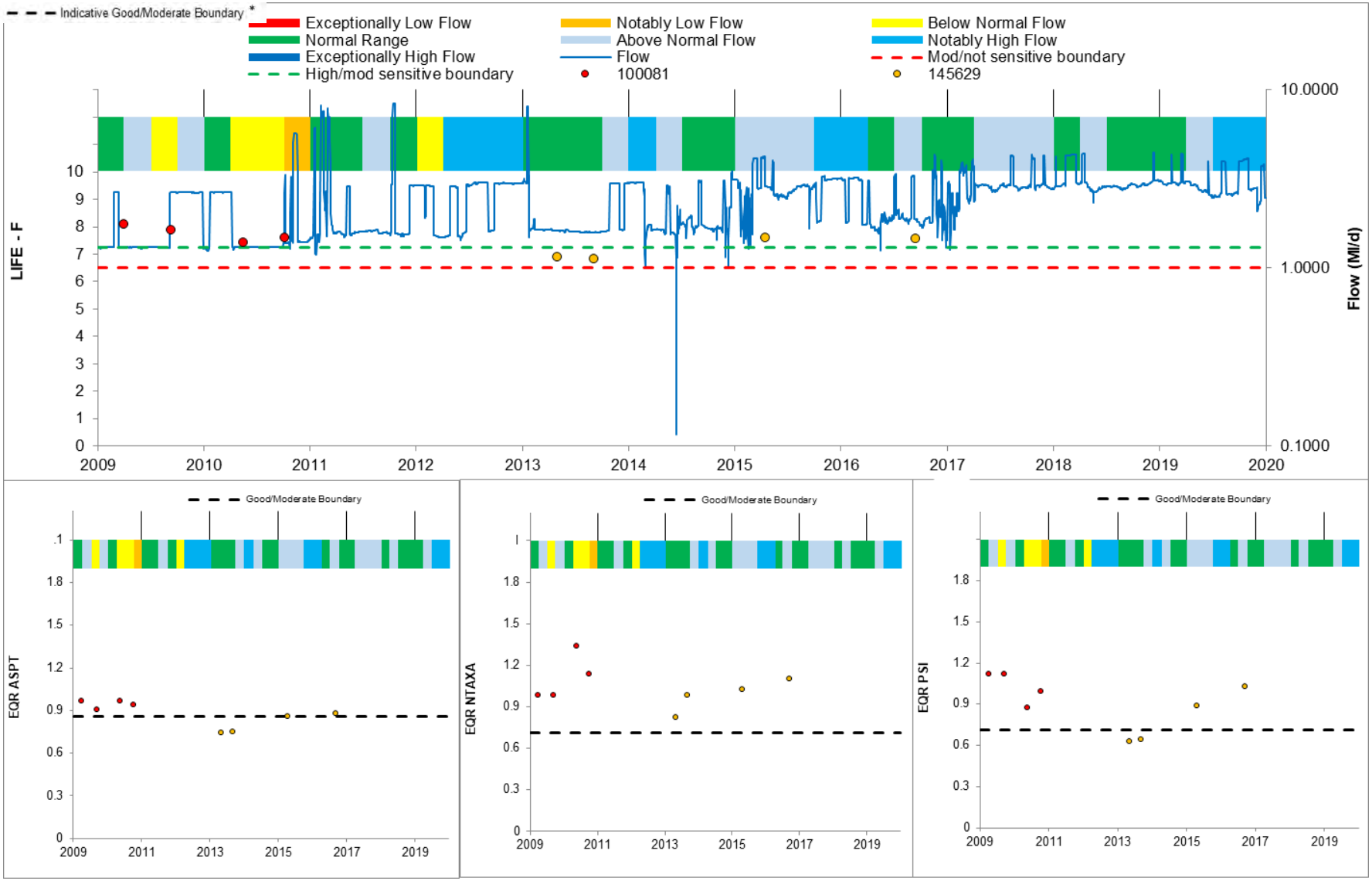
Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 but remain consistent with the standard to achieve good WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality. Upstream Tannery showed a no instances of deterioration to $WHPT_{ASPT}$ scores and maintained scores indicative of good standard during the monitoring period. D/S Embsay showed improved $WHPT_{ASPT}$ scores from 2013 to both 2015 and 2016. $WHPT_{ASPT}$ scores in 2013 were indicative of fair standard and improved in both 2015 and 2016 to scores indicative of good standard.

In Eller Beck T1 data from the site identifies macroinvertebrate communities which significantly vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 21 and 34. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community.

YWSL spring and autumn data from the site D/S Embsay Village for 2015 to 2018 describes a macroinvertebrate community which is also highly sensitive to flow reductions (LIFE score 7.37 and 7.78) and also show a high level of both diversity ($BMWP_{NTAXA}$ scores 25 and 32) and proportion of pollution sensitive taxa, $BMWP_{ASPT}$ scores of 5.61 and 6.54. This is consistent with the Environment Agency's baseline data and provides further evidence of the sensitivity of the community to drought option impacts.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Figure B2.1 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment.

B2.1.4.2 Fish

Waterbody GB104027063060 Haw Beck from Source to Eller beck is classified under cycle 2 (2016) as poor. Baseline fisheries data was provided for eight sites; Pasture Road (ID 32972), Skipton Road Bridge (ID 36768), U/S Pasture Road (ID 68064), D/S Skipton Road (ID 68065), Embsay Beck Reach 1 (ID 70144), Embsay Beck Reach 2 (ID 70145), Embsay Beck Reach 3 (ID 70146), Embsay Beck Treatment Works (ID 70147). Pasture Road was surveyed in 2009, 2015 and 2016; Skipton Road Bridge was only surveyed in 2016; U/S Pasture Road and D/S Skipton Road were only surveyed in 2016; and Embsay Beck Reach 1, Embsay Beck Reach 2, Embsay Beck Reach 3, Embsay Beck Treatment Works were only surveyed in 2017.

Based on the available information the fish community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.5**Table B2.5** sets out the available fish survey data from these sites. Additional YSWL baseline fisheries surveys were available for 2015 to 2017 at Skipton Road d/s (YW10077), Skipton Road u/s (YW10079) and Sewage Works (YW10078).

The WFD status of the fish community in Eller Beck T1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

No FCS2 was available to inform the classification of poor under cycle 2 (2016) for the WFD waterbody, however the latest FCS2 data was available for Skipton Road Bridge based on the 2015 survey. The site Skipton Road Bridge individually classifies as high with a site EQR of 0.8098, based on the FCS2 EQR scores from the 2015 survey. The site has a high diversity, with all of the three expected species present, and two additional species were also observed. Stone loach and bullhead are present at a level that meets/exceeds expectations, with an EQR scores of 1. Individual lamprey and three-spined-stickleback were also observed at the site, though both species had a low expected prevalence. Trout are observed at the site at a significantly lower densities than expected, contributing to an EQR score of 0.41. The lower than expected density of trout had a significant overall effect on the site EQR value. The impacts to the lamprey, bullhead and brown trout population of the waterbody has been detailed in **Section B2.1.3**.

Additional baseline fish data for Eller Beck T1 from YWSL sites at Skipton Road d/s (YW10077), Skipton Road u/s (YW10079) and Sewage Works (YW10078) showed similar species diversity with the reach. The number of brown trout and bullhead present were comparable to that observed in the surveys undertaken by the EA.

Based on the available information the fish community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.5 Fish survey data from Eller Beck T1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Stone loach	3-spined stickleback	Lamprey sp.	Minnow
32972	Pasture Road	07/08/2009	Catch depletion sample	6	17				
		24/08/2015	Single catch sample	No fish					
		13/09/2016	Single catch sample	No fish					
36768	Skipton Road Bridge	14/08/2014	Single catch sample	10	43	2			
68064	U/S Pasture Road	13/09/2016	Single catch sample	No fish					
68065	D/S Skipton Road	13/09/2016	Single catch sample	2	41	5	1		
70144	Embsay Beck Reach 1	24/08/2017	Single catch sample	1	3				
70145	Embsay Beck Reach 2	24/08/2017	Single catch sample	8	1				
70146	Embsay Beck Reach 3	24/08/2017	Single catch sample	2	11				
70147	Embsay Beck Treatment Works	24/08/2017	Single catch sample	1	6				
YW10077	Skipton Road d/s	13/08/2015	Semi-quantitative	14	29	1	1		
		01/08/2016			3			1	
		14/08/2017		4	44				
YW10078	Sewage Works	13/08/2015	Semi-quantitative	13	45	5	1		
		01/08/2016		3	23	3		5	
		14/08/2017		4	19	5			
YW10079	Skipton Road u/s	13/08/2015	Quantitative	21	59	1		1	
		11/08/2016		5	55			6	
		14/08/2017		6	44	1			

B2.1.4.3 WFD Waterbody Status

Table B2.6 summarises the WFD Classification of waterbody which contain the impacted reach. **Table B2.6** also displays the objective status for 2016 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.6 WFD Classifications

Waterbody ID & Name		GB104027063060 Haw Beck	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Poor	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Poor	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.1.5 Invasive non-native species (INNS)

Table B2.7 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.7**).

Table B2.7 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates Northern Crangonyctid (*Crangonyx pseudogracilis*) New Zealand mud snail (*Potamopyrgus antipodarum*)	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial and Aquatic plants Himalayan balsam (*Impatiens glandulifera)* Giant Hogweed *(Heracleum mantegaziaunum)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.1.6 Landscape, Navigation, Recreation and Heritage

Table B2.8 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.8**).

Table B2.8 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location	Susceptibility to flow and level impacts	Sensitivity	Further Consideration Required (Y/N)
Park Hill earthwork – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No

B2.2 Eller Beck 1

B2.2.1 Statutory designated sites

No sites of international/national importance that are sensitive or susceptible to drought option impacts have been identified.

B2.2.2 NERC and local wildlife sites

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified.

B2.2.3 NERC and other protected species

Table B2.9 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish is sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. The data shows the species has not been recorded in the reach prior to 2009. Additionally, white-clawed crayfish surveys carried out by YWSL in 2016 (in Eller Beck 1) found no evidence of white-clawed crayfish, however, it is not possible to conclusively rule out their presence. As the presence of the feature cannot be ruled out within the impacted reach and suitable habitat present, a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.9 identifies the potential for impacts associated with the drought option upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates the presence of otter within the Eller Beck 1. However, no information from survey findings was available and although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option.

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including two NERC Act Section 41 fish species (brown trout and river lamprey) and two notable fish species (bullhead and brook lamprey). Baseline data for these species is detailed in **Section B2.2.4.**

Several NERC Act section 41 and notable bird species have been identified as present in water dependent habitats which rely on the impacted reach. Based on the available information these species are considered not to be susceptible to drought option impacts and **not sensitive** to the physical environment impacts identified in **Appendix A.**

Table B2.9 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipes)*	Moderate/Minor	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals Otter *(Lutra lutra)*	Moderate/Minor	Otters are known to use the impacted reaches. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Fish -Brown Trout (*Salmo trutta)*	Moderate/Minor	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species – Fish -Bullhead *(Cottus gobio)* -Brook lamprey *(Lampetra planeri)*	Moderate/Minor	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
NERC and Notable Species – Birds There are a number of species	Moderate/Minor	The following bird species to varying extents rely on water dependent habitats. However, they are not expected to be impacted severely from implementation of the drought option against a baseline of	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
present across the region.		reduced flows characteristic of drought: - Eurasian Curlew (*Numenius arquata)* - Swallow (*Hirundo rustica)* - Redshank (*Tringa tetanus)* - House Martin (*Delichonurbica)*		

B2.2.4 WFD Features

B2.2.4.1 Macroinvertebrates

The WFD GB104027063020 Eller Beck from Haw Beck to River Aire classifies as 'good' for macroinvertebrates in 2016, Cycle 2. Baseline data is provided by two Environment Agency monitoring sites, Skipton Woods (ID 1065) and U/S River Aire (ID 1272). The Skipton Woods monitoring site comprises spring and autumn sampling, for only 2009. The U/S River Aire monitoring site comprises spring and autumn sampling for 2013 and only a spring sample for 2015. YSWL monitoring data was also available for survey sites located at the site D/S Embsay Village (ID YW1063). D/S Embsay Village had baseline survey data for two seasonal samples for 2015 to 2018. WHPT scores were not available at D/S Embsay Village in 2015, with only BMWP scores recorded. WHPT scores were recorded at D/S Embsay Village from 2016 to 2018, however, to allow year over year analysis only BWMP scores will be used at this site.

The WFD status of the macroinvertebrate community in Eller Beck 1 may be impacted by the implementation of the Embsay Reservoir drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Baseline data indicates that under present conditions, the macroinvertebrate community in Eller Beck 1 is highly sensitive to reduced flows (**Figure B2.2**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.2** Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve moderate to good WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a proportion of taxa which have medium sensitivity to pressures including water quality. U/S River Aire recorded a decrease in $WHPT_{ASPT}$ scores, from spring 2013 to autumn 2013 and spring 2015, though all scores remained above the good/moderate boundary.

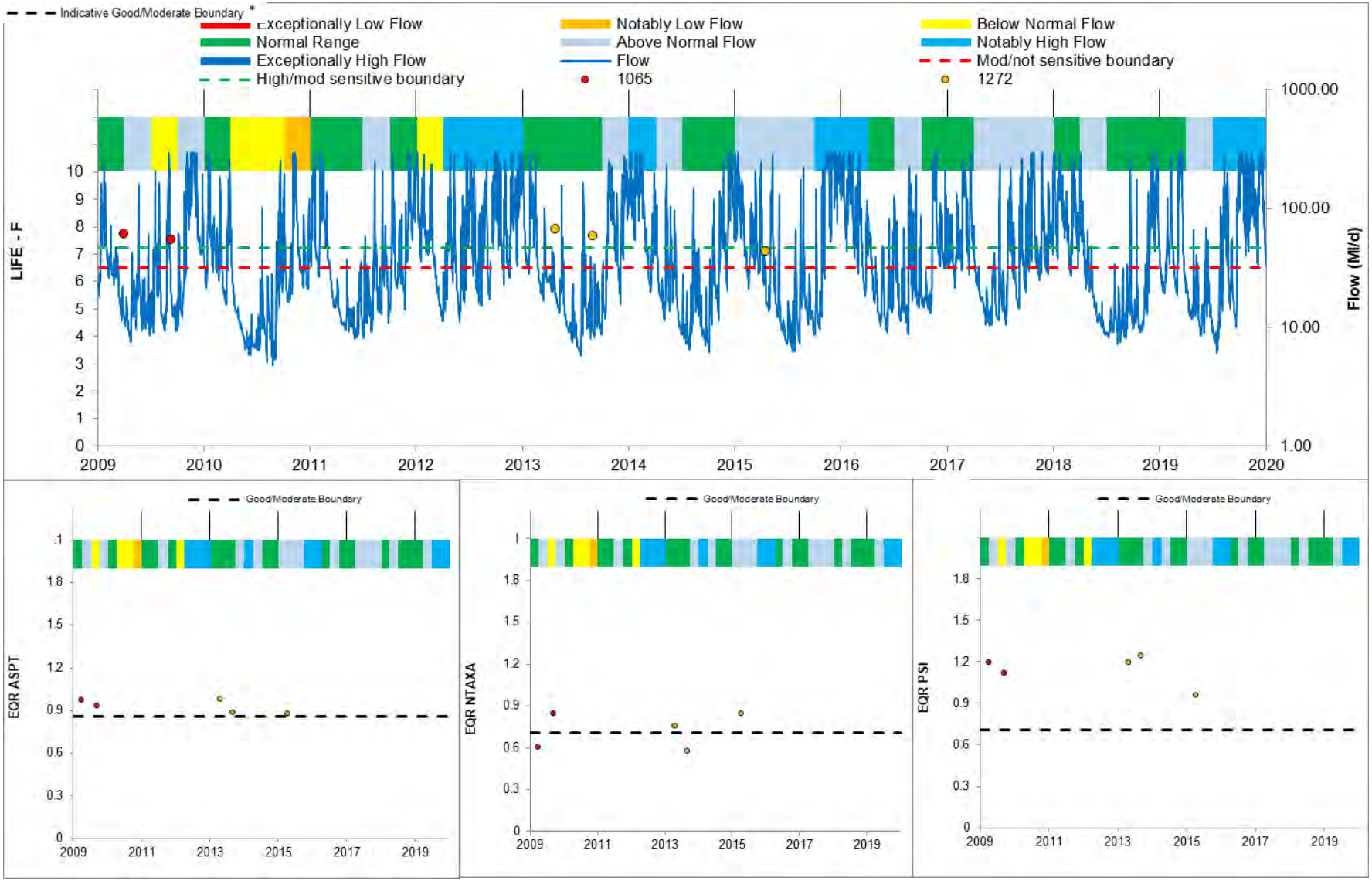
In Eller Beck 1 data from the site identifies macroinvertebrate communities which significantly vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 19 and 28. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community.

YWSL spring and autumn data from the site D/S Embsay Village for 2015 to 2018 describes a macroinvertebrate community which is also highly sensitive to flow reductions (LIFE score 7.37 and 7.78) and also show a high level of both diversity ($BMWP_{NTAXA}$ scores 25 and 32) and proportion of pollution sensitive taxa, $BMWP_{ASPT}$ scores of 5.61 and 6.54. This is consistent with the Environment

Agency's baseline data and provides further evidence of the sensitivity of the community to drought option impacts.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Figure B2.2 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.2.4.2 Fish

Waterbody GB104027063020 from Haw Beck to River Aire is classified under cycle 2 (2016) as poor. Baseline fisheries data was provided for two sites; Spindle Mill (ID 28825) Ashcroft House (ID 28999). Spindle Mill and Ashcroft House were both surveyed in 2013 and 2014. **Table B2.10** sets out the available fish survey data from these sites. Additional YSWL baseline fisheries surveys were available for 2015 to 2016 at Spindle Mill (YW10080), Ashcroft house (YW10081) and Old Saw Mill (YW10082).

Two fisheries sites inform the classification of GB104027063020 Eller Beck from Haw Beck to River Aire (associated with Eller Beck 1). Spindle Mill and Ashcroft House are both classified as poor with site EQRs of 0.125 and 0. 0388, respectively.

The site Spindle Mill is individually classified as poor with a site EQR of 0.125, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively low diversity, with only two species present from an expected four species. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Trout are observed at the site at a significantly lower densities than expected, contributing to a poor EQR score of 0.1333. The lower than expected density of trout had a significant overall effect on the site EQR value.

The site Ashcroft House is individually classified as poor with a site EQR of 0.0388, based on the FCS2 EQR scores from the 2014 survey. The site has a moderate diversity, with four species present from an expected five species. Minnow and stone loach are present at a level that meets/exceeds expectations, with an EQR scores of 1. Trout are observed at the site at a significantly lower densities than expected, contributing to a poor EQR score of 0.05067. Bullhead were expected to be observed at the site, with an expected prevalence of greater than 50%, being more likely to occur at the site than not. The lower than expected density of trout and the absence of bullhead had a significant overall effect on the site EQR value.

Additional baseline fish data for Eller Beck 1 from YWSL sites at, Spindle Mill (YW10080), Ashcroft house (YW10081) and Old Saw Mill (YW10082) showed similar species diversity with the reach. The number of brown trout and bullhead present were comparable to that observed in the surveys undertaken by the EA. Low numbers of stone loach, three-spined-stickleback and lamprey sp. were also observed, with the addition of low to moderate numbers of minnow observed at Ashcroft house in 2015 and 2016.

Based on the available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.10 Fish survey data from Eller Beck 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Stone loach	3-spined stickleback	Lamprey sp.	Minnow
28825	Spindle Mill	22/08/2013	Single catch	8	28				
		05/09/2014	Single catch	7	233				
YW10080		07/09/2015	Semi-quantitative	15	32	1			
		01/09/2016	Semi-quantitative	8	85	1			
28999	Ashcroft House	22/08/2013	Single catch	19	3	15	3		33
		05/09/2014	Single catch	3		3		3	42
YW10081		07/09/2015	Semi-quantitative	10	21	10	10		
		01/09/2016	Semi-quantitative	1	43	24	1		61
YW10082	Old Saw Mill	07/09/2015	Quantitative	37	74	2	1		5
		01/09/2016	Semi-quantitative	11	41				

B2.2.4.3 WFD Waterbody Status

Table B2.11 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.11** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.11 WFD Classifications

Waterbody ID & Name		GB104027063020 Eller Beck	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Moderate/minor	
RBMP Cycle 2 Status/ Potential	Overall	Poor	
	Fish	Poor	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.2.5 Invasive non-native species (INNS)

Table B2.12 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.12 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates Northern Crangonyctid (*Crangonyx pseudogracilis*) New Zealand mud snail (*Potamopyrgus antipodarum*)	Moderate/minor	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial and Aquatic plants Himalayan balsam (*Impatiens glandulifera)* Giant Hogweed *(Heracleum mantegaziaunum)*	Moderate/minor	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.2.6 Landscape, Navigation, Recreation and Heritage

Table B2.13 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.13**).

Table B2.13 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Park Hill earthwork – Scheduled Ancient Monument	Moderate/minor	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No

B2.3 Silsden Beck 1

B2.3.1 Statutory designated sites

No sites of international/national importance that are sensitive or susceptible to drought option impacts have been identified.

B2.3.2 NERC and local wildlife sites

Table B2.14 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.14**).

Table B2.14 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Silsden Reservoir Woodland LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors	Not sensitive	No

B2.3.3 NERC and other protected species

Table B2.15 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

Table B2.15 identifies the potential for impacts upon otter in Silsden Beck 1, which were identified in the NERC Act Section 41 as species of principal importance.

Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option.

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and two notable fish species (bullhead and grayling). Baseline data for these species is detailed in **Section B2.3.4.**

Table B2.15 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters are known to use the catchment. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Fish	Major	Potentially susceptible as duration of impacts could include all seasons,	High	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
- Brown Trout (*Salmo trutta)*		and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.		
Notable Species - fish - Grayling (*Thymallus thymallus)* - Bullhead *(Cottus gobio)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes

B2.3.4 WFD Features

B2.3.4.1 Macroinvertebrates

The WFD waterbody GB104027062990, Silsden Beck from Source to River Aire classifies as 'good' for macroinvertebrates in 2016, Cycle 2. Baseline data is provided by one Environment Agency monitoring site, U/S Aire (ID 1396). Data for U/S Aire comprised of spring and autumn sampling for only 2013. No additional YSWL monitoring data was available within the impacted reach.

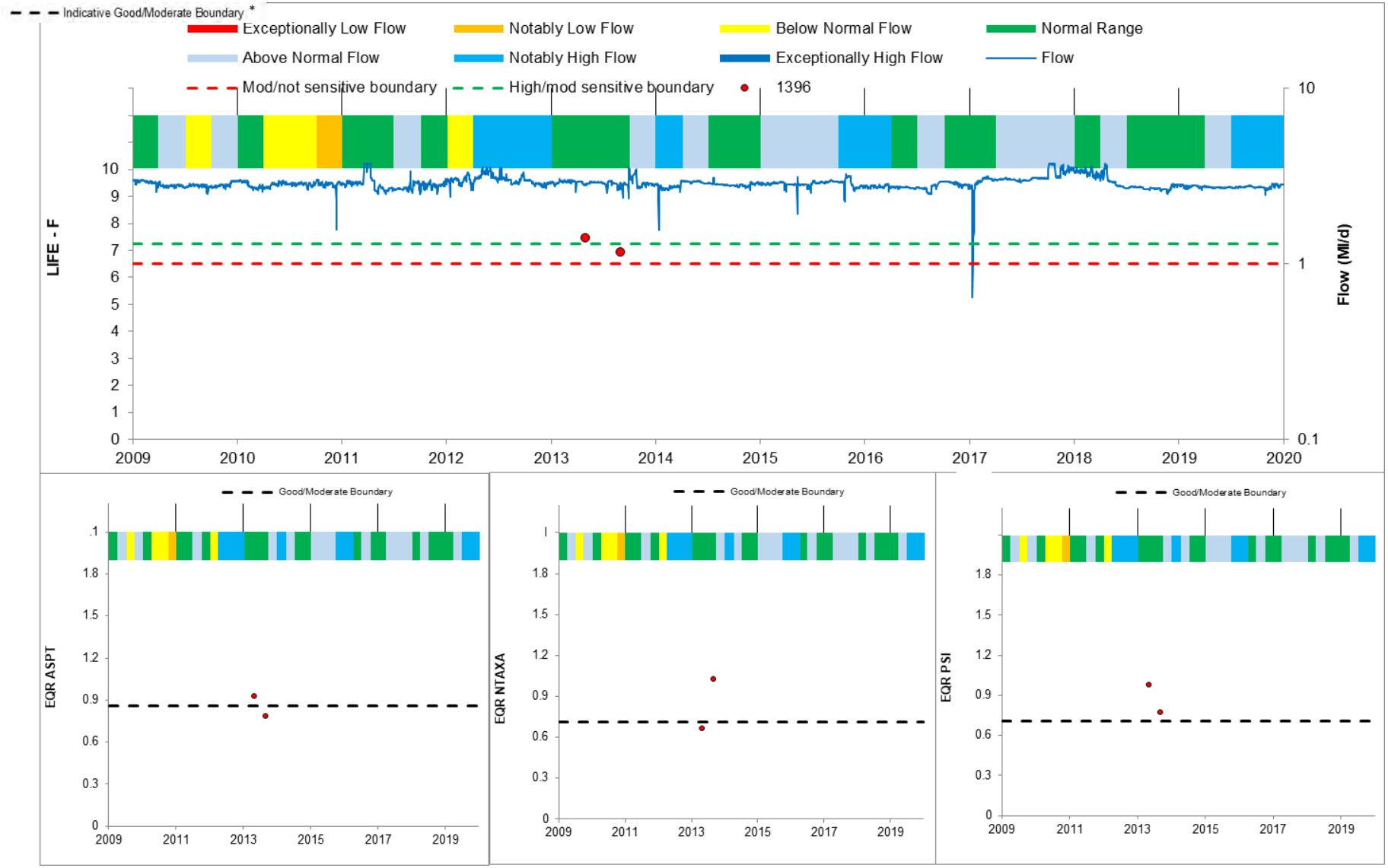
The WFD status of the macroinvertebrate community in Silsden Beck 1 may be impacted by the implementation of the Silsden Reservoir drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore cumulative impacts of the drought option must be considered in the context of environmental drought.

Baseline data indicates that under present conditions, the macroinvertebrate community in Silsden Beck 1 has medium to high sensitivity to reduced flows (**Figure B2.3**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.4**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve moderate or good WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality. U/S Aire recorded a decrease in $WHPT_{ASPT}$ scores indicative of good status in spring 2013 to scores indicative of moderate status from autumn 2013. The reduction in $WHPT_{ASPT}$ and LIFE scores in the most recent survey may suggest the reach is intermittently impaired

by water quality pressures such as organic pollution, however given the limitations in the data available this cannot be confirmed.

Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications. $WHPT_{ASPT}$ EQR scores for sites within the reach ranged between 0.78 and 0.92, indicative of moderate to good ecological status. $WHPT_{NTAXA}$ EQR scores showed extensive variance between spring and autumn, ranging between 0.66 and 1.03, indicative of poor to high ecological status. Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A.**

Figure B2.3 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.3.4.2 Fish

The WFD waterbody GB104027062990, Silsden Beck from Source to River Aire classifies as 'poor' for fish in 2016, Cycle 2. Baseline fisheries data was provided for one site, Silsden Beck d/s of Reservoir (ID 28978). Silsden Beck d/s of Reservoir was surveyed in 2013. **Table B2.16** sets out the available fish survey data from these sites. Additional YSWL baseline fisheries surveys were available for 2015 to 2016 at d/s reservoir (ID YW10072), Belton Road (ID 10073) and Silsden Beck d/s of Reservoir (ID 34).

The classification site Silsden Beck d/s Res provides the one sample site for the overall classification of poor, with an individual site EQR value of 0.0622.

The site Silsden Beck d/s Res is individually classified as poor with a site EQR of 0.0622, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively low diversity, with two species present from an expected three species. Trout had a poor EQR score of 0.054, with a significantly lower observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. The lower than expected density of trout had a significant overall effect on the site EQR value.

The latest FSC2 data from 2014 showed a decrease in the overall site EQR value to 0.0622, however remained indicative of poor status. Only two of the three expected species were recorded at the site, with bullhead being present at the site with an increased count of 137 individuals and low numbers of trout observed (2 Individuals).

Additional baseline fish data for Silsden Beck 1 from YWSL sites at, d/s reservoir (ID YW10072), Belton Road (ID 10073) and Silsden Beck d/s of Reservoir (ID 34) showed similar species diversity with the reach. The number of brown trout and bullhead present were comparable to that observed in the surveys undertaken by the EA. Low numbers of stone loach, three-spined-stickleback, and an individual grayling, with the addition of low to moderate numbers of minnow observed at Belton Road in 2015 and 2016.

Based on the available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.16 Fish survey data from Silsden Beck 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Grayling	Stone loach	Minnow	3-spined stickleback
28978	Silsden Beck d/s Res	22/08/2013	Single catch sample	7	29				
34	Silsden Beck d/s Res	17/09/2015	Single catch sample	6	10				
34	Silsden Beck d/s Res	02/09/2016	Semi-quantitative	4	71				
YW10072	d/s reservoir	07/09/2015	Single catch sample	No fish					
YW10072	d/s reservoir	02/09/2016	Single catch sample	3					
YW10073	Belton Road	17/09/2015	Quantitative	8	41		36	9	1
YW10073	Belton Road	02/09/2016		2	101	1	23	101	

B2.3.4.3 WFD Waterbody Status

Table B2.17 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.17** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.17 WFD Classifications

Waterbody ID & Name		GB104027062990 Silsden Beck	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Poor	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Good	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.3.5 Invasive non-native species (INNS)

Table B2.18 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.18 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates Signal Crayfish (*Pacifastacus leniusculus*) New Zealand mud snail (*Potamopyrgus antipodarum*)	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial and Aquatic plants Himalayan balsam (*Impatiens glandulifera)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.3.6 Landscape, Navigation, Recreation and Heritage

Table B2.19 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No Landscape, navigation, recreation and heritage features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.19 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Millennium Way – National Trail	Major	The route of the trail runs in close proximity to Silsden Beck. The river forms part of the landscape setting of the trail.	Not sensitive	No
Angling (Silsden Beck)	Major	Casual angling only	Low	No

B2.4 Bridgehouse Beck T1

B2.4.1 Statutory designated sites

No sites of international/national importance that are sensitive or susceptible to drought option impacts have been identified.

B2.4.2 NERC and local wildlife sites

No NERC Act Section 41 and other protected habitats that are sensitive or susceptible to drought option impacts have been identified.

B2.4.3 NERC and other protected species

Table B2.20 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

Table B2.20 identifies the potential for impacts associated with drought option implementation upon otter, which is identified in the NERC Act Section 41 as a species of principal importance.

Review of Environment Agency records and information received from the West Yorkshire Biological Records Centre indicates the presence of otter within the Bridgehouse Beck T1. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option.

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.2.4.**

Table B2.20 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters are known to use the impacted reach. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species - Fish -Brown trout *(Salmo trutta)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species - Fish	Major	Due to the presence of obstructions within the	High	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
-Bullhead *(Cottus gobio)*		waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.		

B2.4.4 WFD Features

B2.4.4.1 Macroinvertebrates

The WFD waterbody GB104027064200 Bridgehouse beck from Source to River Worth classifies as 'good' for invertebrates in 2016 under Cycle 2. Baseline macroinvertebrate data was provided by the Environment Agency for one site in Bridgehouse Beck T1, Further D/S Leeshaw Reservoir (ID 464). Further D/S Leeshaw Reservoir had baseline survey data for two seasonal samples for 2010 and 2015. YSWL monitoring data was also available for survey site located at the site Further D/S Leeshaw Reservoir. Further D/S Leeshaw Reservoir had baseline survey data for one seasonal sample for in Autumn 2015. WHPT scores were not available at Further D/S Leeshaw Reservoir in 2015, with only BMWP scores recorded.

The WFD status of the macroinvertebrate community in Bridgehouse Beck T1 may be impacted by the implementation of the Leeshaw Reservoir drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Bridgehouse Beck T1 is highly sensitive to reduced flows (**Figure B2.4**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores were available for the two sites. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.4**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve good or high WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality. There are no instances of deterioration to this standard during the monitoring period as such the community is not expected to have been impaired by water quality pressures historically.

In Bridgehouse Beck T1 data from the site identified a macroinvertebrate community which vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 25 and 35. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community.

YWSL 2015 autumn data from the site Further D/S Leeshaw Reservoir describes a macroinvertebrate community which is highly sensitive to flow reductions which LIFE score of 7.48. The data shows a moderate level of both diversity ($BMWP_{NTAXA}$ score of 29) and proportion of pollution sensitive taxa ($BWMP_{ASPT}$ of 6.17). This is consistent with the Environment Agency's baseline data.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A.**

Figure B2.4 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score

*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.4.4.2 Fish

Waterbody GB104027064200 Bridgehouse Beck from Source to River Worth is classified under cycle 2 (2016) as good. This classification is informed by three sites; D/S Leeshaw Rs (WR), d/s Leeming Res and Bridgehouse Beck which were all classified as being good. D/S Leeshaw Rs (WR) is the only classification site within the impacted reach, both d/s Leeming Res and Bridgehouse Beck are located in sections of the waterbody which are not within the impacted reach. These sites are within the zone of influence for the Leeming and Leeshaw drought options and are assessed within their respective impacted reaches (Bridgehouse Beck T2 and Bridgehouse Beck 1). As such FCS2 outputs from these sites will be utilised to provide an indication of the ecological status of the fish community within the impacted reach in relation to WFD status and informed by the sites within the impacted reach; D/S Leeshaw Res (WR) (ID 11986) and West Shaw Lane (ID 71663). Monitoring of the fish community at this site was also undertaken by YWSL in 2017. Additional monitoring Bridgehouse Beck T1 was undertake by YWSL at three sites; Site 147, Site 148 and Site 149.**Table B2.21** sets out the available fish survey data from these sites.

The site D/S Leeshaw Res (WR) is individually classified as high with a site EQR of 0.91, based on the FCS2 EQR scores from the 2018 survey. The site has a relatively good diversity, with three species present from an expected two species. Trout had a high EQR score of 0.7353, with a higher observed density than expected. Stickleback and bullhead are present at a level that meets/exceeds expectations, with an EQR scores of 1. The higher than expected densities for trout and the generally good diversity at the site both contributed to the high classification.

The FCS2 data provide the most recent indication of how the fish population in the waterbody relates to its 2016 Cycle 2 status and informs the assessment to determine risk to deterioration to the fish element of this waterbody. Data from the sites within the zone of influence and the classification sites detailed above were also used to inform the level of certainty applicable to this assessment.

The site d/s Leeming Res is individually classified as high with a site EQR of 0.724, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively good diversity, with four species present from an expected two species. Trout had a good EQR score of 0.6333, with a slightly higher observed density than expected. Stone loach, stickleback and gudgeon are present at a level that meets/exceeds expectations, with an EQR scores of 1. Stone loach were absent when expected at a moderate prevalence.

The third site, Bridgehouse Beck is individually classified as good with a site EQR of 0.462, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively low diversity, with two species present from an expected three species. Trout had a moderate EQR score of 0.3767, with a lower observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Stone loach were absent when expected at a moderate prevalence of 0.3941.

Sites within the impacted reach (Bridgehouse Beck T1) showed fish populations similar to the classification sites, with the relatively low to moderate counts of trout at sites West Shaw Lane, d/s Leeshaw Res, West Shaw Lane, Outside Lane and Bodkin Lane. Bullhead abundance was also relatively constant at each site, with Outside Lane having the highest count of 42 in 2017, d/s Leeshaw Res and having the lowest count of 4 individuals in 2017. A single Gudgeon was recorded at the site Bodkin Lane in 2017.

Based on the available information the fish community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.21 Fish survey data from Bridgehouse Beck T1

Site ID	Site name	Event date	Method	Brown/sea trout	Bullhead	Gudgeon	3-spined stickleback
11986	D/S Leeshaw Res (WR)	09/09/2014	Single catch sample	53			
11986	D/S Leeshaw Res (WR)	18/09/2018	Single catch sample	58	17		2
71663	West Shaw Lane	18/09/2018	Single catch sample	9	6		
147	d/s Leeshaw Res (West Shaw Lane)	18/09/2017	Single catch sample	14	4		
148	Outside Lane	18/09/2017	Single catch sample	22	42		
149	Bodkin Lane	18/09/2017	Catch depletion	52		6	105

B2.4.4.3 WFD Waterbody Status

Table B2.22 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.22** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.22 WFD Classifications

Waterbody ID & Name		GB104027064200 Bridgehouse Beck from Source to River Worth	**Sensitivity** (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Good	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.4.5 Invasive non-native species (INNS)

Table B2.23 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

Table B2.23 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates -New Zealand mud snail *(Potamopyrgus antipodarum)* -Freshwater shrimp *Crangonyx pseudogracilis*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants -Himalayan balsam (*Impatiens glandulifera)* -Japanese knotweed *(Fallopia japonica)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.4.6 Landscape, Navigation, Recreation and Heritage

Table B2.24 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.24**).

Table B2.24 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Calder/Aire Link – National Trail	Major	The route of the trail runs alongside Bridgehouse Beck. The river forms part the landscape setting of the trail.	Not sensitive	No
Angling (River Worth)	Major	Extensive non-club administered angling along the River Worth.	Low	No

B2.5 Bridgehouse Beck T2

B2.5.1 Statutory designated sites

No sites of international/national importance that are sensitive or susceptible to drought option impacts have been identified.

B2.5.2 NERC and local wildlife sites

Table B2.25 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.25**).

Table B2.25 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Paul Clough LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors	Not sensitive	No

B2.5.3 NERC and other protected species

Table B2.26 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

Table B2.26 identifies the potential for impacts associated with drought option implementation upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

The nationally scarce species of riffle beetle, *Riolus subviolaceus* has been identified as being present in Bridgehouse Beck T2 of the Leeming Reservoir drought option. The species was identified in routine sampling carried out by the Environment Agency at the site D/S Leeming Reservoir in October 2010. One specimen was present. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.5.4.**

Table B2.26 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters are potentially present in the impacted reach. However, they are not expected to be severely impacted by implementation of the drought option against a baseline of reduced flows characteristic of drought.	Low	Yes
NERC Species – Invertebrate -Riffle Beetle *(Riolus subviolaceus)*	Major	This species is moderately tolerant/sensitive of pollution (WHPT scores of 6.4) and such water quality pressures are unlikely to impact the species.	Low	Yes
NERC and Notable Species - Fish -Brown trout *(Salmo trutta)* -Bullhead *(Cottus gobio)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes

B2.5.4 WFD Features

B2.5.4.1 Macroinvertebrates

The WFD waterbody GB104027064200 Bridgehouse beck from Source to River Worth classifies as 'good' for invertebrates in 2016 under Cycle 2. Baseline macroinvertebrate data was provided by the Environment Agency for one site in Bridgehouse Beck T2, D/S Leeming Reservoir (ID 1489). D/S Leeming Reservoir had baseline survey data for two seasonal samples for 2010 and 2015. YSWL monitoring data was also available for survey site located at the site D/S Leeming Reservoir. D/S Leeming Reservoir had baseline survey data for two seasonal samples for 2015. WHPT scores were not available at D/S Leeming Reservoir in 2015, with only BMWP scores recorded.

The WFD status of the macroinvertebrate community in Bridgehouse Beck T2 may be impacted by the implementation of the Leeming Reservoir drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Bridgehouse Beck T2 is highly sensitive to reduced flows (**Figure B2.5**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores were available for the one site.

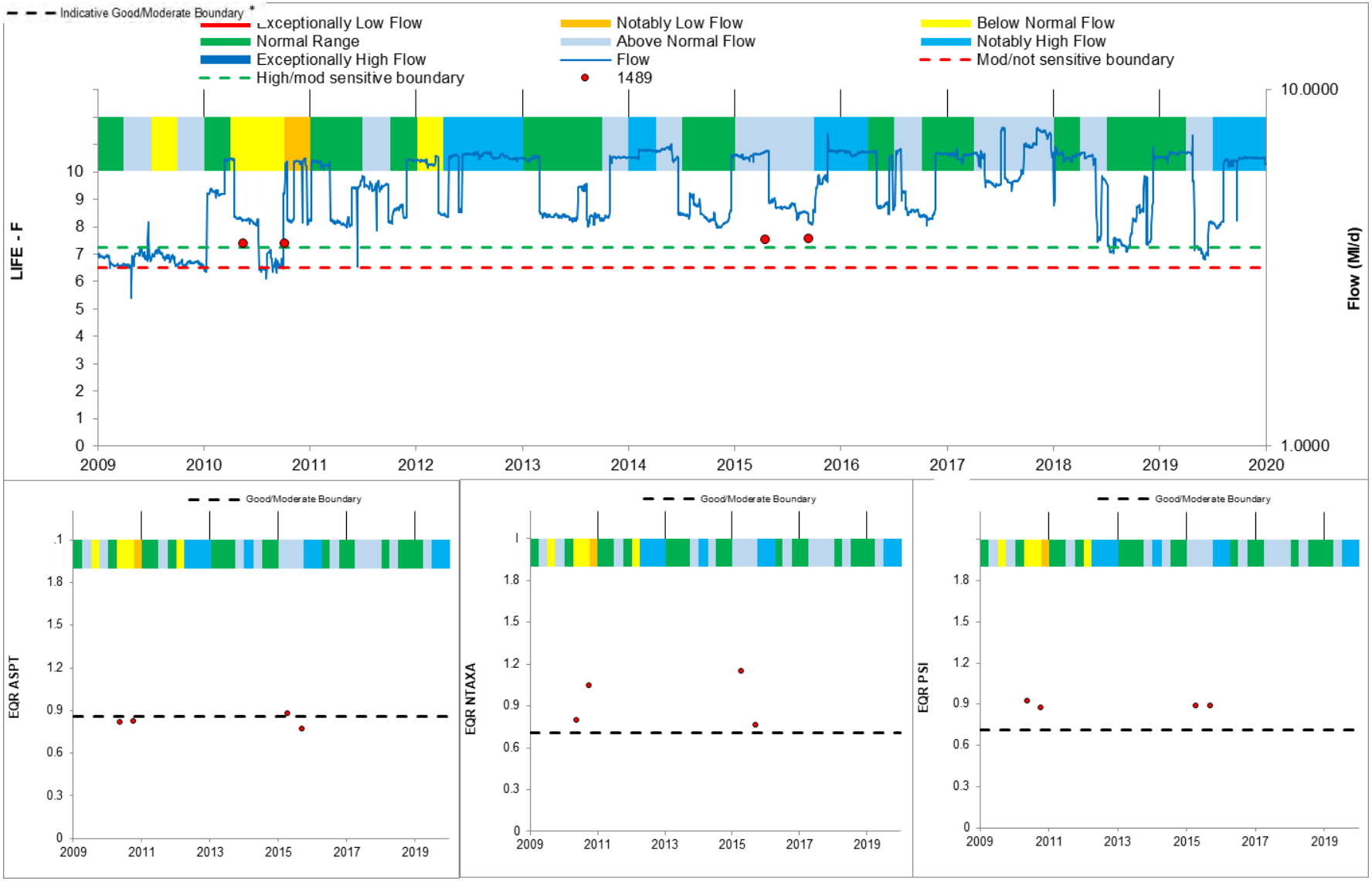
WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.5**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve moderate to good WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a proportion of taxa which have a medium sensitivity to pressures including water quality. This data suggests that the invertebrate community may have been subject to pressures including organic pollution historically, with taxa which are sensitive to such pressures reducing in abundance and diversity.

In Bridgehouse Beck T2 data from the sites identified macroinvertebrate communities which vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 22 and 33. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community.

YWSL 2015 spring and autumn data from the site D/S Leeming Reservoir describes a macroinvertebrate community which is highly sensitive to flow reductions which LIFE scores ranging between 7.61 and 7.80. The data shows a moderate level of both diversity ($WHPT_{NTAXA}$ scores of 21 and 28) and proportion of pollution sensitive taxa ($WHPT_{ASPT}$ = 5.38 and 5.79). This is consistent with the Environment Agency's baseline data.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **high** sensitivity to the physical environment impacts identified in **Appendix A.**

Figure B2.5 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.5.4.2 Fish

Waterbody GB104027064200 Bridgehouse Beck from Source to River Worth is classified under cycle 2 (2016) as good. This classification is informed by three sites; D/S Leeshaw Res (WR) (ID 11986), d/s Leeming Res (ID 29001) and Bridgehouse Beck (ID 29019) which were all classified as being good. D/S Leeming Res (ID 29001) is the only classification site within the impacted reach, both d/s Leeshaw Res and Bridgehouse Beck are located in sections of the waterbody which are not within the impacted reach. These sites are within the zone of influence for the Leeming and Leeshaw drought options and are assessed within their respective impacted reaches (Bridgehouse Beck T1 and Bridgehouse Beck 1). As such FCS2 outputs from these sites will be utilised to provide an indication of the ecological status of the fish community within the impacted reach in relation to WFD status and informed by the site within the impacted reach; D/S Leeming Res (ID 29001). Monitoring of the fish community at this site was also undertaken by YWSL in 2015, 2016 and 2017. Additional monitoring Bridgehouse Beck T2 was undertaken by YWSL at three sites; Site 62 (d/s Leeming Res), Site 63 (Recreation ground) and Site 64 (B6141 Oxenhope). **Table B2.27** sets out the available fish survey data from these sites.

The site d/s Leeming Res is individually classified as high with a site EQR of 0.724, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively good diversity, with four species present from an expected two species. Trout had a good EQR score of 0.6333, with a slightly higher observed density than expected. Stone loach, stickleback and gudgeon are present at a level that meets/exceeds expectations, with an EQR scores of 1. Stone loach were absent when expected at a moderate prevalence.

These FCS2 data provide the most recent indication of how the fish population in the waterbody relates to its 2016 Cycle 2 status and informs the assessment to determine risk to deterioration to the fish element of this waterbody. Data from the sites within the zone of influence and the classification sites detailed above were also used to inform the level of certainty applicable to this assessment.

The site D/S Leeshaw Res (WR) is individually classified as high with a site EQR of 0.91, based on the FCS2 EQR scores from the 2018 survey. The site has a relatively good diversity, with three species present from an expected two species. Trout had a high EQR score of 0.7353, with a higher observed density than expected. Stickleback and bullhead are present at a level that meets/exceeds expectations, with an EQR scores of 1. The higher than expected densities for trout and the generally good diversity at the site both contributed to the high classification.

The third site, Bridgehouse Beck is individually classified as good with a site EQR of 0.462, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively low diversity, with two species present from an expected three species. Trout had a moderate EQR score of 0.3767, with a lower observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Stone loach were absent when expected at a moderate prevalence of 0.3941.

Sites within the impacted reach (Bridgehouse Beck T2) showed fish populations similar to the classification sites, with the relatively low to moderate counts of trout at sites d/s Leeming Res, Recreation ground and B6141 Oxenhope. Bullhead abundance was also relatively constant at Recreation ground and B6141 Oxenhope, while bullhead were absent from d/s Leeming Res. A single 3-spined-stickleback was recorded at the site d/s Leeming Res in 2015.

Based on the available information the fish community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.27 Fish survey data from Bridgehouse Beck T2

Site ID	Site name	Event date	Method	Brown/sea trout	Bullhead	Stone loach	Gudgeon	3-spined stickleback
11986	D/S Leeshaw Res (WR)	05/08/2009	Catch depletion	36	68	2		
		08/09/2010	Catch depletion	44				
		09/09/2014	Single catch sample	53				
		18/09/2018	Single catch sample	58	17			2
29019	Bridgehouse Beck	09/09/2014	Single catch sample	28	21			
29001 (62)	D/s Leeming Res	09/09/2014	Single catch sample	68		11	1	1
		17/08/2015	Catch depletion	56		2		1
		01/08/2016	Single catch sample	31				
		07/08/2017	Catch depletion	28				
63	Recreation ground	17/08/2015	Catch depletion	25	82			
		01/08/2016	Single catch sample	6	41			
		07/08/2017	Single catch sample	6	34			
64	B6141 Oxenhope	17/08/2015	Catch depletion	45	26			
		04/08/2016	Single catch sample	12	23			

B2.5.4.3 WFD Waterbody Status

Table B2.28 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.28** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate

elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.28 WFD Classifications

Waterbody ID & Name		GB104027064200 Bridgehouse beck from Source to River Worth	**Sensitivity** (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Moderate	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Good	Medium
	Macroinvertebrates	Good	High
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.5.5 Invasive non-native species (INNS)

Table B2.29 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.29**).

Table B2.29 INNS Features

Site/Feature and designation	**Hydrological Impact at Location (Major, Moderate, Minor, Negligible)**	**Susceptibility to flow and level impacts**	**Sensitivity (Uncertain, High, Medium, Low, Not sensitive)**	**Further Consideration Required (Y/N)**
Invasive non-native species – Terrestrial plants -Himalayan balsam *Impatiens glandulifera* -Japanese knotweed *Fallopia japonica*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates -New Zealand mud snail *Potamopyrgus antipodarum* -Freshwater shrimp *Crangonyx pseudogracilis*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.5.6 Landscape, Navigation, Recreation and Heritage

Table B2.30 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.30**).

Table B2.30 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Bronte Way – National Trail	Major	The route of the trail runs alongside Leeming Water. The river forms part the landscape setting of the trail.	Not sensitive	No
Calder/Aire Link – National Trail	Major	The route of the trail runs alongside Bridgehouse Beck. The river forms part the landscape setting of the trail.	Not sensitive	No
Angling (River Worth)	Major	Extensive non-club administered angling along the River Worth. Flows during a drought will be low such that further reduction in flows would not be likely to further reduce the angling quality of the reach.	Low	No

B2.6 Bridgehouse Beck 1

B2.6.1 Statutory designated sites

No habitats that are sensitive or susceptible to drought option impacts have been identified.

B2.6.2 NERC and local wildlife sites

Table B2.31 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

One NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.31**).

Table B2.31 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Ives Plantation LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptor. St Ives plantation is a strip of woodland comprised predominately of oak, with beech and sycamore also present. Some oak are up to 150 years old.	Not sensitive	No
Airedale Spring Mill Pond, Haworth LWS	Major	Likely to be in connectivity with impacted reach and support aquatic receptors A rich species diversity for wet woodland and swamp.	Low	Yes
Brow Moor with Sugden End LWS	Major	Species-rich lowland acid mire within another qualifying habitat: large heathland unit; species rich nutrient rich swamp; mixed habitats. Unlikely to be in connectivity with impacted reach	Not sensitive	No

B2.6.3 NERC and other protected species

Table B2.32 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish is sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. Review of Environment Agency records indicate white-clawed crayfish were not historically recorded within the impacted reach at the two survey locations in 2007. Based on an assessment of habitat, during an Environment Agency walkover survey, potentially suitable habitat was observed. However, no current surveys were undertaken, so it is not possible to conclusively rule out their presence. As the presence of the feature cannot be ruled out within the impacted reach, a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.32 identifies the potential for impacts associated with the drought options upon otter, which is identified in the NERC Act Section 41 as a species of principal importance.

Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.6.4.**

Table B2.32 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipes)*	Major	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals -Otter *(Lutra lutra)*	Major	Otters are known to use the impacted reaches. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Fish - Brown Trout (*Salmo trutta)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species – Fish -Bullhead *(Cottus gobio)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes

B2.6.4 WFD Features

B2.6.4.1 Macroinvertebrates

The WFD waterbody GB104027064200 Bridgehouse Beck from Source to River Worth classifies as 'good' for invertebrates in 2016 under Cycle 2. Baseline data is provided by two Environment Agency monitoring sites, U/S Manhole (ID 1368) and U/S River Worth (ID 1273). Data for U/S Manhole comprised of spring and autumn sampling for 2009, 2013, and 2014. Data for U/S River Worth had two seasonal samples for 2013 and 2014. No additional YSWL monitoring data was available within the impacted reach.

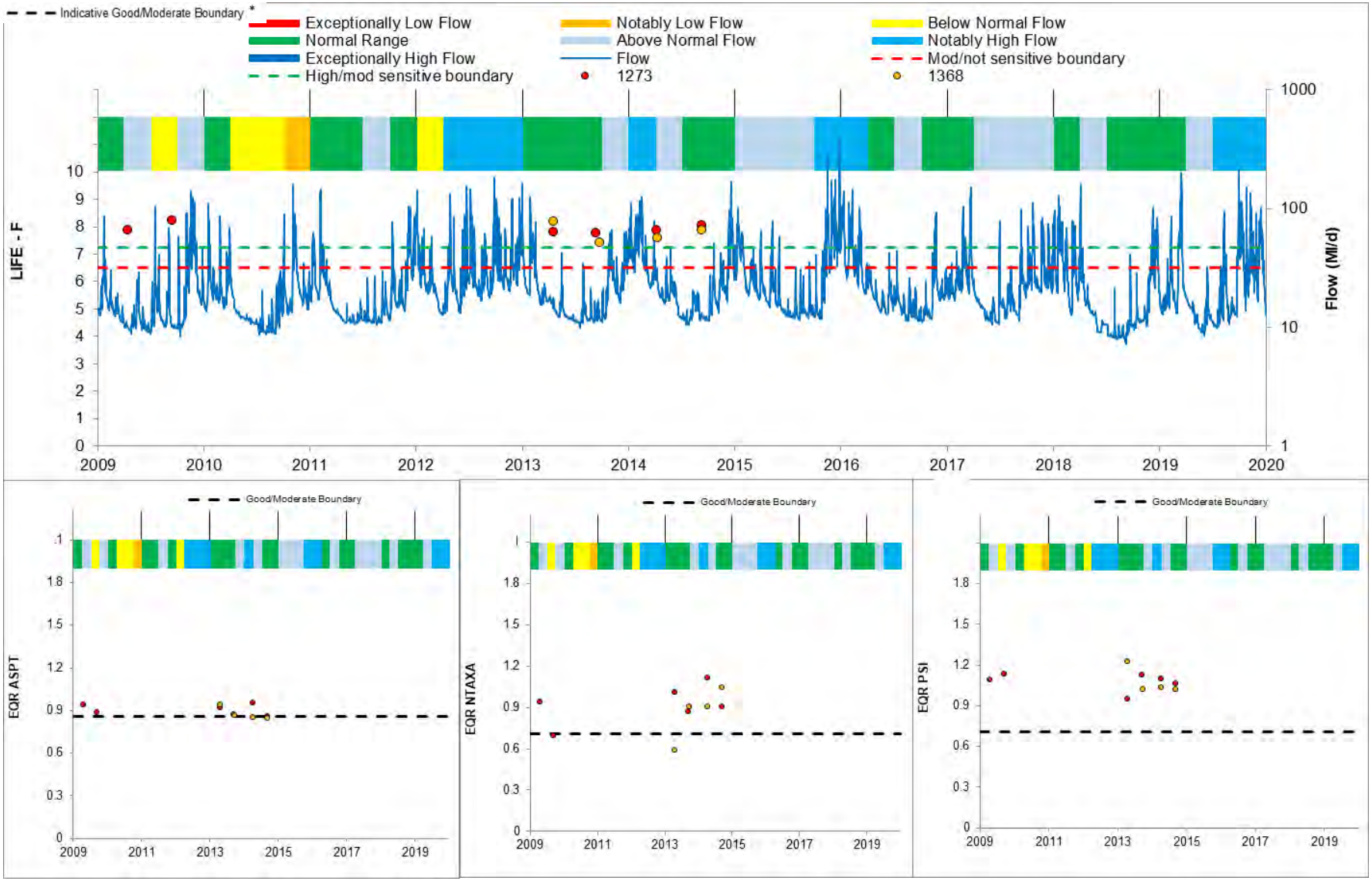
The WFD status of the macroinvertebrate community in Bridgehouse Beck 1 may be impacted by the implementation of the Leeming and Leeshaw Reservoirs' drought options. However, low flow impacts of these drought option implementations would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of these drought options must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Bridgehouse Beck Reach1 is high sensitivity to reduced flows (**Figure B2.6**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores were available for the two sites. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.6**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve good WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the sites identified macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality. $WHPT_{ASPT}$ EQRs describes a macroinvertebrate community which consistently achieves EQRs on the boundary of good to high status. There are instances of deterioration to this standard during the monitoring period as such the community has possibly been impaired by water quality pressures historically.

In Bridgehouse Beck 1 data from the sites identified macroinvertebrate communities which vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 17 and 32. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A.**

Figure B2.6 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.6.4.2 Fish

Waterbody GB104027064200 Bridgehouse Beck from Source to River Worth is classified under cycle 2 (2016) as good. This classification is informed by three sites; D/S Leeshaw Res (WR) (ID 11986), d/s Leeming Res (ID 29001) and Bridgehouse Beck (ID 29019) which were all classified as being good. Bridgehouse Beck (ID 29019) is the only classification site within the impacted reach, both d/s Leeshaw Res and Leeming Res are located in sections of the waterbody which are not within the impacted reach. These sites are within the zone of influence for the Leeming and Leeshaw drought options and are assessed within their respective impacted reaches (Bridgehouse Beck T1 and Bridgehouse Beck T2). As such FCS2 outputs from these sites will be utilised to provide an indication of the ecological status of the fish community within the impacted reach in relation to WFD status and informed by the site within the impacted reach; D/S Leeming Res (ID 29001). Monitoring of the fish community at this site was also undertaken by YWSL in 2015, 2016 and 2017. Additional monitoring Bridgehouse Beck 1 was undertaken by YWSL at three sites; Site 92 (Bridgehouse Beck), Site 93 (Bridgehouse Lane) and Site 94 (Ebor Lane). **Table B2.33** sets out the available fish survey data from these sites.

The site Bridgehouse Beck is individually classified as good with a site EQR of 0.462, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively low diversity, with two species present from an expected three species. Trout had a moderate EQR score of 0.3767, with a lower observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Stone loach were absent when expected at a moderate prevalence of 0.3941.

The FCS2 data provide the most recent indication of how the fish population in the waterbody relates to its 2016 Cycle 2 status and informs the assessment to determine risk to deterioration to the fish element of this waterbody. Data from the sites within the zone of influence and the classification sites detailed above were also used to inform the level of certainty applicable to this assessment.

The site D/S Leeshaw Res (WR) is individually classified as high with a site EQR of 0.91, based on the FCS2 EQR scores from the 2018 survey. The site has a relatively good diversity, with three species present from an expected two species. Trout had a high EQR score of 0.7353, with a higher observed density than expected. Stickleback and bullhead are present at a level that meets/exceeds expectations, with an EQR scores of 1. The higher than expected densities for trout and the generally good diversity at the site both contributed to the high classification.

The site d/s Leeming Res is individually classified as high with a site EQR of 0.724, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively good diversity, with four species present from an expected two species. Trout had a good EQR score of 0.6333, with a slightly higher observed density than expected. Stone loach, stickleback and gudgeon are present at a level that meets/exceeds expectations, with an EQR scores of 1. Stone loach were absent when expected at a moderate prevalence.

The site within the impacted reach (Bridgehouse Beck 1) showed fish populations similar to the classification sites, with the relatively low to moderate counts of trout at sites Bridgehouse Beck, Bridgehouse Lane and Ebor Lane. Bullhead were observed at all sites in low to moderate numbers across all survey years. One stone loach was observed at both Bridgehouse Beck and Bridgehouse Lane in 2016, while low numbers of 3-spined-stickleback (5 individuals) were recorded at Ebor Lane in 2015.

The fish community is considered to have a **medium** sensitivity to drought option impacts. As such, further assessment will not be undertaken.

Table B2.33 Fish survey data from Bridgehouse Beck 1

Site ID	Site name	Event date	Method	Brown/sea trout	Bullhead	Stone loach	3-spined stickleback
29019	Bridgehouse Beck	06/08/2009	Catch depletion	82	31		
		09/09/2014	Single Catch Simple	28	21		
		04/09/2015	Single Catch Simple	19	35		
YW92		23/08/2016	Single Catch Simple	17	77	1	
		22/08/2017	Single Catch Simple	24	43		
		04/09/2015	Catch depletion	6	100		
YW93	Bridgehouse Lane	26/08/2016	Catch depletion	9	153	1	
		05/10/2017	Catch depletion	1	7		
		04/09/2015	Catch depletion	35	60		5
YW94	Ebor Lane	23/08/2016	Single Catch Simple	3	11		
		05/10/2017	Single Catch Simple	15	52		

B2.6.4.3 WFD Waterbody Status

Table B2.34 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.34** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.34 WFD Classifications

Waterbody ID & Name		GB104027064200 Bridgehouse beck from Source to River Worth	**Sensitivity** (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Minor	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Good	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.6.5 Invasive non-native species (INNS)

Table B2.35 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.35**).

Table B2.35 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates -New Zealand mud snail *(Potamopyrgus antipodarum)* -Freshwater shrimp *Crangonyx pseudogracilis*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants -Himalayan balsam (*Impatiens glandulifera)* -Japanese knotweed *(Fallopia japonica)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.6.6 Landscape, Navigation, Recreation and Heritage

Table B2.36 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

Table B2.36 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Calder/Aire Link – National Trail	Moderate	The route of the trail runs alongside Bridgehouse Beck. The river forms part the landscape setting of the trail.	Not sensitive	No
Angling (River Worth)	Moderate	Extensive non-club administered angling along the River Worth.	Low	No

B2.7 Worth 1

B2.7.1 Statutory designated sites

No habitats that are sensitive or susceptible to drought option impacts have been identified

B2.7.2 NERC and local wildlife sites

Table B2.37 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.37**)

Table B2.37 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Baden Street LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptor. The site is composed of mixed deciduous oak/birch acid woodland. The shrub layer includes holly and grey willow. Ground plants include hair grass, bracken, wood sorrel and bramble. The site no longer achieves LWS criteria.	Not sensitive	No

B2.7.3 NERC and other protected species

Table B2.38 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish is sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. Review of Environment Agency records indicate white-clawed crayfish were not historically recorded within the impacted reach at the two survey locations in 2007. Based on an assessment of habitat, during an Environment Agency walkover survey, potentially suitable habitat was observed. However, no current surveys were undertaken, so it is not possible to conclusively rule out their presence. As the presence of the feature cannot be ruled out within the impacted reach, a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.38 identifies the potential for impacts associated with the drought options upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including two NERC Act Section 41 fish species (brown trout and brook lamprey) and a notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.1.4.**

Table B2.38 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipes)*	Major	UK NERC states that the White-clawed crayfish is sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters are known to use the impacted reaches. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species-fish Brown trout *(Salmo trutta)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species-fish Bullhead *(Cottus gobio)* Brook lamprey (*Lampetra planeri)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	Medium	Yes

B2.7.4 WFD Features

B2.7.4.1 Macroinvertebrates

The WFD waterbody GB104027064210 Worth from Source to Bridgehouse Beck classifies as 'good' for invertebrates in 2016 under Cycle 2. Baseline macroinvertebrate data was provided by the Environment Agency for two sites in the waterbody located within Worth 1, Providence Lane (ID 1127) and Site ID 1594. Providence Lane had baseline survey data for two seasonal samples for 2013, and Site ID 1594 had baseline survey data for two seasonal samples for 2010, and 2014 to 2019. Site ID 1594 only had autumn baseline survey data for 2013.

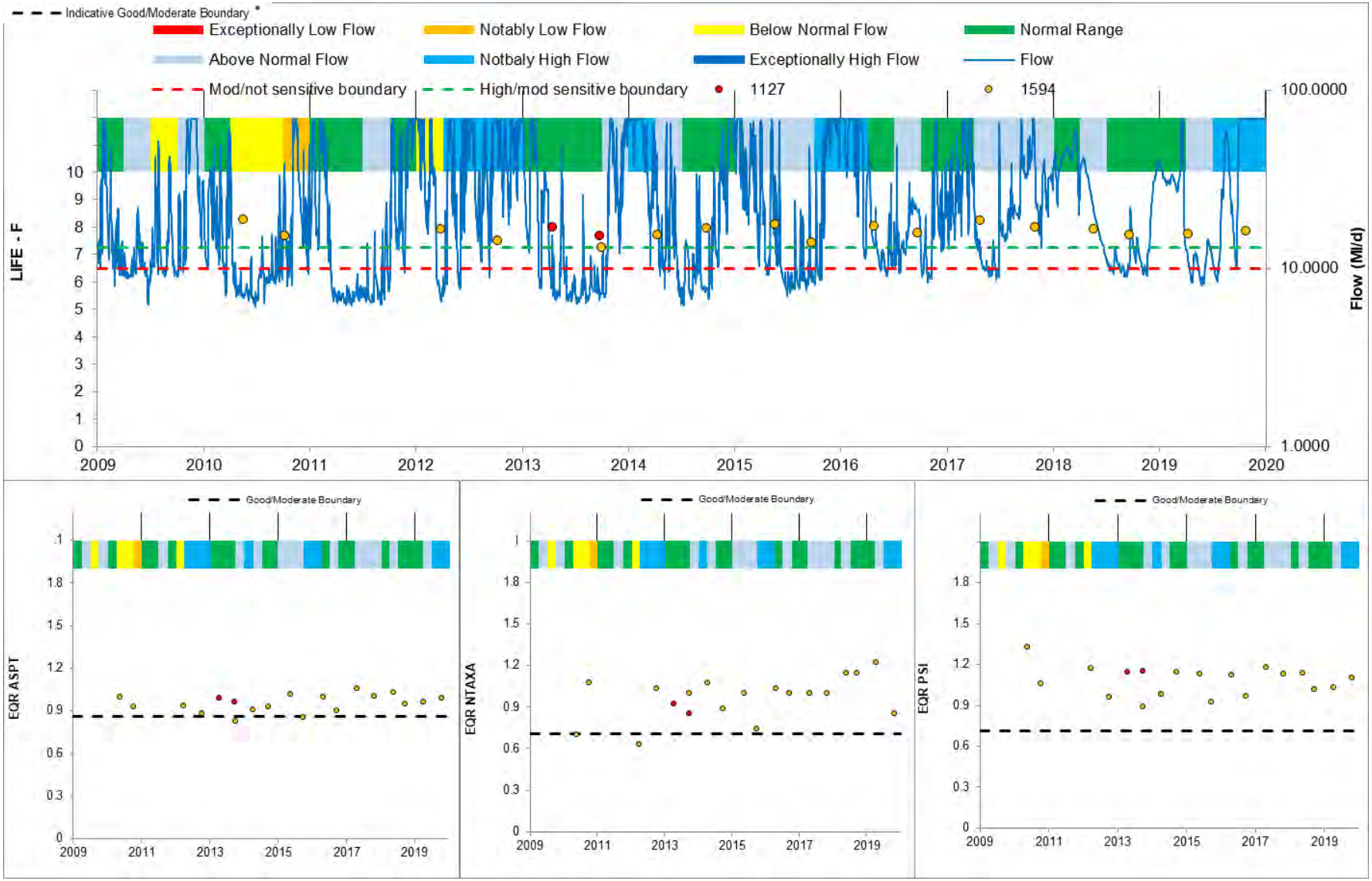
The WFD status of the macroinvertebrate community in Worth 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Worth 1 is highly sensitive to reduced flows (**Figure B2.7**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores were available for the three sites. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.7**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve good to high WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the sites identified macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality. There are no instances of deterioration to this standard during the monitoring period as such the community is unlikely to have been impaired by water quality pressures historically.

In Worth 1 data from the sites identified macroinvertebrate communities with considerable variation in terms of diversity, with $WHPT_{NTAXA}$ ranging between 17 and 33. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community, in particular immediately downstream of the reservoir diversity is most variable.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A.**

Figure B2.7 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.7.4.2 Fish

Waterbody GB104027064210 Worth from source to Bridgehouse Beck is classified under cycle 2 (2016) as 'good'. Two sites (D/S Ponden Mill (WR) and Providence Lane) inform the WFD classification of good for the waterbody GB104027064210 Worth from source to Bridgehouse Beck. Baseline monitoring is informed by two sites; D/S Ponden Mill (WR) (ID 11972) and Providence Lane (ID 16073).

The site D/S Ponden Mill (WR) is individually classified as good with a site EQR of 0.06466, based on the FCS2 EQR scores from the 2014 survey. The site has a relatively good diversity, with three species present from an expected two species. Trout had a good EQR score of 0.577, with a slightly lower observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Lamprey were also observed at the site, with a high EQR score of 0.979.

The site Providence Lane had a moderate EQR value of 0.2746. Species richness was good with three species observed of the three expected. Trout had a moderate EQR score of 0.2377, with a lower observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Lamprey were also observed at the site, with a high EQR score of 0.921. Stone loach were absent when expected at a moderate prevalence.

These FCS2 data provide the most recent indication of how the fish population in the waterbody relates to its 2016 Cycle 2 status and informs the assessment to determine risk to deterioration to the fish element of this waterbody.

Based on the available information the fish community is considered susceptible to impacts with a **high** sensitivity to impacts to physical environment impacts.

Table B2.39 Fish survey data from Worth 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Lamprey sp.
11972	D/S Ponden Mill (WR)	10/10/2010	Catch depletion sample	54	27	3
		09/09/2014	Single catch sample	45	13	1 to 9 [Best Run]
		06/08/2009	Catch depletion	63	35	
		01/09/2010	Single catch sample	35	10 to 99 [Survey]	1 to 9 [Survey]
16073	Providence Lane	15/08/2011	Single catch sample	35	32	2
		09/08/2012	Single catch sample	30	17	10 to 99 [Survey]
		16/08/2013	Single catch sample	30	18	30
		03/09/2014	Single catch sample	47	25	12
		02/09/2016	Single catch sample	18	11	2

B2.7.4.3 WFD Waterbody Status

Table B2.40 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.40** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.40 WFD Classifications

Waterbody ID & Name		GB104027064210 Worth from Source to Bridgehouse Beck	**Sensitivity** (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Good	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.7.5 Invasive non-native species (INNS)

Table B2.41 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.41**).

Table B2.41 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates -New Zealand mud snail *Potamopyrgus antipodarum*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants -Himalayan balsam *Impatiens glandulifera* -Japanese knotweed *Fallopia japonica*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.7.6 Landscape, Navigation, Recreation and Heritage

Table B2.42 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.42**).

Table B2.42 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Angling (River Worth)	Major	Extensive non-club administered angling along the River Worth. Flows during a drought will be low such that further reduction in flows would not be likely to further reduce the angling quality of the reach.	Low	No

B2.8 Worth 2

B2.8.1 Statutory designated sites

No sites of international/national importance that are sensitive or susceptible to drought option impacts have been identified.

B2.8.2 NERC and local wildlife sites

Table B2.43 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.43**Table B2.31).

Table B2.43 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Haworth-Oakworth Disused Sewage Works LWS	Major	Likely to be in connectivity with impacted reach and support aquatic receptors. A grassland area with wetlands and some woodland area.	Low	No
Whin's Wood LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors Woodland with extensive native bluebell cover	Not sensitive	No
Hainworth Wood LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors Species rich acid woodland: proximity to other qualifying woodland.	Not sensitive	No
Park Wood, Keighley LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors Ancient semi-natural woodland: species rich acid woodland	Not sensitive	No

B2.8.3 NERC and other protected species

Table B2.44 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

Table B2.44 identified the potential for impacts associated with the implementation of the drought options upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and three notable fish species (bullhead, grayling and brook lamprey).

Table B2.44 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – mammals Otter *Lutra lutra*	Major	Otters are known to use the impacted reaches. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species-fish -Brown trout *Salmo trutta*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species-fish -Bullhead *Cottus gobio* -Grayling *Thymallus thymallus* -Brook lamprey (*Lampetra planeri*)	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes

B2.8.4 WFD Features

B2.8.4.1 Invertebrates

The WFD waterbody GB104027062891 Worth from Bridgehouse Beck to River Aire classifies as 'good' for invertebrates in 2016 under Cycle 2. Baseline macroinvertebrate data was provided by the Environment Agency for Worth 2 and consists of three sites; Keighley Garforth Rd (ID 584), Knowles Park (ID 1403) and D/S Bridgehouse Beck (ID 1579). Keighley Garforth Rd and Knowles Park both had baseline survey data for two seasonal samples for 2009, and D/S Bridgehouse Beck had baseline

survey data for two seasonal samples for 2010, 2013, 2016 and only a single season in 2018. No additional YWSL monitoring data was available for the macroinvertebrate community.

The WFD status of the macroinvertebrate community in Worth 2 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

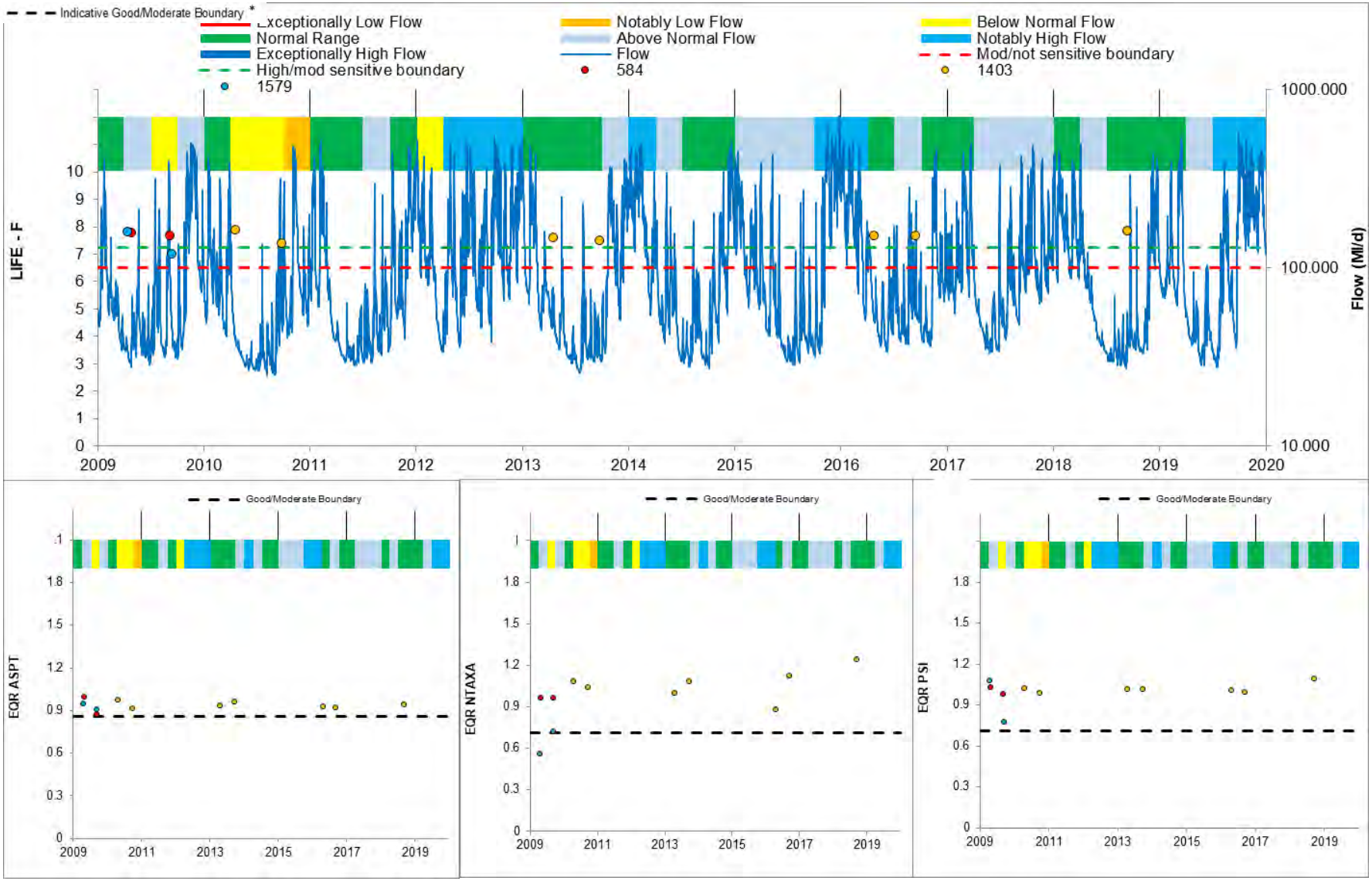
Assessment of macroinvertebrate community LIFE scores collected in spring and autumn sampling periods have been undertaken to determine the sensitivity of the community within Worth 2 to reductions in flow.

At the site D/S Bridgehouse Beck spring LIFE score exceeded 7.26 indicating high sensitivity to flow reductions, with autumn LIFE scores of 7.0 which is consistent with a community with medium sensitivity to flow reductions (**Figure B2.8)**. At Knowles Park and Keighley Garforth Rd all LIFE scores exceeded 7.26 indicating high sensitivity to flow reductions. See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores were available for the three sites. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.8**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve good to high WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the sites identified macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality. There were instances of deterioration to this standard during the monitoring period at across all sites, as such the community is unlikely to have been impaired by water quality pressures historically.

In Worth 2 data from the sites identified macroinvertebrate communities with considerable variation in terms of diversity, with $WHPT_{NTAXA}$ ranging between 14 and 31. $WHPT_{NTAXA}$ EQR scores ranged between 0.56 and 1.24, indicative of moderate to high ecological status. Based on the available baseline data the macroinvertebrate community within the reach is considered sensitive to water quality and environment impacts as identified in **Appendix A**.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A.**

Figure B2.8 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.8.4.2 Fish

Waterbody GB104027062891 Worth from Bridgehouse Beck to River Aire is classified under cycle 2 (2016) as moderate. Baseline fisheries data was provided for seven sites; Dalton Road (ID 73947), Hermit Hole U/S (ID 51967), Hermit Hole (ID 28740), D/S Woodhouse Road - Site 1 (ID 73944), Woodhouse Road - Site 2 (ID 73945), Woodhouse Road - Site 3 (ID 73946), Rock Ramp Weir D/S (ID52024). Hermit Hole was surveyed in 2009, 2013 and 2014, Hermit Hole U/S and Rock ramp weir – D/S were only surveyed in 2013, and Dalton Road, D/S Woodhouse Road - Site 1, Woodhouse Road - Site 2, Woodhouse Road - Site 3 were only surveyed in 2019. Monitoring of the fish community at some these sites was also undertaken in 2015 and 2016 by YWSL. Additional monitoring within the Worth 2 was undertake by YWSL at three sites; Woodhouse Road (YW10088), Hermit Hole U/S (/YW10087), Rock Ramp Weir D/S (YW10070). **Table B2.45** sets out the available fish survey data from these sites.

The WFD status of the fish community in Worth 2 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

The latest FCS2 data provided by the Environment Agency for the site at Hermit Hole individually classifies as moderate with a site EQR of 0.2988, based on the FCS2 EQR scores from the 2014 survey. The site had a relatively low diversity, with only two species from an expected four were present. Trout had a good EQR score of 0.6133, with a slightly lower observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Stone loach and minnow were absent when expected at a moderate prevalence. The impacts to the bullhead and brown trout population of the waterbody has been detailed in **Section B4.8.1** and is assessed as a minor and moderate impact magnitude respectively.

The latest FCS2 data provided by the Environment Agency for the site at Rock ramp weir - d/s individually classifies as high with a site EQR of 0.8506, based on the FCS2 EQR scores from the 2013 survey. The site had a relatively high diversity, with five species from an expected six were present. Trout had a good EQR score of 0.644, with a similar observed density to expected. Bullhead stone loach and minnow are present at a level that meets/exceeds expectations, with an EQR scores of 1. Additionally, grayling were observed at the site with a high EGR score of 0.8807.

Data provided by YWSL for sites Woodhouse Road (YW10088), Hermit Hole U/S (/YW10087), Rock Ramp Weir D/S (YW10070) within Worth 2 which were monitored in 2015, 2016 are also included in **Table B2.45**. This data provides further evidence for a fish population which is consistent with the available Environment Agency data. Bullhead were recorded at all sites and trout were observed at all sites, expect Hermit hole u/s in 2016. Low numbers of grayling, Lamprey sp, stone loach and minnow were also recorded during the surveys.

Based on the available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.45 Fish survey data from Worth 2

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Grayling	Lamprey sp.	Stone loach	Minnow	3-spined stickleback
28740	Hermit hole	12/08/2009	Catch Depletion Sample	25	46		1 to 9 [Survey]			
		16/08/2013	Single catch sample	11	3		1			
		04/09/2014	Single catch sample	34	33					
51967	Hermit hole - u/s	16/08/2013	Single catch sample	13	20					
52024	Rock ramp weir - d/s	16/08/2013	Single catch sample	54	19	16		16	3	
73947	Dalton road	12/09/2019	Single catch sample	6	5	8		5	2	
73944	D/s woodhouse road - site 1	12/09/2019	Single catch sample	1	9		10			12
73945	Woodhouse road - site 2	12/09/2019	Single catch sample	1	8		1			5
73946	Woodhouse road - site 3	12/09/2019	Single catch sample		4		3			12
Yw10070	Rock ramp weir d/s	17/09/2015		51	12	5		1	1	
Yw10070	Rock ramp weir d/s	18/08/2016		13	18			4	1	
Yw10087	Hermit hole u/s	28/08/2015		61	148		4			
Yw10087	Hermit hole u/s	18/08/2016			33					
Yw10088	Woodhouse road	28/08/2015		51	42		4			
Yw10088	Woodhouse road	18/08/2016		32	161		9			

B2.8.4.3 WFD Waterbody Status

Table B2.46 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.46** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.46 WFD Classifications

Waterbody ID & Name		GB104027062891 Worth from Bridgehouse Beck to River Aire	**Sensitivity** (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Minor	
RBMP Cycle 2 Status/ Potential	Overall	Good	
	Fish	Good	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.8.5 Invasive non-native species (INNS)

Table B2.47 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.47**).

Table B2.47 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates -Freshwater Shrimp *Crangonyx pseudogracilis* -New Zealand mud snail *Potamopyrgus antipodarum*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants -Himalayan balsam *Impatiens glandulifera* -Japanese knotweed *Fallopia japonica*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.8.6 Landscape, Navigation, Recreation and Heritage

Table B2.48 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.48**).

Table B2.48 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Angling (River Worth)	Major	Extensive non-club administered angling along the River Worth. Flows during a drought will be low such that further reduction in flows would not be likely to further reduce the angling quality of the reach.	Low	No

B2.9 Denholme Beck 1

B2.9.1 Statutory designated sites

No sites of international/national importance that are sensitive or susceptible to drought option impacts have been identified.

B2.9.2 NERC and local wildlife sites

Table B2.49 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.49**).

Table B2.49 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Thornton - Cullingworth Disused Railway (South) LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. A large section of woodland along the disused railway line.	Not sensitive	No
Buck Park Quarry LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. A large open cast quarry.	Not sensitive	No
Milking Hole Beck and Hewenden Reservoir LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. A large expanse of acid woodland with areas of oak-birch woodland and wet woodland. areas of improved natural grassland, neutral grassland, acid grassland and wet grassland are also present.	Not sensitive	No
Doe Park Reservoir LWS	Major	Unlikely to be in connectivity with impacted reach. The site includes the reservoir and mixed habitats surrounding the water's edge.	Not sensitive	No

B2.9.3 NERC and other protected species

Table B2.50 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish is sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. The data shows no surveys or records have been recorded in the impacted. Discussions with the Environment Agency have not identified the feature is present downstream of Doe Park Reservoir. As the presence of the feature cannot be ruled out within the impacted reach, a precautionary approach has been adopted. Based on the available

information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.50 identified the potential for impacts associated with the drought option upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of water vole in the impacted reach. The data showed no surveys or records have been recorded in the impacted, although historic data does identify the feature to have been present in the impacted reach. However, the distribution of information and survey data for the species was considered to be limited. Therefore, absence cannot be confirmed. It was considered appropriate, following the precautionary principle, to consider water vole likely to be present in the reach at the time of the implementation of a drought option. Based on the limited available information water vole are considered to be susceptible to drought option impacts and have an **uncertain** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.9.4.**

Table B2.50 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipes)*	Major	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters are known to use the impacted reaches. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – mammals Water vole (*Arvicola amphibious)*	Major	Limited data is available for the impacted reach. Changes in water level are the most important factor influencing water vole populations, with species readily inhabiting areas of slow flowing and standing water. As such hydrological and associated impacts as a result of this drought option may reduce habitat	Uncertain	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		availability and alter the species food supply.		
NERC Species – Fish - Brown Trout (*Salmo trutta)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species – Fish -Bullhead (*Cottus gobio)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	Medium	Yes

B2.9.4 WFD Features

B2.9.4.1 Macroinvertebrates

The WFD waterbody GB104027062870 Harden Beck from Source to River Aire classifies as 'good' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by one Environment Agency monitoring site, D/S Doe Park Reservoir (ID 145600). D/S Doe Park Reservoir had baseline survey data for two seasonal samples for 2009, 2010, and only a single season in 2016. Additional YWSL monitoring data was available for the macroinvertebrate community at D/S Doe Park Reservoir for two seasonal samples for 2015. WHPT scores were not available at D/S Doe Park Reservoir in 2015, with only BMWP scores recorded.

The WFD status of the macroinvertebrate community in Denholme Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Denholme Beck 1 is medium to highly sensitive to reduced flows (**Figure B2.9**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.9**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve poor to moderate WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a low proportion of taxa which are sensitive to

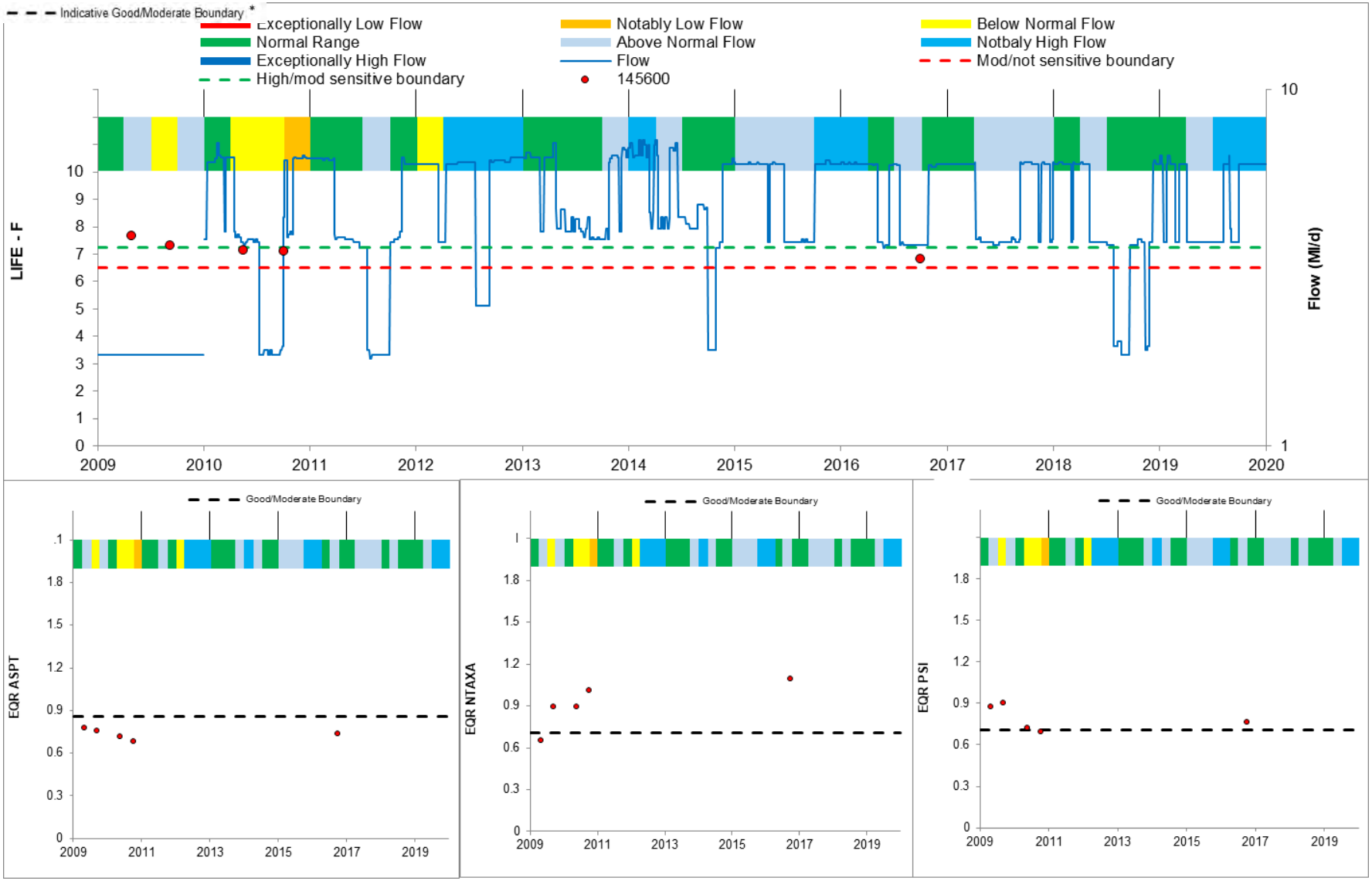
pressures including water quality. As such could the community be subjected to further water quality pressure in relation to this drought option.

In Denholme Beck 1 data from the site identifies macroinvertebrate communities which significantly vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 16 and 27. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows or/and water quality may be an influence on the baseline community, in particular immediately downstream of the reservoir diversity is most variable.

YWSL 2015 spring and autumn data from the site D/S Doe Park Reservoir describes a macroinvertebrate community which is also highly sensitive to flow reductions (LIFE score 6.8 and 6.82) and also show a moderate level of diversity ($BMWP_{NTAXA}$ scores 23 and 26) and a moderate to good proportion of pollution sensitive taxa, $BMWP_{ASPT}$ scores of 5.3 and 5.54. This is consistent with the Environment Agency's baseline data and provides further evidence of the sensitivity of the community to drought option impacts.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a medium sensitivity to the physical environment impacts identified in **Appendix A.**

Figure B2.9 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.9.4.2 Fish

Waterbody GB104027062870 Harden Beck from Source to River Aire is classified under cycle 2 (2016) as moderate. Baseline fisheries data was provided for two sites in the waterbody; Meal Bridge Farm to Reservoir (ID 70424) and d/s Doe Park Reservoir (ID 28942). D/S Doe Park Reservoir was surveyed in 2009, 2014, 2016 and 2017, and Meal Bridge Farm to Reservoir was only surveyed in 2017. Monitoring of the fish community at some these sites was also undertaken in 2015, 2016 and 2017 by YWSL. Additional monitoring within the Denholme Beck 1 was undertake by YWSL at three sites; D/S Doe Park Reservoir (YW10058), u/s Meal Bridge (YW10059), Hollin Park (YW10060). **Table B2.51** sets out the available fish survey data from these sites.

The WFD status of the fish community in Denholme Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

The latest FCS2 data provided by the Environment Agency for the site at D/S Doe Park Reservoir individually classifies as bad with a site EQR of 0.0148, based on the FCS2 EQR scores from the 2016 survey. The site had an extremely low diversity, with only one species from an expected three were present. Bullhead were the only species present at the site, with a low number recorded (6 individuals). Trout were not observed in this reach, although they were expected to be present with a high prevalence of 0.9813. Data for trout from the 2009 survey observed 38 individuals at this site. The absence of trout from the site during the latest survey significantly impacted the classification of the site.

Additional baseline fish data for Denholme Beck 1 from YWSL sites /S Doe Park Reservoir (YW10058), u/s Meal Bridge (YW10059), Hollin Park (YW10060) showed similar species diversity with the reach. No brown trout were observed to be present at any of the survey sites and bullhead were present at comparable densities to that observers by the EA. Low numbers of perch were observed at u/s Meal Bridge in 2015 survey, comparable to the single perch observed in the 2009 survey by the Environment Agency.

Based on the available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.51 Fish survey data from Denholme Beck 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Perch
28942	d/s Doe Park Res	12/08/2009	Catch Depletion Sample	38	32	1
		04/09/2014	Single Catch Sample		18	
		29/09/2016	Single Catch Sample		6	
YW10058	d/s Doe Park Res	17/08/2015	Catch Depletion Sample		144	
		04/08/2016	Catch Depletion Sample		99	
		07/08/2017	Catch Depletion Sample		102	
YW10059	u/s Meal Bridge	17/08/2015	Single Catch Sample		59	2
		04/08/2016	Single Catch Sample		97	
		07/08/2017	Single Catch Sample		68	
70424	Meal Bridge Farm to Reservoir	24/09/2017	Single Catch Sample		10 to 99 [Survey]	
YW10060	Hollin Park	24/08/2015	Single Catch Sample		77	
		04/08/2016	Single Catch Sample		39	
		07/08/2017	Single Catch Sample		20	

B2.9.4.3 WFD Waterbody Status

Table B2.52 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.52** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.52 WFD Classifications

Waterbody ID & Name		GB104027062870 Harden Beck from Source to River Aire	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Moderate	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.9.5 Invasive non-native species (INNS)

Table B2.53 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.53 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates New Zealand mud snail (*Potamopyrgus antipodarum*)	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial and Aquatic plants Himalayan balsam (*Impatiens glandulifera)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.9.6 Landscape, Navigation, Recreation and Heritage

Table B2.54 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No Landscape, navigation, recreation and heritage features that are sensitive or susceptible to drought option impacts have been identified in **Table B2.54**.

Table B2.54 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
National Trails	Major	The routes of several national trails run alongside Denholme Beck. The river forms part the landscape setting of the trails.	Not sensitive	No
Angling	Major	Casual angling only.	Low	No

B2.10 Harden Beck 1

B2.10.1 Statutory designated sites

No sites of international/national importance that are sensitive or susceptible to drought option impacts have been identified

B2.10.2 NERC and local wildlife sites

Table B2.55 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.55**).

Table B2.55 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Milking Hole Beck and Hewenden Reservoir LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. A large expanse of acid woodland with areas of oak-birch woodland and wet woodland. areas of improved natural grassland, neutral grassland, acid grassland and wet grassland are also present.	Not sensitive	No
Thornton - Cullingworth Disused Railway (North) LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. A viaduct over the river.	Not sensitive	No
Harden Beck LWS	Major	The site is the impacted reach and supports aquatic receptors. The beck runs through agricultural land, housing/gardens and woodland and acts as a spawning ground for brown trout.	Medium	Yes
Hewenden Wood LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Base-rich planted broadleaved woodland, beech ancient replanted woodland and wet woodland.	Not sensitive	No
Goitstock Woods, Harden LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Woodland containing Harden Beck and waterfalls	Not sensitive	No
Cottingley Woods - Black Hills LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors.	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		Woodland including ancient woodland, conifer plantations, broadleaved plantations and wet woods and two ponds.		
St Ive's Estate LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. A country park hosting meadows, moorland, woodland including pine plantation and a pond	Not sensitive	No
NERC Habitat - Deciduous woodland -326151 -326150 -326157 -326156 -326152 -326155 -326154 -326161 -326160	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Acid grassland, Neutral grassland - dry tall-herb grassland, Neutral grassland - lowland hay meadow and pasture, improved permanent grassland, Fen meadows/rush pastures	Not sensitive	No
NERC Habitat - Lowland meadows -425211	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Neutral grassland - dry tall-herb grassland, Improved permanent grassland, Neutral Grassland - lowland hay meadow and pasture. Acid Grassland, Fen meadows/rush pastures.	Not sensitive	No

B2.10.3 NERC and other protected species

Table B2.56 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish is sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. The data shows no records have been observed in the impacted, although good habitat is present in the lower sections of the reach. As the presence of the feature cannot be ruled out within the impacted reach, a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.56 identifies the potential for impacts associated with the drought options upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment

Agency records indicates the presence of otter in the impacted reach during a 2011 survey. However, no information from survey findings is available and although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of water vole in the impacted reach. The data showed no surveys or records have been recorded in the impacted, although historic data does identify the feature to have been present in the impacted reach. However, the distribution of information and survey data for the species was considered to be limited. Therefore, absence cannot be confirmed. It was considered appropriate, following the precautionary principle, to consider water vole likely to be present in the reach at the time of the implementation of a drought option. Based on the limited available information water vole are considered to be susceptible to drought option impacts and have an **uncertain** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and two notable fish species (bullhead and grayling). Baseline data for these species is detailed in **Section B2.10.4.**

Several NERC Act section 41 and notable bird species have been identified as present in water dependent habitats which rely on the impacted reach. Based on the available information these species are considered not to be susceptible to drought option impacts identified in **Appendix A.**

Table B2.56 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipe)*	Major	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals Otter *Lutra lutra*	Major	Otters are known to use the impacted reaches. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – mammals Water vole (*Arvicola amphibious)*	Major	Limited data is available for the impacted reach. Changes in water level are the most important factor influencing water vole populations, with species readily inhabiting areas of slow flowing and standing water. As such hydrological and associated impacts as a result of this drought option	Uncertain	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		may reduce habitat availability and alter the species food supply.		
NERC Species – Fish - Brown Trout *Salmo trutta*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species – Fish -Bullhead *Cottus gobio* - Grayling *Thymallus thymallus*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	Medium	Yes
NERC and Notable species – Birds There are many bird species present across the region	Major	The following bird species to varying extents rely on water dependent habitats. However, they are not expected to be impacted severely from implementation of the drought option against a baseline of reduced flows characteristic of drought: - Reed Bunting (*Emberizaschoeniclus*) - Grey Wagtail (*Motacillacinerea)* - Swallow (*Hirundo rustica)* - Mute Swan (*Cygnus olo)*	Not sensitive	No

B2.10.4 WFD Features

B2.10.4.1 Macroinvertebrates

The WFD waterbody GB104027062870 Harden Beck from Source to River Aire classifies as 'good' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by three Environment Agency monitoring sites, Harden (ID 169), Beckfoot Lane (ID 170) and U/S Cowhouse Beck (ID 1116). Harden had baseline survey data for two seasonal samples for 2009 only, Beckfoot Lane had baseline

survey data for two seasonal samples for 2009 and 2013, and U/S Cowhouse Beck had baseline survey data for two seasonal samples for 2009 and 2010.

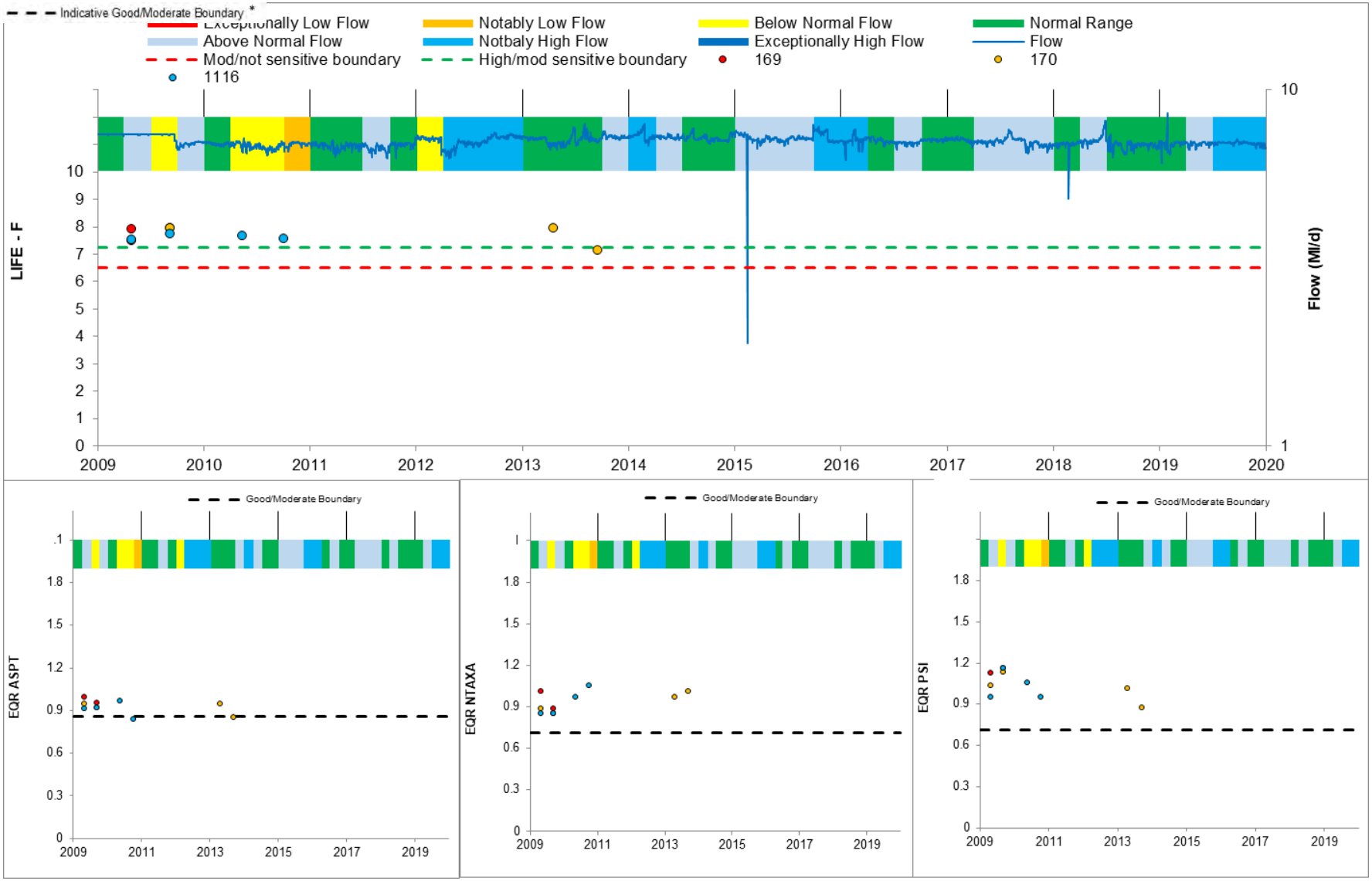
The WFD status of the macroinvertebrate community in Harden Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Harden Beck 1 is medium to highly sensitive to reduced flows (**Figure B2.10**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.10**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve moderate to high WFD status over the monitoring period. The most recent data from these sites was obtained from Beckfoot Lane in autumn 2013 and is consistent with the standards to achieve moderate status, which is a decrease from the spring survey on the same year (consistent with the standards to achieve good status). As such the macroinvertebrate community in the reach is likely to be impacted by water quality pressures including organic pollution. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality.

In Harden Beck 1 data from the site identifies macroinvertebrate communities which significantly vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 21 and 26. The most recent data from these sites was obtained from Beckfoot Lane in 2013, this indicates community diversity consistent with standard for high WFD status. All previous data from the monitoring sites were collected prior to 2010, as such it is assumed that the diversity of the community in recent times remains high. Impaired WHPTNTAXA scores can be indicative of pressures including denuded habitat quality, siltation or reduced water quality. This data suggests that these pressures are not currently acting on the community in Harden Beck 1, although the data does indicate that such pressures may have been present in the reach historically. Considering the limitations of this data there is uncertainty associated with sensitivity of the invertebrate community to these pressures as recent data for the two sites is limited in quantity.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix.**

Figure B2.10 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.10.4.2 Fish

Waterbody GB104027062870 Harden Beck from Source to River Aire is classified under cycle 2 (2016) as moderate. Baseline fisheries data was provided for two Environment Agency monitoring sites in the waterbody; Malt Shovel (Harden) (ID 28522) and Beckfoot Lane (Ford) (ID 11941). Malt Shovel (Harden) and Beckfoot Lane (Ford) were both surveyed in 2009 and 2014.

Additional monitoring of the fish community at this site was also undertaken in October 2015, 2016 and 2017 by YWSL. Additional monitoring within the Harden Beck 1 was undertake by YWSL at nr Harden (ID 28), Beckfoot Lane (YW10061) and Harden Grange (YW10062). **Table B2.56** sets out the available fish survey data from these sites.

The WFD status of the fish community in Harden Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Two sites informed the fish assessment with Beckfoot Lane (Ford) individually classified as high with a site EQR value of 0.703 and the d/s Doe Park Res site is classified as being good with a site EQR value of 0.433. d/s Doe Park Res is not within the impacted reach and has been discussed in further detail in Section B2.9.3.

The latest FCS2 data provided by the Environment Agency for the site Beckfoot Lane (Ford) individually classifies as high with a site EQR of 0.7964, based on the FCS2 EQR scores from the 2014 survey. The site had relatively high diversity, with six species from an expected five were present. Trout had a good EQR score of 0.547, with a slightly lower observed density than expected. Minor species such as stone loach, minnow and bullhead were present at a level that meets/exceeds expectations, with an EQR scores of 1. Additionally, gudgeon were observed at the site with a high EGR score of 0.901.The impacts to the bullhead and brown trout population of the waterbody has been detailed in Section B4.9.3.

Additional baseline fish data for Harden Beck 1 from YWSL sites nr Harden (ID 28), Beckfoot Lane (YW10061) and Harden Grange showed similar species diversity with the reach. The number of brown trout and bullhead present were comparable to that observers in the surveys by the EA. Low numbers of minor species such as stone loach, minnow, gudgeon and perch were observed within the impacted reach.

Based on the available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.57 Fish survey data from Harden Beck 1

Site ID	Site name	Event date	Method	Brown / sea trout	[illegible]	[illegible]	Stone Loach	Minnow	[illegible]	Perch
11941	Beckfoot Lane (Ford)	12/08/2009	Catch Depletion Sample	48	83	1	7	50	1	
		04/09/2014	Single Catch Sample	27	22	2	9	25	11	
28522	Malt Shovel (Harden)	12/08/2009	Catch Depletion Sample	130	94					
		04/09/2014	Single Catch Sample	106	104					3
		03/09/2015	Single Catch Sample	39	63					1
28	nr Harden	22/08/2016	Single Catch Sample	17	53					1
		22/08/2017	Single Catch Sample	27	43					1
YW10061	Beckfoot Lane	03/09/2015	Catch Depletion Sample	54	189	1	11	2		6
		22/08/2016	Single Catch Sample	3	31					
		22/08/2017	Single Catch Sample	22	143		26	24		
YW10062	Harden Grange	03/09/2015	Single Catch Sample	58	104					
		22/08/2016	Catch Depletion Sample	26	74					

B2.10.4.3 WFD Waterbody Status

Table B2.58 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.58** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.58 WFD Classifications

Waterbody ID & Name		GB104027062870 Harden Beck from Source to River Aire	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Moderate	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.10.5 Invasive non-native species (INNS)

Table B2.59 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.59 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates -New Zealand mud snail (*Potamopyrgus antipodarum*)	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants -Himalayan balsam (*Impatiens glandulifera)* -Japanese knotweed *(Fallopia japonica)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.10.6 Landscape, Navigation, Recreation and Heritage

Table B2.60 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.60**).

Table B2.60 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
National Trails	Major	The routes of several national trails run alongside Harden Beck. The river forms part the landscape setting of the trails.	Not sensitive	No
Five carved rocks in Cottingley Woods – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Shipley Golf Course	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Angling (Harden Beck)	Major	Casual angling only. Flows during a drought will be low such that further reduction in flows would not be likely to further reduce the angling quality of the reach.	Low	No

B2.11 Loadpit Beck 1

B2.11.1 Statutory designated sites

Table B2.61 summarises the sites of international/national importance (SSSI, SAC, SPA, Ramsar, Marine Conservation Zone, NNR, LNR) which are in hydrological connectivity with the impacted reach.

No statutory designated sites that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.61**).

Table B2.61 Statutory designated sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Trench Meadows SSSI	Major	The meadows are of special interest for their neutral grassland, which occurs with smaller areas of acid grassland and rush pasture, the latter associated with a number of flushes which run downslope through the fields. The site is above the level of the river and would not be affected by flow or level changes.	Not sensitive	No

B2.11.2 NERC and local wildlife sites

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified.

B2.11.3 NERC and other protected species

Table B2.62 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach. Susceptibility to physical environment impacts is identified according to whether the species are water dependent. Sensitivity is then determined according to environmental requirements of each species.

White-clawed crayfish is sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. The data shows no records have been observed in the impacted. As the presence of the feature cannot be ruled out within the impacted reach, a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.62 identified the potential for impacts associated with the drought option upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.11.4.**

Several NERC Act section 41 and notable bird species have been identified as present in water dependent habitats which rely on the impacted reach. Based on the available information these species are considered not to be susceptible to drought option impacts identified in **Appendix A.**

Table B2.62 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipe)*	Major	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals Otter (*Lutra lutra*)	Major	Otters are known to use the catchment. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Fish - Brown Trout (*Salmo trutta)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species – Fish -Bullhead (*Cottus gobio)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	Medium	Yes
NERC and Notable Species – Birds There are many bird species present across the region	Major	The following bird species to varying extents rely on water dependent habitats. However, they are not expected to be impacted severely from implementation of the drought option against a baseline of reduced flows characteristic of drought:	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		- Eurasian Curlew (*Numeniusarqauta)* - Reed Bunting (*Emberizaschoeniclus)* - Grey Wagtail (*Motacillacinerea)* - Swallow (*Hirundo rustica)* - Redshank (*Tringa tetanus)* - Mute Swan (*Cygnus olor)*		

B2.11.4 WFD Features

B2.11.4.1 Macroinvertebrates

The WFD waterbody GB104027063034 River Aire (River Worth to Gill Beck) classifies as 'moderate' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by two Environment Agency monitoring sites, D/S Reservoir (ID 1490) and Shipley Glen (ID 1118). Both sites had baseline survey data for two seasonal samples for 2009. Additional YWSL monitoring data was available for the macroinvertebrate community at D/S Reservoir for two seasonal samples for 2009. WHPT scores were not available at D/S Reservoir in 2009, with only BMWP scores recorded.

The WFD status of the macroinvertebrate community in Loadpit Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Loadpit Beck 1 is moderate to high sensitive to reduced flows (**Figure B2.11**). At the two sites LIFE scores are markedly higher at Shipley Glen in comparison to D/S Reservoir which also shows a greater degree of variation, this suggests the community present at D/S Reservoir is subject to more flow stress when the reservoir hasn't been overtopping and therefore is expected to be less impacted by further reductions in flow velocity. Whereas the community at Shipley Glen is likely more stable and not subjected to changes in flow velocity to the same extent due to the greater contribution of flow accretion from other sources in this lower section of the waterbody. See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.11**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve good WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality. Due to the limitations of the data set it is not possible to accurately determine the spatial or temporal variation of the macroinvertebrate community composition or diversity.

In Loadpit Beck 1 data from the site identifies macroinvertebrate communities which significantly vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 19 and 30. Low $WHPT_{NAXA}$ scores can be indicative of pressures including denuded habitat quality, siltation or reduced water quality. In this instance the water quality assessments provide no evidence for water quality pressures being present in the reach with ammonia and dissolved oxygen concentrations consistently meeting the standards for

high invertebrate status. Data collected in 2009 shows reduced EQR values relative to prior years, this coincides with elevated LIFE scores in 2009 which suggests a high flow event prior to sampling may have washed out taxa which are unable to tolerate high flows.

YWSL 2015 spring and autumn data from the site D/S Reservoir describes a macroinvertebrate community which is also highly sensitive to flow reductions (LIFE score 6.76 and 7) and also show a good level of both diversity ($BMWP_{NTAXA}$ scores 30 in both seasons) and a moderate to good proportion of pollution sensitive taxa, $BMWP_{ASPT}$ scores of 5.73 in both seasons. This is consistent with the Environment Agency's baseline data and provides further evidence of the sensitivity of the community to drought option impacts.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **high** sensitivity to the physical environment impacts identified in **Appendix A.**

Figure B2.11 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score

*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.11.4.2 Fish

Waterbody GB104027063034 River Aire (River Worth to Gill Beck) is classified under cycle 2 (2016) as moderate. This classification is informed by two sites; Crossflatts and Hirstwood u/s Bradford Beck which were classified as being moderate.

Both Crossflatts and Hirstwood u/s Bradford Beck are located in sections of the waterbody which are not within the impacted reach. As such FCS2 outputs from these sites will be utilised to provide an indication of the ecological status of the fish community within the impacted reach in relation to WFD status and informed by the site within the impacted reach; d/s Eldwick Reservoir (ID 11951), which was surveyed in 2009 and 2014.

Table B2.63 sets out the available fish survey data from these sites.

The WFD status of the fish community in Loadpit Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Two classification sites; Crossflatts and Hirstwood u/s Bradford Beck provide an overall classification of moderate for the waterbody GB104027063034 Aire (River Worth to Gill Beck). Both sites were individually classified as moderate, with Crossflatts having an individual EQR score of 0.274 and Hirstwood u/s Bradford Beck with an EQR of 0.380. Both of these sites were last surveyed in 2011. These FCS2 data provide the indication of how the fish population in the waterbody relates to its 2016 Cycle 2 status. and informs the assessment to determine risk to deterioration to the fish element of this waterbody. Data from the sites within the zone of influence and the classification sites detailed above were also used to inform the level of certainty applicable to this assessment.

The latest FCS2 data provided by the Environment Agency for the site Crossflatts individually classifies as poor with a site EQR of 0.1896, based on the FCS2 EQR scores from the 2017 survey. The site had relatively good diversity, with six species from an expected eight were present. Trout had a moderate EQR score of 0.2517, with a lower observed density than expected. Minor species such as stone loach, minnow and bullhead were present at a level that meets/exceeds expectations, with an EQR scores of 1. Grayling had a good EQR score of 0.5937, with a lower observed density than expected. Pike, chub, perch and roach were listed with an expected prevalence of greater than 50%, being more likely to occur at the site than not, though all species were absent. Additionally, European eel (3 individuals) were observed at the site with a high EQR score of 0.9933 due to the low expected prevalence. The lower than expected densities for trout and the absent of coarse fish species during the survey impacted the overall classification.

The latest FCS2 data provided by the Environment Agency for the site Hirstwood u/s Bradford Beck individually classifies as moderate with a site EQR of 0.380, based on the FCS2 EQR scores from the 2017 survey. The site had relatively good diversity, with six species from an expected eight were present. Trout had a moderate EQR score of 0.282, with a lower observed density than expected. Minor species such as stone loach, minnow and bullhead were present at a level that meets/exceeds expectations, with an EQR scores of 1. Grayling had a moderate EQR score of 0.372, with a lower observed density than expected. Pike and gudgeon were listed with an expected prevalence of greater than 50%, being more likely to occur at the site than not, though both species were absent. Chub had a good EQR score of 0.4663, with a lower observed density than expected.

The site within the impacted reach (Loadpit Beck 1) showed a high abundance of trout recorded in both the 2009 and 2014 surveys, though the number of individuals reduced from114 to 50. Similarly, the abundance of bullhead was high, though recorded individuals increased from 32 in 2009 to 40 in 2014. This site differs from the above classification sites though Crossflatts and Hirstwood u/s Bradford Beck supports a greater diversity the site within the impacted reach shows the presence of a large trout population relative to the watercourse.

Based on the available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.63 Fish survey data from Loadpit Beck 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead
11951	D/S Eldwick Reservoir	14/08/2009	Single Catch Sample	114	32
		10/09/2014	Single Catch Sample	50	40

B2.11.4.3 WFD Waterbody Status

Table B2.64 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.64** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.64 WFD Classifications

Waterbody ID & Name		GB104027063034 River Aire (River Worth to Gill Beck)	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Moderate	Medium
	Macroinvertebrates	Moderate	High
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.11.5 Invasive non-native species (INNS)

Table B2.65 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.65 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates Northern Crangonyctid (*Crangonyx pseudogracilis*) New Zealand mud snail (*Potamopyrgus antipodarum*)	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants Himalayan balsam (*Impatiens glandulifera)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.11.6 Landscape, Navigation, Recreation and Heritage

Table B2.66 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No Landscape, navigation, recreation and heritage features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.66 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Millennium Way – National Trail	Major	The route of the trail runs alongside Loadpit Beck. The river forms part the landscape setting of the trail.	Not sensitive	No
Dales Way Link – National Trail	Major	The route of the trail runs alongside Loadpit Beck. The river forms part the landscape setting of the trail.	Not sensitive	No
Cup-marked rock west of confluence Loadpit Beck and Glovershaw Beck –	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Scheduled Ancient Monument				
Small carved rock in the path east of Glovershaw Quarry – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup and groove marked rock on the east edge of Glovershaw Quarry –Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Carved rock near north east corner of Glovershaw Quarry	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup-marked rock on slight bank north east of Glovershaw Quarry – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Small cup-marked rock 30m east of Glovershaw Quarry	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Two Cairns (north and south) east of Glovershaw Quarry, including adjacent cup-marked rock – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Roadblock, Bracken Hall Green, Baildon Moor	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Enclosed settlement known as 'Soldiers Trench', including cup-marked rock – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Carved rock in field behind Bracken Hall Farm – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Carved rock above Bracken Hall Crag,	Major	Unlikely to be impacted over the duration of the	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
north of the bottom of the track to Mitton Spring		drought options implementation		
Cup-marked rock close to road south east of a small car park south east of Bracken Hall Farm – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Carved bedrock to the northeast of public toilets at Bracken Hall Green – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup-marked bedrock near Old Glen House – Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup-marked rock between road and public toilets at Bracken Hall Green - Scheduled Ancient Monument	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Angling (River Aire)	Major	Formal angling under the Bingley Angling club along the River Aire. Flows during a drought will be low such that further reduction in flows would not be likely to further reduce the angling quality of the reach.	Low	No

B2.12 Gill Beck 1

B2.12.1 Statutory designated sites

Table B2.67 summarises the sites of international/national importance (SSSI, SAC, SPA, Ramsar, Marine Conservation Zone, NNR, LNR) which are in hydrological connectivity with the impacted reach.

No sites of international/national importance habitats that are sensitive or susceptible to drought option impacts have been identified.

Table B2.67 Statutory designated sites

Site/Feature and designation	Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
South Pennine Moors SAC	Major	None. The Moors are upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not Sensitive	No
South Pennine Moors Phase 2 SPA	Major	None. The Moors are upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not Sensitive	No
South Pennine Moors SSSI	Major	None. The Moors are upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not Sensitive	No

B2.12.2 NERC and local wildlife sites

Table B2.68 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.2**).

Table B2.68 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC habitat- Deciduous woodland -325794 -325795 -325796	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Acid Grassland, Neutral Grassland - Lowland hay meadow and pasture, Improved Permanent Grassland, Fen meadows/rush pastures	Not sensitive	No
NERC habitat- Deciduous woodland -325965	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Neutral Grassland - Lowland hay meadow and pasture.	Not sensitive	No
NERC habitat- Lowland meadows -425156 -425158 -425159 -425161 -425163	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Improved permanent grassland, Neutral Grassland - lowland hay meadow and pasture Acid Grassland, Fen meadows/rush pastures	Not sensitive	No
NERC habitat- Lowland meadows -425185 -425186	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Improved permanent grassland, Neutral Grassland - lowland hay meadow and pasture	Not sensitive	No
NERC habitat- Purple moor grass and rush pastures -466861	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Fen meadows/rush pastures. Acid Grassland, Neutral Grassland - Lowland hay meadow and pasture, Improved Permanent Grassland.	Not sensitive	No
Great Wood - West Wood LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors Ancient semi-natural woodland containing acidic lowland oak/birch species. There are also patches of base-rich woodland and possible areas of wet woodland.	Not sensitive	No
Hawksworth Spring Wood LWS	Major	Likely to be in connectivity with impacted reach and support aquatic receptors. Woodland along Gill Beck.	Low	Yes
Tong Park LWS	Major	The Tong Park LWS is located downstream of the impacted reach and however is likely to be in connectivity with the impacted reach. A park with sections of grassland, marshland, rush, swamp, ponds and a dam. The Tong Park Dam is connected to the river. Gill Beck runs through the site and	Low	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		includes riffles and rapids. Islands are present and host willow and alder.		

B2.12.3 NERC and other protected species

Table B2.69 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish are a NERC Act Section 41 species and are sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and YWSL, as well as a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. White-clawed crayfish surveys carried out by YWSL in 2016 in Gill Beck 1 found no evidence of white-clawed crayfish, however it was not possible to conclusively rule out their presence. Additionally, as this species was historically identified in the reaches downstream and suitable habitat is available, the presence of the feature cannot be ruled out within the impacted reach, and a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**. **Table B2.69** identifies the potential for impacts associated with the drought options upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.1.4.**

Several NERC Act section 41 and notable bird species have been identified as present in water dependent habitats which rely on the impacted reach. Based on the available information these species are considered not to be susceptible to drought option impacts and **not sensitive** to the physical environment impacts identified in **Appendix A.**

Table B2.69 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipes)*	Major	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters are known to use the catchment. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Fish - Brown Trout (*Salmo trutta)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species – Fish -Bullhead (*Cottus gobio)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the quality of the supporting environment	High	Yes
NERC and Notable Species – Birds There are many bird species present across the region	Major	The following bird species to varying extents rely on water dependent habitats. However, they are not expected to be impacted severely from implementation of the drought option against a baseline of reduced flows characteristic of drought: - Eurasian Curlew (*Numenius arqauta*) - Redshank (*Tringa tetanus*)	Low	No

B2.12.4 WFD Features

B2.12.4.1 Macroinvertebrates

The WFD waterbody GB104027062940 Gill Beck (Baildon) from Source to River Aire classifies as 'high' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by one Environment Agency monitoring site, D/S Weecher Reservoir (ID 74781). D/S Weecher Reservoir had baseline survey data for two seasonal samples for 2013 and three seasonal samples 2016.

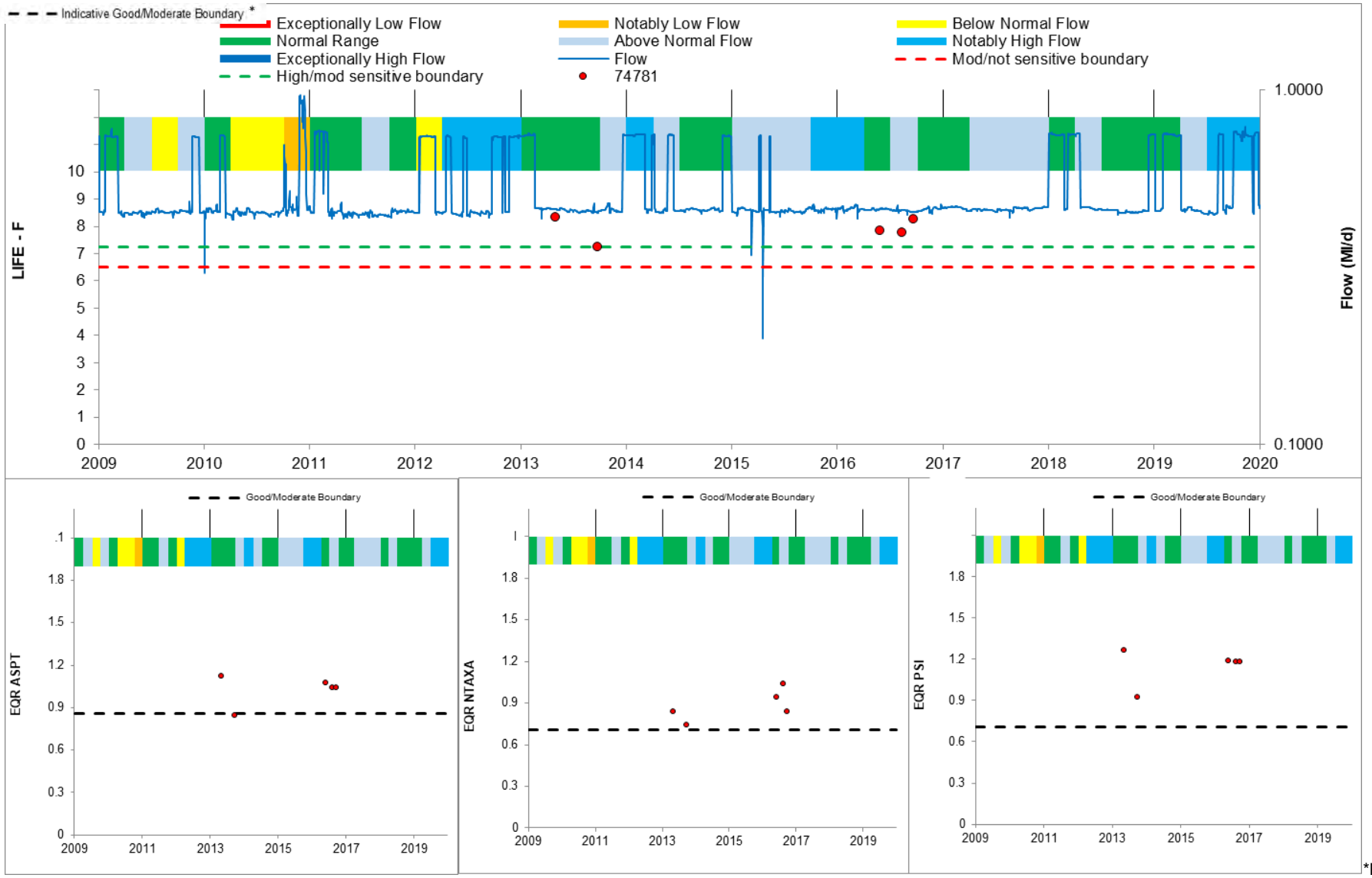
The WFD status of the macroinvertebrate community in Gill Beck 1 may be impacted by the implementation of the drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the hydrological sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Gill Beck 1 is highly sensitive to reduced flows (**Figure B2.12**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.12**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve high WFD status over the monitoring period, with the exception of autumn 2013. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa that are sensitive to pressures including water quality. The $WHPT_{ASPT}$ in autumn 2013 showed an instance of deterioration to the standard for high, showing that the waterbody may infrequently be impacted by water quality pressures.

Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications. $WHPT_{ASPT}$ EQR scores for sites within the reach ranged between 0.84 and 1.12, indicative of moderate to high ecological status. $WHPT_{NTAXA}$ EQR scores range between 0.74 and 1.04, indicative of moderate to high ecological status. Based on the available baseline data the macroinvertebrate community within the reach is considered sensitive to water quality and environment impacts as identified in **Appendix A**.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Figure B2.12 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.12.4.2 Fish

Waterbody GB104027062940 Gill Beck (Baildon) from Source to River Aire is classified under cycle 2 (2016) as moderate. The baseline fisheries assessment is informed by one site, Moor Valley Caravan Park (ID 28946) which was surveyed in 2014 and 2016.

The WFD status of the fish community in Gill Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

The site Moor Valley Caravan Park individually classifies as good with a site EQR of 0.6542, based on the FCS2 EQR scores from the 2016 survey. The site had a good diversity, with only two species from an expected three present. Trout had a high EQR score of 0.7117, with a higher observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Salmon were not observed in this reach, although they were expected to be present. The impacts to the bullhead and brown trout population of the waterbody has been detailed in Section B4.11.1.2.

Due to the limited availability of baseline fisheries assessment information, there is some uncertainty in the likely sensitivity of the fish population as a whole in Gill Beck 1.

Based on a precautionary approach, the limited available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.70 Fish survey data from Gill Beck 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead
28946	Moor Valley Caravan Park	09/09/2014	Single catch sample	13	59
		19/09/2016	Single catch sample	56	20

B2.12.4.3 WFD Waterbody Status

Table B2.71 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.71** Table B2.6 also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.71 WFD Classifications

Waterbody ID & Name		GB104027062940 Gill Beck (Baildon) from Source to River Aire	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Moderate, Minor, Negligible)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Moderate	Medium
	Macroinvertebrates	High	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Good	
	Fish	Good	
	Macroinvertebrates	High	
Waterbody Measures		None	

B2.12.5 Invasive non-native species (INNS)

Table B2.72 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.72)**.

Table B2.72 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates New Zealand mud snail (*Potamopyrgus antipodarum*)	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.12.6 Landscape, Navigation, Recreation and Heritage

Table B2.73 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

Recreational activities, such as angling, could be impacted should impacts on the fish community be identified. As the fish community is considered susceptible and sensitive to drought option impacts, further assessment would be required (see **Table B2.73**).

Table B2.73 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Millennium Way – National Trail	Major	The route of the trail runs alongside Weecher Brow Beck. The river forms a major part the landscape setting of the trail.	Not sensitive	No
Cup and Groove marked rock north of Birch Close Farm house, High Eldwick	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup and ring marked rock at Faweather Farm, High Eldwick	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup and groove marked rock in garden of	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Oakwood Barn, High Elwick				
Carved rock in Hawksworth Spring	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Angling (Gill Beck)	Major	Casual angling only.	Low	No

B2.13 Gill Beck 2

B2.13.1 Statutory designated sites

No sites of international/national importance habitats that are sensitive or susceptible to drought option impacts have been identified.

B2.13.2 NERC and local wildlife sites

Table B2.74 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.74**).

Table B2.74 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC habitat-Deciduous woodland -325794 -325795 -325796	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Acid Grassland, Neutral Grassland - Lowland hay meadow and pasture, Improved Permanent Grassland, Fen meadows/rush pastures	Not sensitive	No
NERC habitat-Deciduous woodland -325965	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Neutral Grassland - Lowland hay meadow and pasture.	Not sensitive	No
NERC habitat-Lowland meadows -425156 -425158 -425159 -425161 -425163	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Improved permanent grassland, Neutral Grassland - lowland hay meadow and pasture Acid Grassland, Fen meadows/rush pastures	Not sensitive	No
NERC habitat-Lowland meadows -425185 -425186	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Improved permanent grassland, Neutral Grassland - lowland hay meadow and pasture	Not sensitive	No
NERC habitat-Purple moor grass and rush pastures -466861	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Fen meadows/rush pastures. Acid Grassland, Neutral Grassland - Lowland hay meadow and pasture, Improved Permanent Grassland.	Not sensitive	No
Great Wood - West Wood LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors Ancient semi-natural woodland containing acidic lowland oak/birch species. There are also patches of	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		base-rich woodland and possible areas of wet woodland.		
Hawksworth Spring Wood LWS	Major	Likely to be in connectivity with impacted reach and support aquatic receptors. Woodland along Gill Beck.	Low	Yes
Tong Park LWS	Major	The Tong Park LWS is located downstream of the impacted reach and however is likely to be in connectivity with the impacted reach. A park with sections of grassland, marshland, rush, swamp, ponds and a dam. The Tong Park Dam is connected to the river. Gill Beck runs through the site and includes riffles and rapids. Islands are present and host willow and alder.	Low	Yes

B2.13.3 NERC and other protected species

Table B2.75 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish are a NERC Act Section 41 species and are sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and YWSL, as well as a review of available data from NBN gateway was used inform the assessment of the feature in the impacted reach. White-clawed crayfish surveys carried out by YWSL in 2016 in Gill Beck 2 found no evidence of white-clawed crayfish, however it was not possible to conclusively rule out their presence. Additionally, as this species was historically identified in the impacted reach and suitable habitat is available, the presence of the feature cannot be ruled out within the impacted reach, and a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and has a **medium/high** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.75 identifies the potential for impacts associated with the drought option upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including one NERC Act Section 41 fish species (brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.13.4.2.**

Several NERC Act section 41 and notable bird species have been identified as present in water dependent habitats which rely on the impacted reach. Based on the available information these species are considered not to be susceptible to drought option impacts and **not sensitive** to the physical environment impacts identified in **Appendix A.**

Table B2.75 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipes)*	Major	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows.	Medium/high	Yes
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters were historically known to use the impacted reach. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Fish - Brown Trout (*Salmo trutta)*	Major	Due to the presence of obstructions within the waterbody preventing upstream migrations there is less chance of natural recovery should the fish populations be damaged. In addition, the scale of the change is very high over a long reach of the watercourse. Predation could occur on fish stranded in pools in high densities.	High	Yes
Notable Species – Fish -Bullhead (*Cottus gobio)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only) and may therefore not markedly detract from the quality of the supporting environment.	High	Yes
NERC and Notable Species – Birds There are many bird species present across the region	Major	The following bird species to varying extents rely on water dependent habitats. However, they are not expected to be impacted severely from implementation of the drought option against a baseline of reduced flows characteristic of drought: - Eurasian Curlew (*Numenius arqauta)* - Redshank (*Tringa tetanus*)	Not sensitive	No

B2.13.4 WFD Features

B2.13.4.1 Macroinvertebrates

The WFD waterbody GB104027062940 Gill Beck (Baildon) from Source to River Aire classifies as 'high' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by one Environment Agency monitoring sites, By Cricket Ground (ID 183986). By Cricket Ground had baseline survey data for three seasonal samples 2016. Additional YWSL monitoring data was also provided in Gill Beck 2 for one site, D/S Jum Beck (u/s cricket field) (ID YW 10069). D/S Jum Beck (u/s cricket field) had baseline survey data for two seasonal samples for 2015 to 2018.

The WFD status of the macroinvertebrate community in Gill Beck 2 may be impacted by the implementation of the drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis of recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Gill Beck 2 is highly sensitive to reduced flows (**Figure B2.13**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.13**.

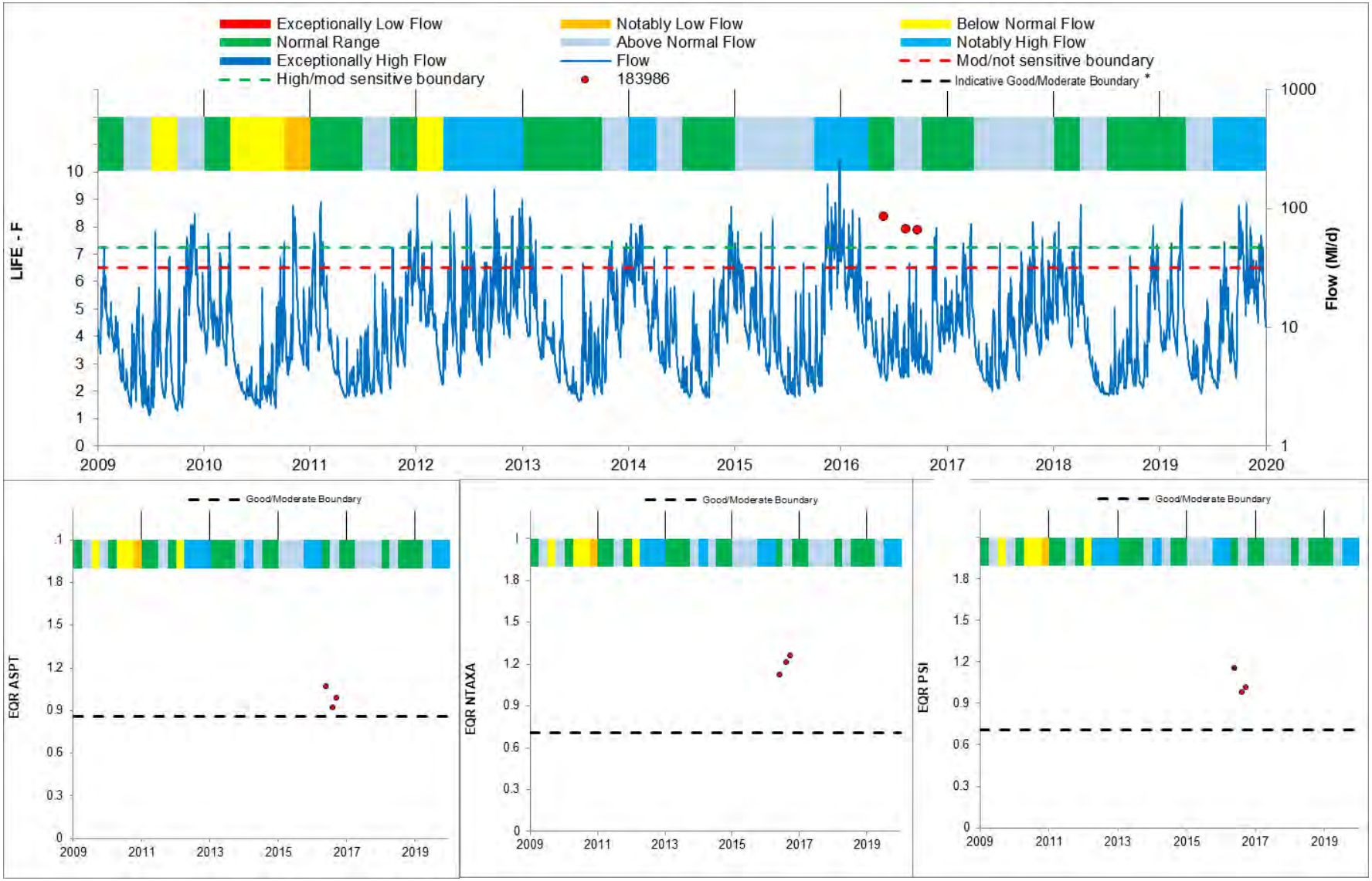
Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 but remain consistent with the standard to achieve high WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa which are sensitive to pressures including water quality. There are no instances of deterioration to this standard during the monitoring period, as such the community is not expected to have been impaired by water quality pressures historically.

In Gill Beck 2 data from the site identifies macroinvertebrate communities which shows a good diversity, with $WHPT_{NTAXA}$ ranging between 25 and 28. This suggests that there aren't additional pressures which could impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community.

YWSL 2015-2018 spring and autumn data from the site D/S Jum Beck (u/s cricket field) describes a macroinvertebrate community which is also highly sensitive to flow reductions (LIFE score 7.50 to 7.92) and also show a good level of both diversity ($BMWP_{NTAXA}$ scores 24 to 30) and moderate to high proportion of pollution sensitive taxa, $BMWP_{ASPT}$ scores of 6.19 to 7.04. This is consistent with the Environment Agency's baseline data and provides further evidence of the sensitivity of the community to drought option impacts.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **high** sensitivity to the physical environment impacts identified in **Appendix A**.

Figure B2.13 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.13.4.2 Fish

Waterbody GB104027062940 Gill Beck (Baildon) from Source to River Aire is classified under Cycle 2 (2016) as moderate. This classification is informed by one site; Moor Valley Caravan Park (ID 28946), which was classified as good and is located upstream of the impacted reach within the waterbody. As such FCS2 outputs from the site will be utilised to provide an indication of the ecological status of the fish community within the impacted reach in relation to WFD status. Baseline fisheries data was provided for one site, Cricket Club (ID 68063) which was surveyed in 2016. Additional YWSL monitoring data was also provided for three sites in the reach which were monitored in 2015, 2016 and 2017, YWSL sites d/s Jum Beck (new site us Cricket field) (ID YW10069), Tong Park Industrial Estate (ID YW10071) and Esholt Lane (ID YW10070). **Table B2.76** sets out the available fish survey data from these sites.

The site Moor Valley Caravan Park individually classifies as good with a site EQR of 0.6542, based on the FCS2 EQR scores from the 2016 survey. The site had a good diversity, with only two species from an expected three present. Trout had a high EQR score of 0.7117, with a higher observed density than expected. Bullhead are present at a level that meets/exceeds expectations, with an EQR score of 1. Salmon were not observed in this reach, although they were expected to be present.

The FCS2 data provide the most recent indication of how the fish population in the waterbody relates to its 2016 Cycle 2 status and informs the assessment to determine risk to deterioration to the fish element of this waterbody. Data from the site within the zone of influence and the classification site detailed above were also used to inform the level of certainty applicable to this assessment.

The sites within the impacted reach (Gill Beck 2) showed fish populations similar to the classification sites, with the relatively low to moderate counts of trout at sites Bridgehouse Beck, Bridgehouse Lane and Ebor Lane. Bullhead were observed at all sites in low to moderate numbers across all survey years. One stone loach was observed at both Bridgehouse Beck and Bridgehouse Lane in 2016, while low numbers of 3-spined-stickleback (5 individuals) were recorded at Ebor Lane in 2015.

Fisheries survey information from Cricket Club in Gill Beck 2, presented in **Table B2.76**, indicates the presence of a low number of trout and bullhead at the site. Additional baseline fish data for Gill Beck 2 from YWSL sites, d/s Jum Beck (new site us Cricket field), Tong Park Industrial Estate and Esholt Lane showed a low to moderate number of trout and bullhead, with the population of both species likely to be moderate. A low to moderate number of stone loach and minnows were also observed in the reach, while only a single roach was identified in the 2017 survey at d/s Cricket Club, and therefore a low population is considered likely to be present.

Based on the available information the fish community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.76 Fish survey data from Gill Beck 2

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Minnow	Roach	Stone loach
YW10069	d/s Jum Beck (new site u/s cricket field)	21/08/2015	Single catch sample	75	7			
		15/08/2016	Single catch sample	16	5			
		15/08/2017	Catch depletion sample	42	18		1	
		16/08/2018	Catch depletion sample	44	9			
YW10070	Esholt Lane	21/08/2015	Single catch sample	36	8	6		29
		16/08/2016	Single catch sample	2	26	1		24
		15/08/2017	Single catch sample	13	16	59		21
		16/08/2018	Single catch sample	22	19	41		32

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Minnow	Roach	Stone loach
YW10071	Tong Park Industrial Estate	21/08/2015	Catch depletion sample	14	19			
		16/08/2016	Catch depletion sample	5	39			
		15/08/2017	Single catch sample	56	8			
		16/08/2018	Single catch sample	32	12			
68063	Cricket Club	19/09/2016	Single catch sample	7	8			

B2.13.4.3 WFD Waterbody Status

Table B2.77 summarises the WFD Classifications of waterbody which contains the impacted reach (Gill Beck 2). **Table B2.77** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.77 WFD Classifications

Waterbody ID & Name		GB104027062940 Gill Beck (Baildon) from Source to River Aire	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Moderate, Minor, Negligible)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Moderate	Medium
	Macroinvertebrates	High	High
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Good	
	Fish	Good	
	Macroinvertebrates	High	
Waterbody Measures		None	

B2.13.5 Invasive non-native species (INNS)

Table B2.78 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.78 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates New Zealand mud snail (*Potamopyrgus antipodarum*)	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.13.6 Landscape, Navigation, Recreation and Heritage

Table B2.79 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

Table B2.79 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Millennium Way – National Trail	Major	The route of the trail runs alongside Weecher Brow Beck. The river forms a major part the landscape setting of the trail.	Not sensitive	No
Cup and Groove marked rock north of Birch Close Farm house, High Eldwick	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup and ring marked rock at Faweather Farm, High Eldwick	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup and groove marked rock in garden of Oakwood Barn, High Elwick	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Carved rock in Hawksworth Spring	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Angling (Gill Beck)	Major	Casual angling only.	Low	No

B2.14 Jum Beck 1

B2.14.1 Statutory designated sites

No sites of international/national importance that are sensitive or susceptible to drought option impacts have been identified.

B2.14.2 NERC and local wildlife sites

Table B2.80 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.80**).

Table B2.80 LWS and NERC Act Section 41 priority habitats

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC habitat- Deciduous woodland -325794 -325795 -325796	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Acid Grassland, Neutral Grassland - Lowland hay meadow and pasture, Improved Permanent Grassland, Fen meadows/rush pastures	Not sensitive	No
NERC habitat- Deciduous woodland -325965	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Neutral Grassland - Lowland hay meadow and pasture.	Not sensitive	No
NERC habitat- Lowland meadows -425156 -425158 -425159 -425161 -425163	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Improved permanent grassland, Neutral Grassland - lowland hay meadow and pasture Acid Grassland, Fen meadows/rush pastures	Not sensitive	No
NERC habitat- Lowland meadows -425185 -425186	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Improved permanent grassland, Neutral Grassland - lowland hay meadow and pasture	Not sensitive	No

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC habitat- Purple moor grass and rush pastures -466861	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors. Fen meadows/rush pastures. Acid Grassland, Neutral Grassland - Lowland hay meadow and pasture, Improved Permanent Grassland.	Not sensitive	No
Great Wood - West Wood LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors Ancient semi-natural woodland containing acidic lowland oak/birch species. There are also patches of base-rich woodland and possible areas of wet woodland.	Not sensitive	No
Hawksworth Spring Wood LWS	Major	Unlikely to be in connectivity with impacted reach as the watercourse associated with the site is not impacted by the drought permit implementation. Woodland along Gill Beck.	Not sensitive	No
Tong Park LWS	Major	Unlikely to be in connectivity with impacted reach as the watercourse associated with the site is not impacted by the drought permit implementation. A park with sections of grassland, marshland, rush, swamp, ponds and a dam. The Tong Park dam is connected to the river. Islands are present and host willow and alder.	Not sensitive	No

B2.14.3 NERC and other protected species

Table B2.81 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

Data obtained from the Environment Agency, YWSL and a review of available data from NBN gateway was used inform the assessment of white-clawed crayfish in the impacted reach. The data showed no

surveys or records have been recorded in the impacted. Based on an assessment of habitat, during an Environment Agency walkover survey, no suitable habitat was observed. Based on the absence of suitable habitat in the impacted reach, the feature is not considered at risk from the drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and **not sensitive** to the physical environment impacts identified in **Appendix A.**

Table B2.81 identifies the potential for impacts associated with the drought options upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Baseline fisheries data is limited in the impacted reach. The lack of information on the NERC Act Section 41 and notable fish species present in the impacted reach, creates uncertainty as to the longevity of impacts. One notable fish species (bullhead) has been identified in the impacted reach, however one NERC Act Section 41 species (brown trout) is thought to be present in the reach. Baseline data for the species is detailed in Section B2.14.4.2. Base on limited available data in the reach, a precautionary approach has been adopted and a **moderate (uncertain)** sensitivity to the physical environment impacts identified in **Appendix A.**

Table B2.81 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea Freshwater White – clawed Crayfish (*Austropotamobius pallipes)*	Major	Limited data is available for the impacted reach. White-clawed crayfish are not likely to be present in the impacted reach as identified by an assessment of habitat during an Environment Agency walkover survey.	Not sensitive	No
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters may potentially use the impacted reach. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Fish - Brown Trout (*Salmo trutta)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the	Moderate (uncertain)	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		quality of the supporting environment		
Notable Species – Fish -Bullhead (*Cottus gobio)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the quality of the supporting environment	Moderate (uncertain)	Yes

B2.14.4 WFD Features

B2.14.4.1 Macroinvertebrates

The WFD waterbody GB104027062940 Gill Beck (Baildon) from Source to River Aire classifies as 'high' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by one Environment Agency monitoring site, D/S Reva Reservoir (ID 1492). D/S Reva Reservoir had baseline survey data for two seasonal samples for 2016. Additionally data from the site in Near Hawksworth Hall (ID 1379) which is located in Jum Beck downstream of Reva Reservoir is used for this assessment to provide an indication of the status of the invertebrate community present in the impacted reach and to determine the sensitivity to impacts from the implementation of the drought option. Additional YWSL monitoring data was also provided for two sites in Jum Beck 1 which were monitored in 2015, D/S Reva Reservoir and D/S Reva Reservoir (new site).

The WFD status of the macroinvertebrate community in Jum Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Jum Beck 1 is highly sensitive to reduced flows (**Figure B2.14**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores were available for the three sites. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.14**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve high WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the sites identified macroinvertebrate communities which are composed of a moderate proportion of taxa which are sensitive to pressures including water quality. There are no instances of deterioration to this standard during the monitoring period as such the community is unlikely to have been impaired by water quality pressures historically.

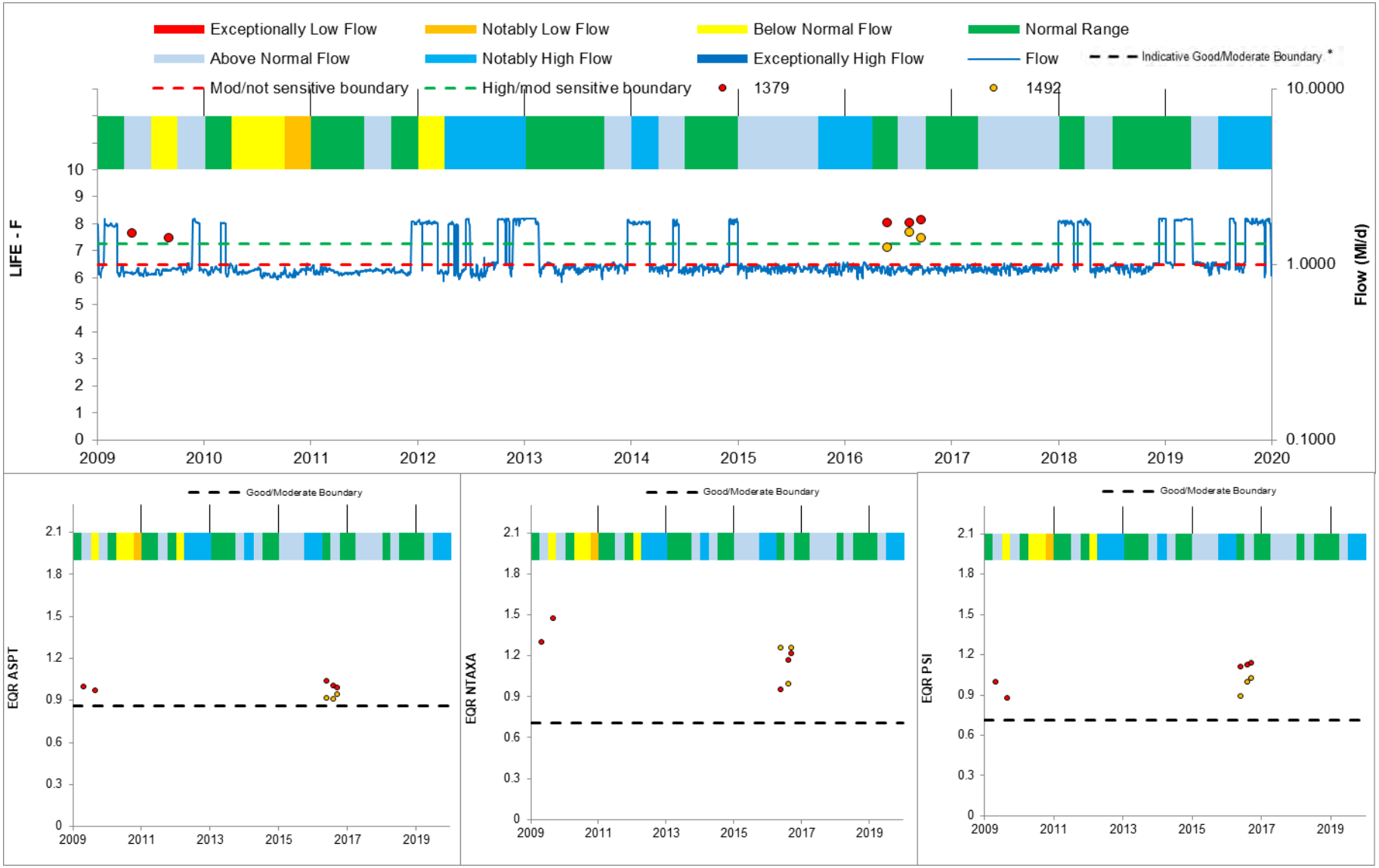
In Jum Beck 1 data from the sites identified macroinvertebrate communities with a modest degree variation in terms of diversity, with $WHPT_{NTAXA}$ ranging between 22 and 34. This suggests that pressures

which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community.

YWSL 2015 spring and autumn data from the sites D/S Reva Reservoir (new site) and D/S Reva Reservoir describes a macroinvertebrate community which has a medium sensitivity to flow reductions which LIFE scores ranging between 6.77 and 7.22. The data shows a moderate level of both diversity ($BMWP_{NTAXA}$ scores of 19 and 28) and moderate proportion of pollution sensitive taxa ($BMWP_{ASPT}$ = 5.58 and 6.29). YWSL's data available from the site D/S Reva Reservoir and D/S Reva Reservoir (new site), suggests that the invertebrate community present within the zone of influence is less sensitive to flow reductions than data from the Environment Agency's site Near Hawksworth Hall indicated. Similarly, ASPT and NTAXA scores from D/S Reva Reservoir suggest slightly lower sensitivity to associate pressures such as habitat availability and organic pollution.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Figure B2.14 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.14.4.2 Fish

Waterbody GB104027062940 Gill Beck (Baildon) from Source to River Aire is classified under Cycle 2(2016) as moderate. Baseline monitoring is informed by one site, Jum Beck (ID 68067). Additional YWSL monitoring data was also provided for three sites in the reach which were monitored in 2016, YWSL sites d/s Reva Reservoir (ID YW10063), Meadowcroft Farm u/s (ID YW10064) and Meadowcroft Farm d/s (ID YW10065). Table B2.82 sets out the available fish survey data from these sites.

Limit fisheries information for sites in the Jum Beck 1 within the extent of influence from the Reva Reservoir option is available. It is assumed that a low number of brown trout and bullhead are present in both watercourses. Considering the fish species identified for impact in the watercourse downstream (Gill Beck 2 associated with the Weecher Reservoir option), no other fish species are considered likely to be in the reach.

Based on the limited fisheries available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.82 Fish survey data from Jum Beck 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead
YW 10063	d/s Reva Reservoir	24/08/2016	Semi-quantitative	No fish caught	
YW 10064	Meadowcroft Farm u/s	24/08/2016	Semi-quantitative	No fish caught	
YW 10065	Meadowcroft Farm d/s	24/08/2016	Semi-quantitative		1
68067	Jum Beck	19/09/2016	Single Catch Sample		3

B2.14.4.3 WFD Waterbody Status

Table B2.83 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.83** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.83 WFD Classifications

Waterbody ID & Name		GB104027062940 Gill Beck*	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Moderate	Medium
	Macroinvertebrates	High	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Good	
	Fish	Good	
	Macroinvertebrates	High	
Waterbody Measures		None	

*Jum beck is a minor watercourse in the waterbody. Details identified relate to the receiving watercourse of Jum Beck and may have limited relevance.

B2.14.5 Invasive non-native species (INNS)

Table B2.84 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.84 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates Northern Crangonyctid (*Crangonyx pseudogracilis*) New Zealand mud snail (*Potamopyrgus antipodarum*)	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants Himalayan balsam (*Impatiens glandulifera)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.14.6 Landscape, Navigation, Recreation and Heritage

Table B2.85 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

Table B2.85 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Angling (Jum Beck)	Major	Unknown angling usage. However, Minor impacts on flows will not impact angling.	Low	No

B2.15 Aire 1

B2.15.1 Statutory designated sites

Table B2.86 summarises the sites of international/national importance (SSSI, SAC, SPA, Ramsar, Marine Conservation Zone, NNR, LNR) which are in hydrological connectivity with the impacted reach.

No statutory designated sites that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.86**).

Table B2.86 Statutory designated sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Bingley South Bog SSSI	Minor	This small mire occupies a peat-filled hollow in undulating ground between the Leeds-Liverpool Canal and the River Aire, at Bingley, north of Bradford. Surviving wetland provides a transition from fen to dam neutral grassland, maintained in a species-rich condition. Unlikely to be impacted by the very minor change to flows in the Aire against a probable baseline of drought conditions. Levels controlled by means of a sluice.	Not sensitive	No

B2.15.2 NERC and local wildlife sites

Table B2.87 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.87**).

Table B2.87 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Fairbank Wood LWS	Minor	Unlikely to be in connectivity with impacted reach or support aquatic receptors.	Not sensitive	No
Leeds-Liverpool Canal LWS	Minor	Unlikely to be in connectivity with impacted reach or support aquatic receptors.	Not sensitive	No
Langholme, Esholt LWS	Minor	Unlikely to be in connectivity with impacted reach or support aquatic receptors.	Not sensitive	No
NERC Habitat - Deciduous woodland -311733	Minor	Unlikely to be in connectivity with impacted reach or support aquatic receptors.	Not sensitive	No

B2.15.3 NERC and other protected species

Table B2.88 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach. Susceptibility to physical environment impacts is identified according to whether the species are water dependent. Sensitivity is then determined according to environmental requirements of each species.

Table B2.88 identifies the potential for impacts associated with the drought option upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including two NERC Act Section 41 fish species (brown trout, and European eel) and three notable fish species (bullhead, grayling and barbel). Based on the available information this feature is considered not to be susceptible to drought option impacts and has a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Table B2.88 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Fish	Minor	Potentially susceptible as duration of impacts could include all seasons, and	Low	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
- Brown Trout (*Salmo trutta)* -Eel *(Anguilla anguilla)*		thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the quality of the supporting environment		
Notable Species – Fish -Grayling (*Thymallus thymallus)* -Bullhead *(Cottus gobio)* - Barbel (*Barbus barbus*)	Minor	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the quality of the supporting environment	Low	Yes

B2.15.4 WFD Features

B2.15.4.1 Macroinvertebrates

The WFD waterbody GB104027063034 Aire (River Worth to Gill Beck) classifies as 'moderate' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by two Environment Agency monitoring sites, Saltaire (ID 1313) and Buck Bridge, Site ID 144117. Saltaire had baseline survey data for two seasonal samples for 2013, 2016, and only one seasonal sample for 2017. Site ID 144117had baseline survey data for two seasonal samples for 2013, 2016, and only one seasonal sample for 2017. Additional YWSL monitoring data was available for the macroinvertebrate community at u/s Cottingley Bridge (ID 1358) for two seasonal samples for 2015 to 2018, and at Saltaire for two seasonal samples for 2015 and 2018, and only one seasonal sample for 2017. WHPT scores were not available at u/s Cottingley Bridge and Saltaire in 2015, with only BMWP scores recorded.

The WFD status of the macroinvertebrate community in Aire 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Assessment of the sensitivity of the macroinvertebrate community was undertaken by analysis recorded LIFE scores. Baseline data indicates that under present conditions, the macroinvertebrate community in Aire 1 is medium to highly sensitive to reduced flows (**Figure B2.15**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises spring and autumn sampling occasions for a given year have generated WFD classifications, these EQR's are displayed

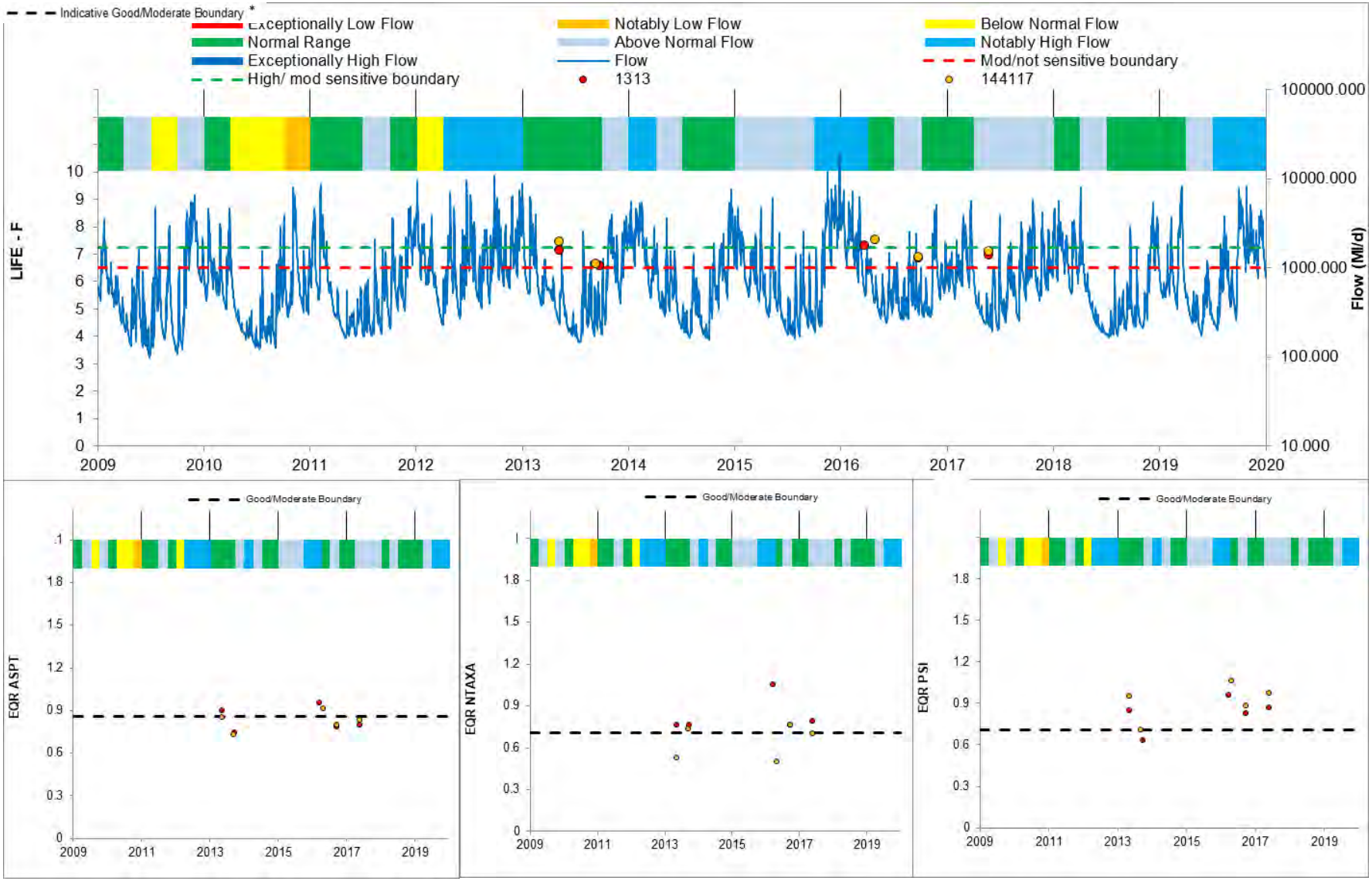
for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.15**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ EQR scores over the period 2009 to 2019 are consistent for the standard to achieve moderate to good WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a moderate proportion of taxa which are sensitive to pressures including water quality.

In Aire 1 data from the site identifies macroinvertebrate communities which significantly vary in terms of diversity, with $WHPT_{NTAXA}$ ranging between 17 and 36. Saltaire, which is the most upstream site, recorded a consistently higher $WHPT_{NTAXA}$ score when compared to the downstream site. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community, in particular immediately further downstream in the impacted reach, were diversity is most variable.

YWSL 2015 spring and autumn data from the sites u/s Cottingley Bridge and Saltaire describes macroinvertebrate communities which is also medium to highly sensitive to flow reductions (LIFE score 6.38 and 7.47) and also show a varied diversity ($_{NTAXA}$ scores 16 and 30) and moderate proportion of pollution sensitive taxa, $_{ASPT}$ scores of 4.95 and 5.91. This is consistent with the Environment Agency's baseline data and provides further evidence of the sensitivity of the community to drought option impacts.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix.**

Figure B2.15 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.15.4.2 Fish

Waterbody GB104027063034 Aire (River Worth to Gill Beck) is classified under Cycle 2 (2016) as 'moderate' for the fish element. Baseline fisheries data is informed by one site, Hirstwood, u/s Bradford Beck (ID 4244).

The site Hirstwood, u/s Bradford Beck individually classifies as moderate with a site EQR of 0.295, based on the FCS2 EQR scores from the 2017 survey. The site had relatively good diversity, with six species from an expected eight were present. Trout had a moderate EQR score of 0.282, with a lower observed density than expected. Minor species such as stone loach, minnow and bullhead were present at a level that meets/exceeds expectations, with an EQR scores of 1. Grayling had a moderate EQR score of 0.372, with a lower observed density than expected. Pike and Gudgeon were listed with an expected prevalence of greater than 50%, being more likely to occur at the site than not, though both species were absent. Additionally, Chub were observed at lower than expected densities with an EQR score of 0.4663. The lower than expected densities for trout and the absent of pike/gudgeon during the survey impacted the overall classification.

The FCS2 data provide the most recent indication of how the fish population in the waterbody relates to its 2016 Cycle 2 status and informs the assessment to determine risk to deterioration to the fish element of this waterbody. Data from the site within the zone of influence and the classification site detailed above were also used to inform the level of certainty applicable to this assessment.

Fisheries survey information from Aire 1, presented in **Table B2.89**, suggests that additional surveys at the classification site showed similar species diversity. The number of brown trout present between 2010 and 2014 were slightly higher than that observed in the 2017, though the 2009 survey was lower. The number of bullhead varied at the site, with estimated number between 10 to 99 in 2009, 2011 and 2014 and only two individuals in 2017. The number of stone loach and minnow were estimated from 2009 to 2014, while the numbers varying per survey both species were consistently recorded. A low number of grayling, European eel, chub, dace, gudgeon were also observed in the reach, while only a single barbel was identified in the 2011 survey, and therefore a small population is considered likely to be present.

Based on the available information the fish community is considered **not sensitive** to the physical environment impacts identified in **Appendix A**.

Table B2.89 Fish survey data from Aire 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Grayling	European eel	Barbel	Stone loach	Minnow	Chub	Gudgeon
4244	Hirstwood, u/s Bradford Beck	22/06/2009	Single catch sample	7	10 to 99	2			10 to 99	100 to 999	6	11
		22/06/2010	Single catch sample	25	1 to 9	2			10 to 99	100 to 999	3	11
		28/06/2011	Single catch sample	26	10 to 99	1		1	10 to 99	1000 to 9999	6	
		01/07/2014	Single catch sample	27	10 to 99	8	1 to 9		100 to 999	100 to 999		2
		24/07/2017	Single catch sample	17	2	1			150	304	3	

WFD Waterbody Status

Table B2.90 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.90** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.90 WFD Classifications

Waterbody ID & Name		GB104027063034 Aire (River Worth to Gill Beck)	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Minor	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Moderate	Not Sensitive
	Macroinvertebrates	Moderate	Low
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.15.5 Invasive non-native species (INNS)

Table B2.91 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.91 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates Northern Crangonyctid (*Crangonyx pseudogracilis*) New Zealand mud snail (*Potamopyrgus antipodarum*)	Minor	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants Himalayan balsam (*Impatiens glandulifera)* Japanese knotweed *(Fallopia japonica)*	Minor	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.15.6 Landscape, Navigation, Recreation and Heritage

Table B2.92 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No Landscape, navigation, recreation and heritage features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.92 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Dales Way – National Trail	Minor	The route of the trail runs alongside the River Aire. The river forms part the landscape setting of the trail.	Not sensitive	No
Shipley Golf Course	Minor	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Late Prehistoric enclosed settlement in Crosley Wood, Bingley – Scheduled Ancient Monument	Minor	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup-marked rock between road and public toilets at Bracken Hall Green – Scheduled Ancient Monument	Minor	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Cup and ring marked rock at Hoyle Court Drive, Charlestown – Scheduled Ancient Monument	Minor	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Prehistoric enclosure, carved rocks and orthostat wall, Buck Wood, 195m west of football ground	Minor	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Angling (River Aire)	Minor	Organised angling on the Aire, but minor hydrological impact only	Low	No

B2.17 Aire 2

B2.17.1 Statutory designated sites

Table B2.93 summarises the sites of international/national importance (SSSI, SAC, SPA, Ramsar, Marine Conservation Zone, NNR, LNR) which are in hydrological connectivity with the impacted reach.

No statutory designated sites that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.93**).

Table B2.93 Statutory designated sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Trench Meadows SSSI	Minor	The meadows are of special interest for their neutral grassland, which occurs with smaller areas of acid grassland and rush pasture, the latter associated with a number of flushes which run downslope through the fields. The site is above the level of the river and would not be affected by flow or level changes. Unlikely to be impacted by the very minor change to flows in the Aire against a probable baseline of drought conditions.	Not Sensitive	No

B2.17.2 NERC and local wildlife sites

Table B2.94 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified.

Table B2.94 NERC and local wildlife sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Leeds-Liverpool Canal LWS	Minor	Unlikely to be in connectivity with impacted reach or support aquatic receptors.	Not sensitive	No
St Paul's Wood LWS	Minor	Unlikely to be in connectivity with impacted reach or support aquatic receptors.	Not sensitive	No

B2.17.3 NERC and other protected species

Table B2.95 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

Table B2.95 identifies the potential for impacts associated with the drought option upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of water vole in the impacted reach. The data showed no surveys or records have been recorded in the impacted, although historic data does identify the feature to have been present in the surrounding reaches. However, the distribution of information and survey data for the species was considered to be limited. Therefore, absence cannot be confirmed. It was considered appropriate, following the precautionary principle, to consider water vole likely to be present in the reach at the time of the implementation of a drought option. Based on the limited available information water vole are considered to be susceptible to drought option impacts and have a **low (uncertain)** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including two NERC Act Section 41 fish species (brown trout and European eel) and two notable fish species (bullhead and grayling). Baseline data for these species is detailed in Section B2.17.4.2.

Table B2.95 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – mammals Otter *(Lutra lutra)*	Minor	Otters may potentially use the impacted reach and are known to use to surrounding catchment. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – mammals Water vole (*Arvicola amphibious)*	Minor	Limited data is available for the impacted reach. Changes in water level are the most important factor influencing water vole populations, with species readily inhabiting areas of slow flowing and standing water. As such hydrological and associated impacts as a result of this drought option may reduce habitat availability and alter the species food supply.	Low (uncertain)	Yes
NERC Species – Fish - Brown trout (*Salmo trutta)*	Minor	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of	Low	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
-European eel *(Anguilla anguilla)*		cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the quality of the supporting environment		
Notable Species – Fish -Grayling (*Thymallus thymallus)* -Bullhead *(Cottus gobio)*	Minor	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the quality of the supporting environment	Low	Yes

B2.17.4 WFD Features

B2.17.4.1 Macroinvertebrates

The WFD waterbody GB104027063032 Aire from Gill Beck (Baildon) to River Calder classified as 'poor' for macroinvertebrates in 2016, Cycle 2. Baseline data is provided by one Environment Agency monitoring site, Esholt Village (ID 11). Two additional Environment Agency monitoring sites, Site ID 157221 and Site ID 157220, located in sections of the waterbody which were not within the zone of influence of this drought option was included in the Baseline data. Esholt Village (ID 11) survey data for two seasonal samples for 2009 and only a single seasonal sample for Site ID 157221 and Site ID 157220 in 2016. YSWL monitoring data was also available for a survey site located at the Environment Agency survey site Esholt Village in 2015.

The WFD status of the macroinvertebrate community in Aire 2 may be impacted by the implementation of the drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Baseline data indicates that under present conditions, the macroinvertebrate community in Aire 2 which is medium to high sensitivity to flow reductions (**Figure B2.16**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.16**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve poor or moderate WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa that have a low sensitivity to pressures including water quality.

Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications. $WHPT_{ASPT}$ EQR scores for sites within the reach ranged between 0.80 and 0.86,

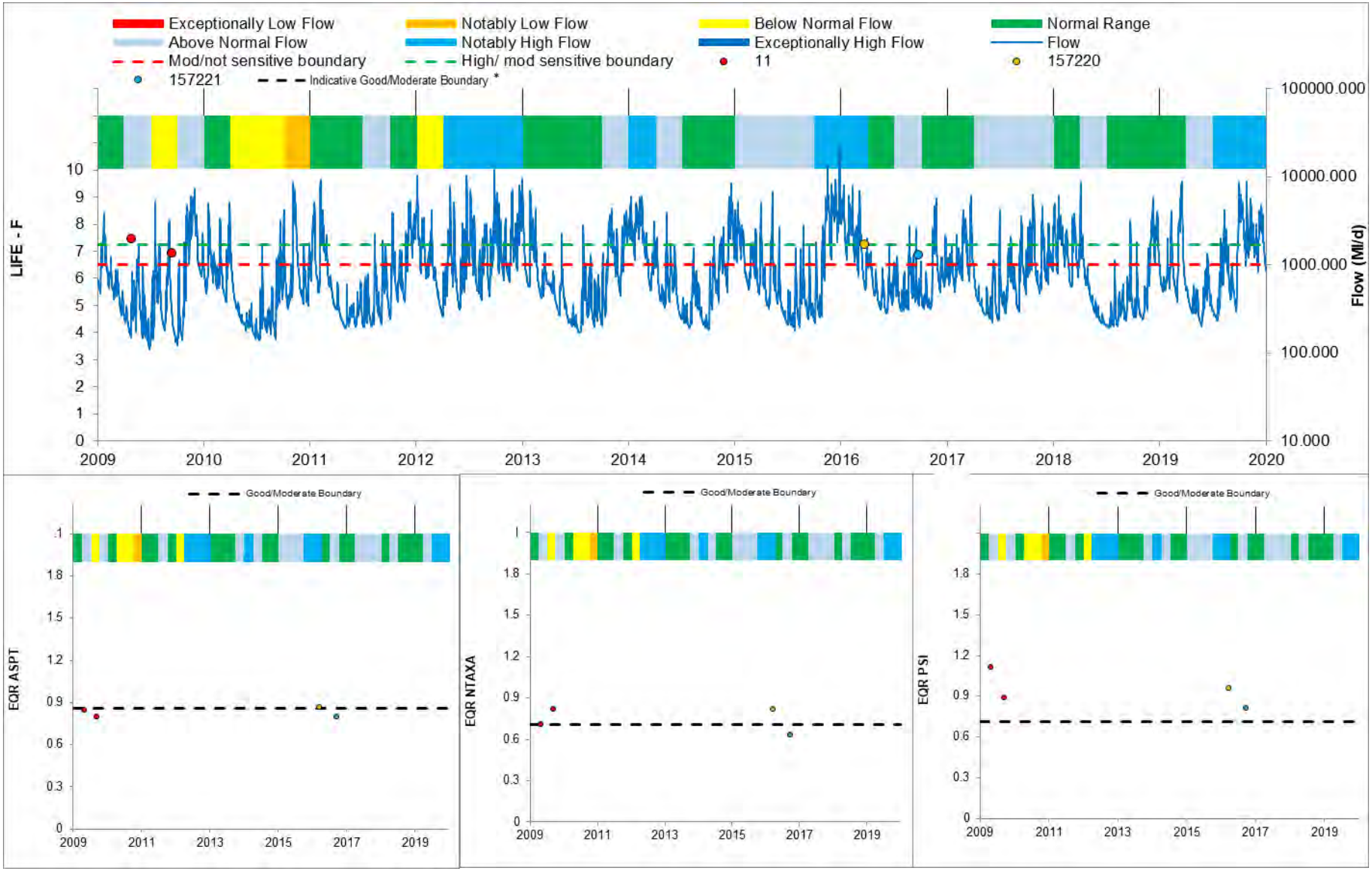
indicative of moderate ecological status. $WHPT_{NTAXA}$ EQR scores range between 0.63 and 0.82, indicative of poor to moderate ecological status. Based on the available baseline data the macroinvertebrate community within the reach is considered not to be sensitive to water quality and environment impacts as identified in **Appendix A**.

Baseline monitoring was carried by YWSL in 2015 at Esholt Village. The data provides further understanding of the invertebrate community present in the zone of influence, supplementing the baseline data provided by the Environment Agency.

YWSL 2015 spring and autumn data from the site Esholt Village describes a macroinvertebrate community which is medium sensitivity to flow reductions (LIFE score 6.83 and 6.90) and also shows a good level of diversity ($BMWP_{NTAXA}$ scores 21 and 24) and a moderate proportion of pollution sensitive taxa, $BMWP_{ASPT}$ scores of 4.71 and 4.86. This is consistent with the Environment Agency's baseline data and provides further evidence of the sensitivity of the community to drought option impacts.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A**.

Figure B2.16 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.17.4.2 Fish

Waterbody GB104027063032 Aire from Gill Beck (Baildon) to River Calder is not classified under Cycle 2 (2016) for the fish element. Baseline fisheries data is informed by one site, U/S Esholt STW (ID 36756) and one site, Apperley Bridge (ID 36755) located in sections of the waterbody which are not within the zone of influence of this drought option.

Fisheries survey information from Aire 2, presented in **Table B2.96**, indicates the presence of a moderate abundance of brown/sea trout and bullhead. A low to moderate number of stone loach and minnows were also observed in the reach, with the population of both species likely to be moderate. A low number of European eel, chub, dace, gudgeon were also observed in the reach, while only a single grayling was identified in the 2014 survey at U/S Esholt STW, and therefore a low population is considered likely to be present.

Based on the available information the fish community is considered to have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.96 Fish survey data from Aire 2

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	Grayling	European eel	Stone loach	Minnow	Chub	Dace	Gudgeon	3-spined stickleback
36755	Apperley Bridge	18/07/2013	Single Catch Sample	29	1 to 9		1	100 to 999	10 to 99	4			
36756	U/S Esholt STW	01/07/2014	Single Catch Sample	25	10 to 99		1 to 9	10 to 99	100 to 999		2	7	1 to 9
		02/07/2014	Single Catch Sample	34	10 to 99	1		10 to 99	10 to 99	7		2	

B2.17.4.3 WFD Waterbody Status

Table B2.97 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.97** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.97 WFD Classifications

Waterbody ID & Name		GB104027063032 Aire from Gill Beck (Baildon) to River Calder	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Minor	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	-	Medium
	Macroinvertebrates	Poor	Low
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	-	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.17.5 Invasive non-native species (INNS)

Table B2.98 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.98 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates Northern Crangonyctid (*Crangonyx pseudogracilis*) New Zealand mud snail (*Potamopyrgus antipodarum*)	Minor	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants Himalayan balsam (*Impatiens glandulifera)* Japanese knotweed *(Fallopia japonica)*	Minor	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.17.6 Landscape, Navigation, Recreation and Heritage

Table B2.99 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No features that are sensitive or susceptible to drought option impacts have been identified (see **Table B2.99**).

Table B2.99 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Calder/Aire Link – National Trail	Major	The route of the trail runs alongside Bridgehouse Beck. The river forms part the landscape setting of the trail.	Negligible	No
Dales Way – National Trail	Minor	The route of the trail runs alongside the River Aire. The river forms part the landscape setting of the trail.	Negligible	No
Shipley Golf Course	Minor	Unlikely to be impacted over the duration of the drought options implementation	Negligible	No
Late Prehistoric enclosed settlement in Crosley Wood, Bingley – Scheduled Ancient Monument	Minor	Unlikely to be impacted over the duration of the drought options implementation	Negligible	No
Cup-marked rock between road and public toilets at Bracken Hall Green – Scheduled Ancient Monument	Minor	Unlikely to be impacted over the duration of the drought options implementation	Negligible	No
Cup and ring marked rock at Hoyle Court Drive, Charlestown – Scheduled Ancient Monument	Minor	Unlikely to be impacted over the duration of the drought options implementation	Negligible	No
Prehistoric enclosure, carved rocks and orthostat wall, Buck Wood, 195m west of football ground	Minor	Unlikely to be impacted over the duration of the drought options implementation	Negligible	No
Angling (River Aire)	Minor	Organised angling on the Aire, but minor hydrological impact only	Minor	No

B2.18 Dibb 1

B2.18.1 Statutory designated sites

Table B2.100 summarises the sites of international/national importance (SSSI, SAC, SPA, Ramsar and MCZ) which are in hydrological connectivity with the impacted reach.

No sites of international/national importance habitats that are sensitive or susceptible to drought option impacts have been identified.

Table B2.100 Statutory designated sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
North Pennine Moors SAC	Minor	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No
North Pennine Moors SPA	Minor	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No
West Nidderdale, Barden and Blubberhouses Moors SSSI	Minor	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No

B2.18.2 NERC and local wildlife sites

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified.

B2.18.3 NERC and other protected species

Table B2.101 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway is used inform the assessment of the feature in the impacted reach. White-clawed crayfish are assumed to be present on a precautionary bases due to available habitat and known populations in the locality. Historic records obtained from the Environment Agency have identified the species was present prior to 2009, however, no quantitative data on the population of this species in the impacted reach. As the presence of the feature cannot be ruled out within the impacted reach, a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.101 identifies the potential for impacts associated with the drought option upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates no records of the feature present in the impacted reach, however it was not possible to conclusively rule out their presence. Although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including two NERC Act Section 41 fish species (Atlantic salmon and brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in **Section B2.18.4.2.**

Several NERC Act section 41 and notable bird species have been identified as present in water dependent habitats which rely on the impacted reach. Based on the available information these species are considered not to be susceptible to drought option impacts and **not sensitive** to the physical environment impacts identified in **Appendix A.**

Table B2.101 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea -Freshwater White -clawed Crayfish (*Austropotamobius pallipes)*	Minor	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows. Iron Blue Mayflies are also sensitive to flow, especially in the larvae stage.	Medium	Yes
NERC Species – mammals Otter *(Lutra lutra)*	Minor	Otters may potentially use the impacted reach. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – Fish - Atlantic salmon (*Salmo salar)* -Brown trout (*Salmo trutta)*	Minor	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the	Low	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
		quality of the supporting environment		
Notable Species – Fish -Bullhead *(Cottus gobio)*	Minor	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only) and may therefore not markedly detract from the quality of the supporting environment.	Low	Yes
NERC and Notable Species – Birds There are a number of species present across the region.	Minor	The following bird species to varying extents rely on water dependent habitats. However, they are not expected to be impacted severely from implementation of the drought option against a baseline of reduced flows characteristic of drought: - Eurasian Curlew (*Numenius arqauta)* - Swallow (*Hirundo rustica)* - Redshank (*Tringa tetanus)* - House Martin (*Delichon urbica)*	Not Sensitive	No

B2.18.4 WFD Features

B2.18.4.1 Macroinvertebrates

The WFD waterbody GB104027064120 Barben Beck/River Dibb Catchment (trib of Wharfe) classifies as 'good' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by two Environment Agency monitoring sites, ID 110 and ID 155342. ID 110 had baseline survey data for two seasonal samples for 2009 to 2019. ID 155342 comprised of spring and autumn sampling for 2012, 2013, 2014, and 2019, with only a single autumn sample for 2017.Data was available for a single survey for sites ID 190093 and ID 190094 in 2017, these two sites were not considered for the baseline data assessment as the site only had one survey's sample data.

The WFD status of the macroinvertebrate community in Dibb 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

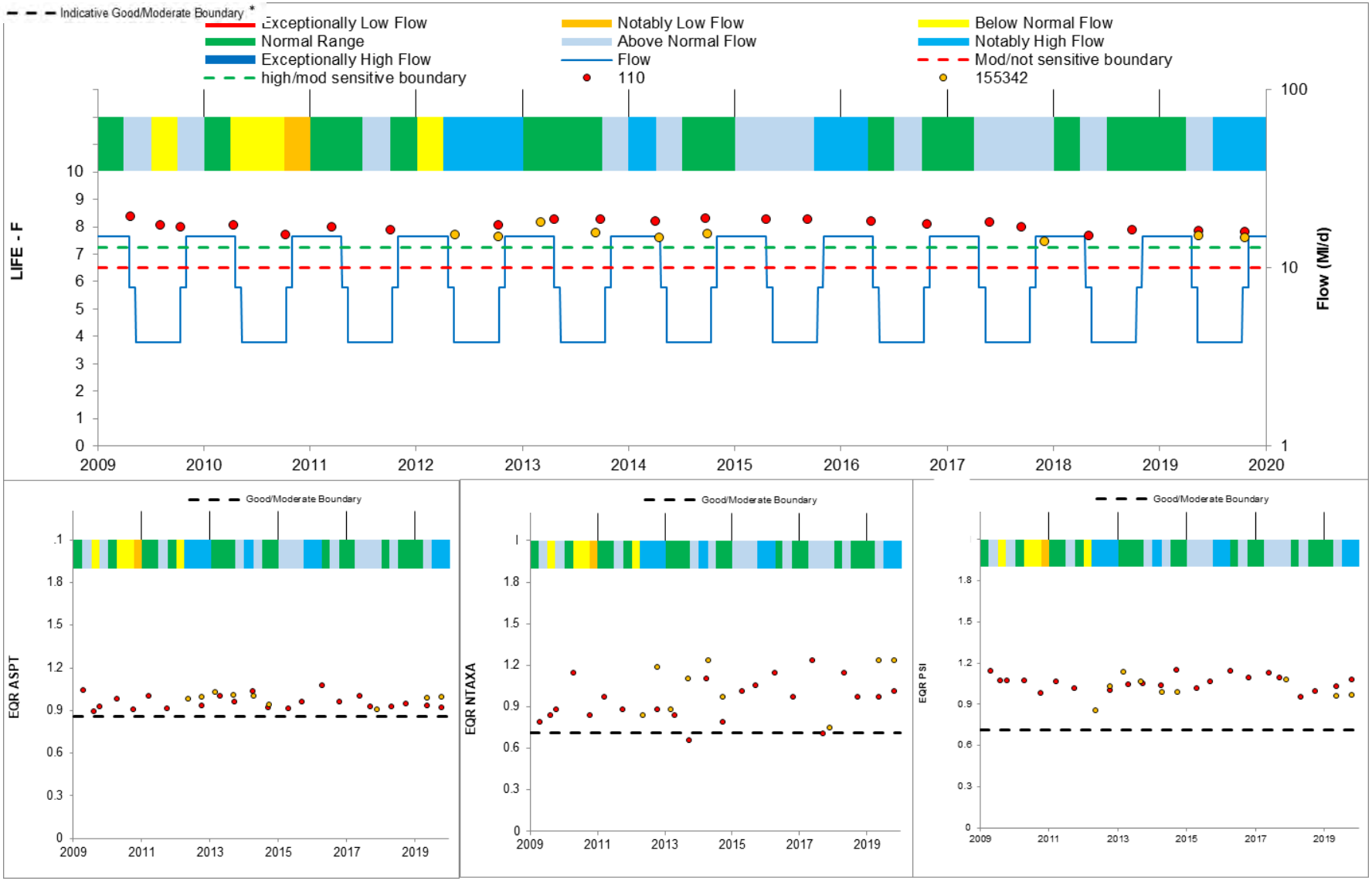
Baseline data indicates that under present conditions, the macroinvertebrate community in Dibb 1 is highly sensitive to reduced flows (**Figure B2.17**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are

calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications, these EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.17**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve good or high WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa that are sensitive to pressures including water quality. There are no instances of deterioration to this standard during the monitoring period as such the community is not expected to have been impacted by water quality pressures historically.

Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications. $WHPT_{ASPT}$ EQR scores for sites within the reach ranged between 0.95 and 1.07, indicative of high ecological status. $WHPT_{NTAXA}$ EQR scores range between 0.66 and 1.23, indicative of poor to high ecological status. This suggests that pressures which impair macroinvertebrate diversity such as habitat loss or/and low or high flows may be an influence on the baseline community. Based on the available baseline data the macroinvertebrate community within the reach is considered sensitive to water quality and environment impacts as identified in **Appendix A**.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Figure B2.17 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.18.4.2 Fish

The WFD waterbody GB104027064120 Barben Beck/River Dibb Catchment (trib of Wharfe) classifies as 'good' for macroinvertebrates in 2016, Cycle 2. This classification is informed by five sites; Hartlington Bridge (ID 3792), Burnett Fold Nook G1 (ID 47243), Sheepfold G3 (ID 47244), Far Lathe G4 (ID 47245) and Ewe Close Scar G5 (ID 47247). **Table B2.102** sets out the available fish survey data from these sites.

The WFD status of the fish community in Dibb 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

The site Hartlington Bridge individually classifies as moderate with a site EQR of 0.2454, based on the FCS2 EQR scores from the 2015 survey. The site has a relatively low diversity, with only three species present from an expected five species. EQR scores for trout are low, at 0.259, while EQR scores for bullhead and stone loach were higher than expected. Salmon are not observed in this reach, although they are expected to be present. The absence of minnow also influences the site EQR as they have an expected prevalence of 0.6244.

Fisheries survey information from Dibb 1, presented in **Table B2.102**, suggests that additional surveys within the reach showed similar species diversity. The number of brown trout present throughout the reach were comparable to the classification site, with the number of bullhead varying between the sites. Stone loach and minnow were present at the classification and only one survey at Burnett Fold Nook G1. A single Atlantic salmon was identified in the 2014 survey at Hartlington Bridge, and therefore a low population is considered likely to be present.

Based on the available information the fish community is considered susceptible to impacts with a **medium** sensitivity to impacts to physical environment impacts.

Table B2.102 Fish survey data from Dibb 1

Site ID	Site name	Event date	Method	Atlantic salmon	Brown / sea trout	Bullhead	Stone loach	Minnow
3792	Hartlington Bridge	16/09/2010	Single Catch Sample		42	7	2	
		05/08/2014	Single Catch Sample	1	17	7	20	1
		20/10/2015	Catch Depletion Sample		28	3	4	
		22/10/2014	Catch Depletion Sample		38	6	8	3
47243	Burnett Fold Nook G1	20/10/2015	Catch Depletion Sample		52	44		
		23/10/2014	Catch Depletion Sample		43	35		
47244	Sheepfold G3	20/10/2015	Catch Depletion Sample		35	17		
		22/10/2014	Catch Depletion Sample		45	54		
47247	Ewe Close Scar G5	20/10/2015	Catch Depletion Sample		28	5		
		23/10/2014	Catch Depletion Sample		38	18		
47245	Far Lathe G4	20/10/2015	Catch Depletion Sample		40	31		
		22/10/2014	Catch Depletion Sample		56	37		

B2.18.4.3 WFD Waterbody Status

Table B2.103 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.103** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate

elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.103 WFD Classifications

Waterbody ID & Name		GB104027064120 Barben Beck/River Dibb Catchment (trib of Wharfe)	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Minor	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	Good	Medium
	Macroinvertebrates	Good	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Moderate	
	Fish	Good	
	Macroinvertebrates	Good	
Waterbody Measures		None	

B2.18.5 Invasive non-native species (INNS)

Table B2.104 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.104 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates -Signal Crayfish *(Pacifastacus leniusculus)* -New Zealand mud snail (*Potamopyrgus antipodarum*)	Minor	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants Himalayan balsam (*Impatiens glandulifera)*	Minor	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.18.6 Landscape, Navigation, Recreation and Heritage

Table B2.105 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No Landscape, navigation, recreation and heritage features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.105 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Ring cairn on Kali Hill 300m northeast of High Woodhouse – Scheduled Ancient Monument	Minor	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Angling (River Dibb and Barben Beck)	Minor	Casual angling only	Low	No

B2.19 Carr Beck 1

B2.19.1 Statutory designated sites

Table B2.106 summarises the sites of international/national importance (SSSI, SAC, SPA, Ramsar and MCZ) which are in hydrological connectivity with the impacted reach.

No sites of international/national importance habitats that are sensitive or susceptible to drought option impacts have been identified.

Table B2.106 Statutory designated sites

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
North Pennine Moors SAC	Major	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No
North Pennine Moors SPA	Major	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No
South Pennine Moors SSSI	Major	None. The site is upstream of the impacted reach. The gradients between the moor and the valley are sufficiently steep that there would be no hydrodynamic connectivity between channel and the moor, particularly during dry conditions.	Not sensitive	No

B2.19.2 NERC and local wildlife sites

Table B2.107 summaries the NERC Act Section 41 and other notable and/or protected habitats (e.g. LWS) which are located on or within 500m of the impacted reach.

No NERC Act Section 41 or other notable and/or protected habitats that are sensitive or susceptible to drought option impacts have been identified for detailed assessment (see **Table B2.107**).

Table B2.107 LWS and NERC Act Section 41 priority habitats

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Burley Disused Railway LWS	Major	Unlikely to be in connectivity with impacted reach or support aquatic receptors	Not sensitive	No
River Wharfe LWS	Major	Likely to be in connectivity with impacted reach and support aquatic receptors. A typical lowland river. Unlikely to be impacted, due to the relative size of the River Wharfe compared to Carr Beck.	Not sensitive	No

B2.19.3 NERC and other protected species

Table B2.108 summaries the NERC Act Section 41 and other protected species which are located on or within 500m of the impacted reach.

White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Data obtained from the Environment Agency and a review of available data from NBN gateway is used inform the assessment of the feature in the impacted reach. White-clawed crayfish are assumed to be present on a precautionary bases due to available habitat and known populations in the locality. Historic records obtained from the Environment Agency have identified the species was present prior to 2009, however, no quantitative data on the population of this species in the impacted reach. As the presence of the feature cannot be ruled out within the impacted reach, a precautionary approach has been adopted. Based on the available information this feature is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.108 identifies the potential for impacts associated with the drought option upon otter, which is identified in the NERC Act Section 41 as a species of principal importance. Review of Environment Agency records indicates the presence of otter within the impacted reach. However, no information from survey findings was available and although the home ranges of otter can extend over tens of kilometres it is considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the available information these species are considered not to be susceptible to drought option impacts and have a **low** sensitivity to the physical environment impacts identified in **Appendix A.**

Data obtained from the Environment Agency and a review of available data from NBN gateway was used inform the assessment of water vole in the impacted reach. The data showed no surveys or records have been recorded in the impacted, although historic data does identify the feature to have been present in the impacted reach. However, the distribution of information and survey data for the species was considered to be limited. Therefore, absence cannot be confirmed. It was considered appropriate, following the precautionary principle, to consider otter likely to be present in the reach at the time of the implementation of a drought option. Based on the limited available information water vole are considered to be susceptible to drought option impacts and have an **uncertain** sensitivity to the physical environment impacts identified in **Appendix A.**

Several NERC Act section 41 and notable fish species have been identified as present in the impacted reach, including two NERC Act Section 41 fish species (Atlantic salmon and brown trout) and one notable fish species (bullhead). Baseline data for these species is detailed in Section B2.18.4.2.

Several NERC Act section 41 and notable bird species have been identified as present in water dependent habitats which rely on the impacted reach. Based on the available information these species are considered not to be susceptible to drought option impacts and **not sensitive** to the physical environment impacts identified in **Appendix A.**

The environmental preferences within which a species can successfully exist and the relationship between populations in stressed river conditions remains subject to debate. The prediction of impacts of hydrological and water quality changes on aquatic ecology remains subject to significant uncertainty and this may be exacerbated where data are limited. This assessment has, therefore, adopted a precautionary approach, with potential impact highlighted where doubt exists.

Table B2.108 NERC Act Section 41 and other protected species

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
NERC Species – Crustacea -Freshwater White -clawed Crayfish (*Austropotamobius pallipes)*	Major	White-clawed crayfish are sensitive to habitat modification from the management of waterbodies. Therefore, they are considered to be sensitive to hydrological impacts, particularly low flows. Iron Blue Mayflies are also sensitive to flow, especially in the larvae stage.	Medium	Yes
NERC Species – mammals Otter *(Lutra lutra)*	Major	Otters may potentially use the impacted reach. Further consideration would be necessary to determine to what extent or how they may be impacted by reduced flows caused by the drought option.	Low	Yes
NERC Species – mammals Water vole (*Arvicola amphibious)*	Major	Limited data is available for the impacted reach. Changes in water level are the most important factor influencing water vole populations, with species readily inhabiting areas of slow flowing and standing water. As such hydrological and associated impacts as a result of this drought option may reduce habitat availability and alter the species food supply.	Uncertain	Yes
NERC Species – Fish -Brown Trout	Major	Potentially susceptible as duration of impacts could include all seasons, and	High	Yes

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
(*Salmo trutta)*		thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and may therefore not markedly detract from the quality of the supporting environment		
Notable Species – Fish -Bullhead *(Cottus gobio)*	Major	Potentially susceptible as duration of impacts could include all seasons, and thus could impact spawning, migration, provision of cover etc. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only) and may therefore not markedly detract from the quality of the supporting environment.	Medium	Yes
NERC and Notable Species – Birds There are a number of species present across the region.	Major	The following bird species to varying extents rely on water dependent habitats. However, they are not expected to be impacted severely from implementation of the drought option against a baseline of reduced flows characteristic of drought: - Eurasian Curlew (*Numeniusarqauta)* - Swallow (*Hirundo rustica)* - Redshank (*Tringa tetanus)* - House Martin (*Delichonurbica)*	Not Sensitive	No

B2.19.4 WFD Features

B2.19.4.1 Macroinvertebrates

The WFD waterbody GB104027064258 Wharfe from Hundwith Beck to River Washburn classifies as 'High' for macroinvertebrates in 2016, Cycle 2. Baseline macroinvertebrate data is provided by two Environment Agency monitoring sites, ID 194411 and ID 194411. ID 194411 and 194412 both only had baseline survey data for one seasonal sample for 2018.

The WFD status of the macroinvertebrate community in Carr Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation

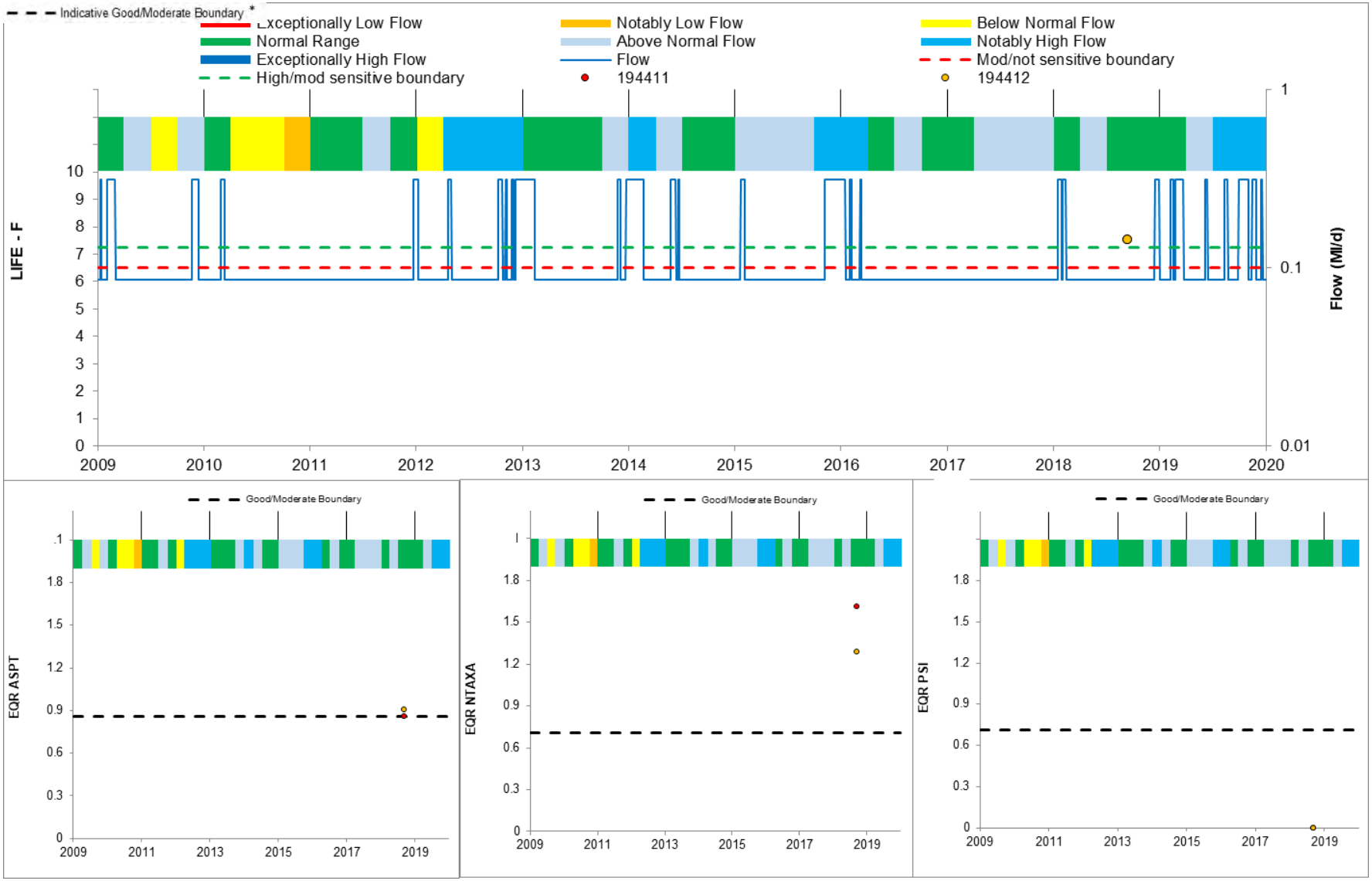
would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Baseline data indicates that under present conditions, the macroinvertebrate community in Carr Beck 1 is highly sensitive to reduced flows (**Figure B2.18**). See **Table B2.4** for guidance in interpreting raw LIFE scores. $WHPT_{ASPT}$ and $WHPT_{NTAXA}$ scores are available for the site. WHPT and PSI EQR scores are calculated based on available environmental parameters provided by the Environment Agency's online Ecology & Fish Data Explorer. Data which comprises of spring and autumn sampling occasions for a given year generate WFD classifications, whilst it is not possible to classify sites on a single season's data, the estimated WFD class would be good. The EQR's are displayed for $WHPT_{NTAXA}$ and $WHPT_{ASPT}$, see **Figure B2.18**. Data from the monitoring site shows variation in $WHPT_{ASPT}$ scores over the period 2009 to 2019 are consistent for the standard to achieve good WFD status over the monitoring period. $WHPT_{ASPT}$ scores from the site identifies macroinvertebrate communities which are composed of a good proportion of taxa that are sensitive to pressures including water quality.

$WHPT_{ASPT}$ EQR scores for sites within the reach ranged between 0.86 and 0.91, indicative of good ecological status. $WHPT_{NTAXA}$ EQR scores range between 1.29 and 1.61, indicative of high ecological status.

Based on the available information the macroinvertebrate community is considered to be susceptible to drought option impacts and have a **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Figure B2.18 LIFE score sensitivities, EQR values for $WHPT_{NTAXA}$, $WHPT_{ASPT}$ and PSI score



*PSI EQR scores are not used to inform the WFD status of macroinvertebrates, instead these values are used to provide supplementary information to the assessment

B2.19.4.2 Fish

The WFD waterbody GB104027064258 Wharfe from Hundwith Beck to River Washburn is not classified under Cycle 2 (2016) for the fish element. This classification is informed by two sites; Carr Beck Upper Site (ID 71424) and Carr Beck Lower Site (ID 71425). **Table B2.109** sets out the available fish survey data from these sites.

The WFD status of the fish community in Carr Beck 1 may be impacted by the implementation of this drought option. However, low flow impacts of drought option implementation would occur against a baseline of drought conditions (i.e. compensation flow only), and therefore impacts of the drought option must be considered in the context of environmental drought.

Fisheries survey information from Carr Beck 1, presented in **Table B2.109,** indicates the presence of a low abundance of brown/sea trout. A low to moderate number of bullhead and 3-spined stickleback were also observed in the reach, with the population of both species likely to be moderate.

Based on the available information the fish community is considered **medium** sensitivity to the physical environment impacts identified in **Appendix A**.

Table B2.109 Fish survey data from Carr Beck 1

Site ID	Site name	Event date	Method	Brown / sea trout	Bullhead	3-spined stickleback
71424	Carr Beck Upper Site	12/09/2018	Single catch sample	15		
71425	Carr Beck Lower Site	12/09/2018	Single catch sample	9	60	50

B2.19.4.3 WFD Waterbody Status

Table B2.110 summarises the WFD Classifications of waterbodies which contain the impacted reach. **Table B2.110** also displays the objective status for 2021 (Cycle 2) or the predicted status in 2021 where objective to meet good status is in 2027. This is displayed for overall, fish and macroinvertebrate elements and provides comparison with 2016 status, the table also displays the measures which have been assigned to the waterbody in order to reach their objective.

Table B2.110 WFD Classifications

Waterbody ID & Name		GB104027064258 Wharfe from Hundwith Beck to River Washburn	Sensitivity (Uncertain, High, Medium, Low, Not Sensitive)
Physical Environment Impact at Location (Major, Mod, Minor, Neg)		Major	
RBMP Cycle 2 Status/ Potential	Overall	Moderate	
	Fish	-	Medium
	Macroinvertebrates	High	Medium
Hydro-morph designation		Heavily modified	
RBMP2 Waterbody Objective	Overall	Good	
	Fish	-	
	Macroinvertebrates	High	
Waterbody Measures		None	

B2.19.5 Invasive non-native species (INNS)

Table B2.111 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No INNS features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.111 INNS Features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Invasive non-native species – macroinvertebrates -Signal Crayfish *(Pacifastacus leniusculus)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Terrestrial plants -Himalayan balsam (*Impatiens glandulifera)* - Giant Hogweed *(Heracleum mantegazzianum)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No
Invasive non-native species – Aquatic plants -Australian Swamp Stonecrop *(Crassula helmsii)* -Canadian Pondweed *(Elodea Canadensis)*	Major	The implementation of this drought option is not anticipated to increase the spread of Invasive non-native species.	Not sensitive	No

B2.19.6 Landscape, Navigation, Recreation and Heritage

Table B2.112 summarises the wider features which should be taken into account in determining the potential impacts of drought option implementation.

No landscape, navigation, recreation and heritage features that are sensitive or susceptible to drought option impacts have been identified.

Table B2.112 Landscape, navigation, recreation and heritage features

Site/Feature and designation	Hydrological Impact at Location (Major, Moderate, Minor, Negligible)	Susceptibility to flow and level impacts	Sensitivity (Uncertain, High, Medium, Low, Not sensitive)	Further Consideration Required (Y/N)
Bradford Millennium Way footpath	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No
Otley Golf Course	Major	Unlikely to be impacted over the duration of the drought options implementation	Not sensitive	No

B3. Environmental Features Screening Summary

Table B3.1 Environmental Features summary of the North West Area

Reach	Eller Beck T1 (Major)	Eller Beck 1 (Minor/Moderate)	Silsden Beck 1 (Major)	Bridgehouse Beck T1 (Major)	Bridgehouse Beck T2 (Major)	Bridgehouse Beck 1 (Major)	Worth 1 (Major)	Worth 2 (Major)	Denholme Beck 1 (Major)	Harden Beck 1 (Major)	Loadpit Beck 1 (Major)	Gill Beck 1 (Major)	Gill Beck 2 (Minor/Moderate)	Jum Beck 1 (Major)	Aire 1 (Minor/Moderate)	Aire 2 (Minor/Moderate)	Dibb1 (Major)	Carr Beck1 (Major)
Associated Drought Options	**Embsay Reservoir**	**Embsay Reservoir**	**Silsden Reservoir**	**Leeshaw Reservoir**	**Leeming Reservoir**	**Leeshaw Reservoir; Leeming Reservoir**	**Springhead Weir Maintained Flow**	**Leeshaw Reservoir; Leeming Reservoir; Spring-head Weir Maintained Flow**	**Doe Park Reservoir**	**Doe Park Reservoir; Hewenden Reservoir**	**Eldwick Reservoir**	**Weecher Reservoir**	**Weecher Reservoir**	**Reva Reservoir**	**Eldwick Reservoir**	**Weecher Reservoir; Eldwick Reservoir**	**Grimwith Reservoir**	**Carr Bottom Reservoir**
WFD Waterbody	GB104027063060 Haw Beck	GB104027063020 Eller Beck	GB104027062990 Silsden Beck	GB104027064200 Bridgehouse Beck from Source to River Worth	GB104027064200 Bridgehouse Beck from Source to River Worth	GB104027064200 Bridgehouse Beck from Source to River Worth	GB104027064210 Worth from Source to Bridgehouse Beck	GB104027064200 Bridgehouse Beck from Source to River Worth	GB104027062870 Harden Beck from Source to River Aire	GB104027062870 Harden Beck from Source to River Aire	GB104027063034 River Aire (River Worth to Gill Beck)	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027062940 Gill Beck (Baildon) from Source to River Aire	GB104027063034 Aire (River Worth to Gill Beck)	GB104027063032 Aire from Gill Beck (Baildon) to River Calder	GB104027064120 Barben Beck/River Dibb Catchment (trib of Wharfe)	GB104027064258 Wharfe from Hundwith Beck to River Washburn
Statutory and Non-Statutory Designated Sites / NERC Habitats																		
Harden Beck Wood LWS	X	X	X	X	X	X	X	X	X	✓	X	X	X	X	X	X	X	X
Hawksworth Spring Wood LWS	X	X	X	X	X	X	X	X	X	X	✓	✓	X	X	X	X	X	X
Tong Park LWS	X	X	X	X	X	X	X	X	X	X	✓	✓	X	X	X	X	X	X
NERC and Notable Species Receptors																		
White-clawed crayfish	✓	✓	X	X	X	✓	✓	X	✓	✓	✓	✓	✓	X	X	X	✓	✓
Otter	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water vole	✓	X	X	X	X	X	X	X	✓	✓	X	X	X	X	X	✓	X	✓
Riolus subviolaceus	✓	X	X	X	✓	X	X	X	X	X	X	X	X	X	X	X	X	X
Atlantic salmon	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X
Barbel	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	X	X	X
Brook lamprey	✓	✓	X	X	X	X	✓	✓	X	X	X	X	X	X	X	X	X	X
Brown trout	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bullhead	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
European eel	X	X	X	X	X	X	X	X	X	X	X	X	X	X	✓	✓	X	X
Grayling	X	X	✓	X	X	X	X	✓	X	✓	X	X	X	X	✓	✓	X	X
River lamprey	✓	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Birds	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WFD Waterbody WFD Status Receptors																		

Reach	Eller Beck T1 (Major)	Eller Beck 1 (Minor/Moderate)	Silsden Beck 1 (Major)	Bridgehouse Beck T1 (Major)	Bridgehouse Beck T2 (Major)	Bridgehouse Beck 1 (Major)	Worth 1 (Major)	Worth 2 (Major)	Denholme Beck 1 (Major)	Harden Beck 1 (Major)	Loadpit Beck 1 (Major)	Gill Beck 1 (Major)	Gill Beck 2 (Minor/Moderate)	Jum Beck 1 (Major)	Aire 1 (Minor/Moderate)	Aire 2 (Minor/Moderate)	Dibb1 (Major)	Carr Beck1 (Major)
Fish	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Invertebrates	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Further assessment required = ✓ No further assessment required = *x*

B4. Features assessment

Details regarding the approaches/methodologies used for the assessment of the impacts associated with drought option implementation are presented in Section 3.7 of YWSL's Drought Plan 2022 Environmental Assessment Methodology[2]. The potential changes to the physical environment as a result of drought option implementation are described in **Appendix A**.

B4.1 Eller Beck T1

B4.1.1 Feature Assessment

B4.1.1.1 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Eller Beck T1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the Embsay Reservoir drought option are identified in **Table B4.1**.

Table B4.1 Impacts on White-clawed Crayfish in Eller Beck

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources as habitat availability reduces. • Water quality risks are considered minor and water quality related impacts are considered unlikely.	National	High	Major

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.2**.

Table B4.2 Impacts on otter in Eller Beck T1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

[2] Ricardo Energy & Environment (2020). Yorkshire Water Drought Plan 2022. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. June 2020.

Water vole

In the absence of quantitative data on populations of water vole a detailed assessment of the impact in Eller Beck T1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, burrows may potentially become exposed leading to an increased susceptibility to predators such as stoat and weasels.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.3.** The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.3 Impacts on water vole in Eller Beck T1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Water vole	• Risk of deterioration in water quality has been identified as minor and will not impact on this feature • Species has a preference for waterbodies that do not have extreme fluctuations in water level[3]. • Increased predation as a result of decreased water width and exposure of burrows. • The reduction in wetted width could result in an increased distance between water vole food source and the burrows. • Impacts could occur throughout the breeding season for this species. • Alteration to food supply could occur although the species has been known to feed upon crayfish at times[4] and the potentially increased density of this species could lead to increased predation efficiency • Although the impacts are restricted to the reach, the effects of increased predation upon the species could have long-term impacts. • There are uncertainties relating to the presence of this species with the impacted reach.	National	Medium	Moderate

Riffle Beetle, *Riolus subviolaceus*

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.4.**

Table B4.4 Impacts on *R. subviolaceus* in Eller Beck T1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Riolus subviolaceus	• Species has a moderate sensitivity to organic pollution, but water quality impacts are minor. There will be no likely impacts	County	High	Moderate

[3] English Nature, the Environment Agency and the 1998 Wildlife Conservation Research Unit Water vole Conservation Handbook. George Street Press Ltd.

[4] Strachan, R. and Moorhouse, T. (2006) Water Vole Conservation Handbook. 2nd Edition. Wildlife Conservation Research Unit, Oxford.

	on the species as a result of water quality pressures. • Although the species is less mobile compared to fish and the reductions in wetted width and depth could reduce habitat availability for the species.			

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.5**.

Table B4.5 Impacts on NERC and notable fish species in Eller Beck T1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is likely as longitudinal connectivity could be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[5] and the species is also widespread within the catchment	National	High	Major
Bullhead		Regional	High	Moderate
Brook lamprey		National	High	Major

B4.1.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a major reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. Ammonia and dissolved oxygen status in the reach are considered to be at a low risk of deteriorating respectively, the community is considered sensitive to water quality deterioration due to good WFD classifications.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027063060 Haw Beck from Source to Eller beck (associated with Eller Beck T1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community

[5] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[6,7]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

Drought option impacts on the physical environment are summarised in **Appendix A**. Reductions in wetted width, depth and flow velocity may lead to stranding of individuals. Spawning and juvenile nursery habitat is considered likely to be present, the integrity of these important habitats identified as potentially present may become compromised (e.g. siltation of spawning gravels), the significance of barriers may become more significant and higher densities of fish will attract increased predation.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a moderate risk to the WFD status of the waterbody GB104027063060 Haw Beck from Source to Eller Beck (associated with Eller Beck T1). Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **major**.

B4.1.2 Summary of Impacts

Table B4.6 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.6 Summary of impacts identified in Eller Beck T1's environmental features assessment

Reach	Eller Beck T1	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
White-clawed crayfish	Major	Yes
Otter	Negligible	No
Water Vole	Moderate	Yes
Riolus subviolaceus	Moderate	Yes
Brook lamprey	Major	Yes
Brown trout	Major	Yes
Bullhead	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027063060 Haw Beck from Source to Eller beck	
Fish	Major	Yes
Invertebrates	Moderate	Yes

6 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

7 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

B4.2 Eller Beck 1

B4.2.1 Feature Assessment

B4.2.1.1 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Eller Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.7**.

Table B4.7 Impacts on White-clawed Crayfish in Eller Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources due to reduced suitability of habitat. • Mortality as a result of water quality deterioration.	National	Low	Moderate

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.8**.

Table B4.8 Impacts on otter in Eller Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.9**.

Table B4.9 Impacts on NERC and notable fish species in Eller Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered minor • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is unlikely as longitudinal connectivity will not be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[8] and the species is also widespread within the catchment	National	Medium	Moderate
Bullhead		Regional	Medium	Minor
Brook lamprey		National	Medium	Moderate

B4.2.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in moderate reduction in flow in summer/autumn and minor impacts in winter. The potential changes in river flows will likely lead to a minor reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. Dissolved oxygen status in the reach is considered to be at a low risk of deteriorating, the community is considered sensitive to water quality deterioration due to good WFD classifications. One potential flow pressure is present in the impacted reach, a non-consumptive large volume hydropower abstraction, without a hands-off-flow condition ('Skipton Corn Mill') with potential flow impacts over a short ~5m reach. Water quality deterioration as a result of the drought option may potentially have a short-term acute impact on invertebrate community, associated with temporary water quality pressures locally downstream of a listed CSOs during rainfall events. The risk of water quality deterioration is moderate as identified in **Appendix A.**

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027063020 Eller Beck from Haw Beck to River Aire (associated with Eller Beck 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in

[8] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

macroinvertebrates[9'10]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

Considering the hydrological impacts and the risk of water quality deterioration in the reach, the risk to the WFD status the fish elements of GB104027063020 Eller Beck from Haw Beck to River Aire (associated with Eller Beck 1) is considered to be **moderate**.

B4.2.2 Summary of Impacts

Table B4.10 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.10 Summary of impacts identified in Eller Beck 1's environmental features assessment

Reach	Eller Beck 1		
	Significance of Impact		Mitigation Required (Y/N)
NERC and Notable Species Receptors	**Summer/autumn**	**Winter**	
White-clawed crayfish	Moderate	Moderate	Yes
Otter	Negligible		No
Brook lamprey	Moderate	Moderate	Yes
Brown trout	Moderate	Moderate	Yes
Bullhead	Minor	Negligible	No
WFD Status Receptors	**Risk of Deterioration**		
	Summer/autumn	**Winter**	
WFD Waterbody	GB104027063020 Eller Beck from Haw Beck to River Aire		
Fish	Moderate		Yes
Invertebrates	Moderate		Yes

9 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

10 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

B4.3 Silsden Beck 1

B4.3.1 Feature Assessment

B4.3.1.1 NERC and other protected species

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.11**.

Table B4.11 Impacts on otter in Silsden Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.12.**

Table B4.12 Impacts on NERC and notable fish species in Silsden Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals due to risk to longitudinal connectivity. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[11]	National	High	Major
Bullhead		Regional	High	Moderate
Grayling		Regional	High	Moderate

[11] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

B4.3.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a moderate level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, the water quality changes as a result of the implementation of the drought option are predicted to present a minor risk. Furthermore, there are no significant flow pressures, either abstractions or discharges, influencing flow in Silsden Beck 1, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027062990, Silsden Beck from Source to River Aire (associated with Silsden Beck 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[12,13].Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

Considering the hydrological impacts and the risk of water quality deterioration in the reach, the risk to the WFD status the fish elements of GB104027062990, Silsden Beck from Source to River Aire (associated with Silsden Beck 1) is considered to be **major**.

B4.3.2 Summary of Impacts

Table B4.13 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.13 Summary of impacts identified in Silsden Beck 1's environmental features assessment

Reach	Silsden Beck 1	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
Otter	Negligible	No
Brown trout	Major	Yes
Bullhead	Moderate	Yes
Grayling	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	

12 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

13 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Reach	Silsden Beck 1	
WFD Waterbody	GB104027062990 Silsden Beck from Source to River Aire	
Fish	Major	Yes
Invertebrates	Moderate	Yes

B4.4 Bridgehouse Beck T1

B4.4.1 Feature Assessment

B4.4.1.1 NERC and other protected species

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.14.**

Table B4.14 Impacts on otter in Bridgehouse Beck T1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• The limited impacts on the foraging habitat and prey in this reach will result in negligible impacts on this feature	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.15.**

Table B4.15 Impacts on NERC and notable fish species in Bridgehouse Beck T1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals due to risk to longitudinal connectivity. • Increased mortality (density dependant) as a result of increased predation	National	Medium	Moderate
Bullhead		Regional	Medium	Minor

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
	• It is noted that depth of water is not critical to bullhead[14]			

B4.4.1.2 WFD features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a minor reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a moderate level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a minor risk. Furthermore, there are no significant flow pressures, either abstractions or discharges, influencing flow in Bridgehouse Beck T1, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027064200 Bridgehouse Beck from Source to River Worth waterbody (associated with Bridgehouse Beck T1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[15,16]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

Impacts to the fish population of the waterbody has been detailed above in **Section B4.4.1.1** and are assessed as having a moderate impact magnitude for trout and minor impact magnitude for bullhead. Risk to deterioration in water quality may be significant to brown trout in particular, however as the risk has been assessed as low, the impact on the WFD status of the fish population will be **moderate**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a moderate risk to the fish component of the WFD status in waterbody GB104027064200 Bridgehouse Beck from Source to River Worth (associated with Bridgehouse Beck T1). The duration of impacts could be up to 6 months. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

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14 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

15 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

16 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

B4.4.2 Summary of Impacts

Table B4.16 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.16 Summary of impacts identified in Bridgehouse Beck T1's environmental features assessment

Reach	Bridgehouse Beck T1	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
Otter	Negligible	No
Brown trout	Moderate	Yes
Bullhead	Minor	No
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027064200 Bridgehouse Beck from Source to River Worth	
Fish	Moderate	Yes
Invertebrates	Moderate	Yes

B4.5 Bridgehouse Beck T2

B4.5.1 Feature Assessment

B4.5.1.1 NERC and other protected species

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.17**.

Table B4.17 Impacts on otter in Bridgehouse Beck T2

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches	International	Negligible	Negligible

Riffle Beetle, *Riolus subviolaceus*

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.18**.

Table B4.18 Impacts on *R. subviolaceus* in Bridgehouse Beck T2

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Riolus subviolaceus	• Species has a moderate sensitivity to organic pollution, but water quality impacts are minor. There will be no likely impacts on the species as a result of water quality pressures. • Although dominant flow types could remain, the species is less mobile compared to fish and the reductions in wetted width and depth could reduce habitat availability for the species.	County	Medium	Minor

Fish

The hydrological and water quality impacts associated with the implementation of the drought option are identified in **Appendix A**, however the impact on individual fish species will vary.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.19.**

Table B4.19 Impacts on NERC and notable fish species as a result of the Leeming Reservoir drought option on Bridgehouse Beck T2

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals, due to risk to longitudinal connectivity. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[17]	National	High	Major
Bullhead		Regional	High	Moderate

B4.5.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a minor risk. Furthermore, there are no significant flow pressures, either abstractions or discharges, influencing flow in Bridgehouse Beck T2, as indicated in **Appendix A**.

The combined changes to the physical environment (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027064200 Bridgehouse beck from Source to River Worth waterbody (associated with Bridgehouse Beck T2). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[18'19]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

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17 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

18 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

19 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Fish

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the fish component of the GB104027064200 Bridgehouse beck from Source to River Worth (associated with Bridgehouse Beck T2). The duration of impacts could be up to 6 months. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **major**.

B4.5.2 Summary of Impacts

Table B4.20 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.20 Summary of impacts identified in Bridgehouse Beck T2's environmental features assessment

Reach	Bridgehouse Beck T2	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
Otter	Negligible	No
Riolus subviolaceus	Minor	No
Brown trout	Major	Yes
Bullhead	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027064200 Bridgehouse Beck from Source to River Worth	
Fish	Major	Yes
Invertebrates	Moderate	Yes

B4.6 Bridgehouse Beck 1

B4.6.1 Feature Assessment

B4.6.1.1 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Bridgehouse Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.21**.

Table B4.21 Impacts on White-clawed Crayfish in Bridgehouse Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources as habitat availability reduces. • Water quality risks are considered moderate and water quality related impacts are considered likely.	National	Medium	Moderate

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.22**.

Table B4.22 Impacts on otter in Bridgehouse Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.23**.

Table B4.23 Impacts on NERC and notable fish species in Bridgehouse Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered minor • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is likely as longitudinal connectivity could be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[20]	National	Medium	Moderate
Bullhead		Regional	Medium	Moderate

B4.6.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, with the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. Water quality deterioration as a result of the drought option may potentially have a medium-term chronic, regular, temporary water quality pressures downstream of Oxenhope WwTW, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027064200 Bridgehouse Beck from Source to River Worth waterbody (associated with Bridgehouse Beck 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[21'22]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

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20 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

21 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

22 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Fish

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a **moderate** risk to the fish component of the WFD GB104027064200 Bridgehouse Beck from Source to River Worth (associated with Bridgehouse Beck 1).

B4.6.2 Summary of Impacts

Table B4.24 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.24 Summary of impacts identified in Bridgehouse Beck 1's environmental features assessment

Reach	Bridgehouse Beck 1	
	Significance of Impact	**Mitigation Required** (Y/N)
NERC and Notable Species Receptors		
White-clawed crayfish	Moderate	Yes
Otter	Negligible	No
Brown trout	Moderate	Yes
Bullhead	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027064200 Bridgehouse Beck from Source to River Worth	
Invertebrates	Moderate	Yes
Fish	Moderate	Yes

B4.7 Worth 1

B4.7.1 Feature Assessment

B4.7.1.1 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Worth 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.25**.

Table B4.25 Impacts on White-clawed Crayfish in Worth 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources as habitat availability reduces. • Water quality risks are considered moderate and water quality related impacts are considered likely.	National	High	Major

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.26**.

Table B4.26 Impacts on otter in Worth 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.27**. Drought option impacts on the physical environment are summarised in **Appendix A**.

Reductions in wetted width, depth and flow velocity may lead to stranding of individuals. Spawning and juvenile nursery habitat is considered likely to be present, the integrity of these important habitats identified as potentially present may become compromised (e.g. siltation of spawning gravels), the significance of barriers may become more significant and higher densities of fish will attract increased predation.

Hydrological impacts (detailed in **Appendix A**) include a reduction in flow and reduction in wetted width and depth. This will lead to increasing exposure of channel margins, the margins of within-channel features (such as channel bars and islands). Spawning and juvenile nursery habitat will be particularly impacted. Impacts on water quality is assumed as being moderate.

Table B4.27 Impacts on NERC and notable fish species in Worth 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is likely as longitudinal connectivity will possibly be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[23] and the species is also widespread within the catchment.	National	High	Major
Brook lamprey		National	High	Major
Bullhead		Regional	Medium	Moderate

B4.7.1.2 WFD Features

Invertebrates

The potential changes to river flows are likely to result in major reduction in flow and will lead to a major reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, and the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. There are no significant flow pressures, either abstractions or discharges, influencing flow in Worth 1, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027064210 Worth from Source to Bridgehouse Beck waterbody (associated with Worth 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in

[23] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

macroinvertebrates[24'25]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

Impacts to the fish population of the waterbody has been detailed in **Table B4.27** and are assessed as having a moderate impact magnitude for trout and brook lamprey, and minor impact magnitude for bullhead.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a **major** risk to the fish component of the WFD GB104027064210 Worth from Source to Bridgehouse Beck (associated with Worth 1).

B4.7.2 Summary of Impacts

Table B4.28 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.28 Summary of impacts identified in Worth 1's environmental features assessment

Reach	Worth 1	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
White-clawed crayfish	Major	Yes
Otter	Negligible	No
Brown Trout	Major	Yes
Brook lamprey	Major	Yes
Bullhead	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027064210 Worth from Source to Bridgehouse Beck	
Fish	Major	Yes
Invertebrate	Moderate	Yes

24 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

25 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

B4.8 Worth 2

B4.8.1 Feature Assessment

B4.8.1.1 NERC and other protected species

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.29**.

Table B4.29 Impacts on otter in Worth 2

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.30**.

Table B4.30 Impacts on NERC and notable fish species in Worth 2

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is likely as longitudinal connectivity will possibly be impacted. • Mortality as a result of water quality deterioration (oxygen stress). • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[26]	National	High	Major
Grayling		Regional	Medium	Moderate
Bullhead		Regional	Medium	Moderate
Brook lamprey		Regional	High	Major

[26] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

B4.8.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, with the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. Water quality deterioration as a result of the drought option may potentially have an medium-term chronic, regular, temporary water quality pressures downstream of Oxenhope wastewater treatment works (WwTW), as indicated in **Appendix A**. Additionally, water quality deterioration as a result of the drought option may potentially have an short-term acute impact on invertebrate community, associated with additional temporary water quality pressures locally downstream of two listed CSOs during rainfall events.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027062891 Worth from Bridgehouse Beck to River Aire waterbody (associated with Worth 2). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[27'28]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

Impacts to the fish population of the waterbody has been detailed in **Table B4.30** and are assessed as having a major impact magnitude for trout, and brook lamprey and moderate impact magnitude for bullhead, river lamprey and grayling.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the fish component of the WFD GB104027062891 Worth from Bridgehouse Beck to River Aire (associated with Worth 2) is considered to be **major.**

B4.8.2 Summary of Impacts

Table B4.31 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

27 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

28 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Table B4.31 Summary of impacts identified in Worth 2's environmental features assessment

Reach	Worth 2	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
Otter	Negligible	No
Brown Trout	Major	Yes
Bullhead	Moderate	Yes
Grayling	Moderate	Yes
Brook lamprey	Major	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	**GB104027062891 Worth from Bridgehouse Beck to River Aire**	
Fish	Major	Yes
Invertebrates	Moderate	Yes

B4.9 Denholme Beck 1

B4.9.1 Feature Assessment

B4.9.1.1 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Denholme Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.32.** The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.32 Impacts on White-clawed Crayfish in Denholme Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources as habitat availability reduces. • Water quality risks are considered minor and water quality related impacts are considered unlikely.	National	Low	Moderate

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.33**.

Table B4.33 Impacts on otter in Denholme Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Water vole

In the absence of quantitative data on populations of water vole a detailed assessment of the impact in Denholme Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, burrows may potentially become exposed leading to an increased susceptibility to predators such as stoat and weasels.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.34.** The combined physical environment changes (river flows, river

habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.34 Impacts on water vole in Denholme Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Water vole	• Risk of deterioration in water quality has been identified as minor and will not impact on this feature. • Species has a preference for waterbodies that do not have extreme fluctuations in water level[29]. • Increased predation as a result of decreased water width and exposure of burrows. • The reduction in wetted width could result in an increased distance between water vole food source and the burrows. • Impacts could occur throughout the breeding season for this species. • Alteration to food supply could occur although the species has been known to feed upon crayfish at times[30] and the potentially increased density of this species could lead to increased predation efficiency • Although the impacts are restricted to the reach, the effects of increased predation upon the species could have long-term impacts. • There are uncertainties relating to the presence of this species with the impacted reach.	National	Medium	Moderate

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.35**.

Table B4.35 Impacts on NERC and notable fish species in Denholme Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration	National	Medium	Moderate
Bullhead		Regional	Medium	Moderate

29 English Nature, the Environment Agency and the 1998 Wildlife Conservation Research Unit Water vole Conservation Handbook. George Street Press Ltd.

30 Strachan, R. and Moorhouse, T. (2006) Water Vole Conservation Handbook. 2nd Edition. Wildlife Conservation Research Unit, Oxford.

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
	• Stranding of individuals due to risks to longitudinal connectivity. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[31]			

B4.9.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community has medium sensitivity to flow velocity reductions, as indicated by moderate LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by poor to moderate $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a minor risk. Doe Park STW presents a risk to localised ammonia deterioration which may cause temporary deterioration to the invertebrate community downstream of the site, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027062870 Harden Beck from Source to River Aire waterbody (associated with Denholme Beck 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[32'33]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **minor**.

Fish

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a **moderate** risk to the fish component of the WFD GB104027062870 Harden Beck from Source to River Aire (associated with Denholme Beck 1).

B4.9.2 Summary of Impacts

Table B4.36 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

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31 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

32 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

33 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Table B4.36 Summary of impacts identified in Denholme Beck 1's environmental features assessment

Reach	Denholme Beck 1	
	Significance of Impact	**Mitigation Required** (Y/N)
NERC and Notable Species Receptors		
White-clawed crayfish	Moderate	Yes
Otter	Negligible	No
Water vole	Moderate	Yes
Brown trout	Moderate	Yes
Bullhead	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027062870 Harden Beck from Source to River Aire	
Fish	Moderate	Yes
Invertebrates	Minor	No

Harden Beck 1

B4.9.3 Feature Assessment

B4.9.3.1 Statutory designated sites/Local wildlife sites

Harden Beck LWS

The Harden Beck LWS is situated in the valley of the watercourse and encompasses the river and Goit Stock Wood. The Harden Beck is an overflow channel of Glacial Erosion which was carved out during the last ice age[34]. The site is known for is variety of bird species, wildflowers with a well-structured woodland and well developed bryophyte flora. The site contains the county's largest population of climbing corydalis (*Ceratocapnos claviculata*), a species of scattered occurrence. The grassland communities are good examples of diverse hay meadows. Harden Beck has previously been reported as a spawning site for brown trout, though a major barrier is present in the form of Goit Stock Waterfall. The site is well covered by public footpaths, bridleways and tracks, giving good access throughout.

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach for aquatic receptors. As such, the risk from the implementation of the drought option to Harden Beck LWS is deemed to be **moderate** on the aquatic receptors.

B4.9.3.2 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Harden Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the drought option are identified in **Table B4.37**. The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.37 Impacts on White-clawed Crayfish in Harden Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources as habitat availability reduces. • Mortality as a result of water quality deterioration.	National	Medium	Moderate

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.38**.

[34] Landscape Character Supplementary Planning Document - October 2008 Volume 9:Wilsden

Table B4.38 Impacts on otter in Harden Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Water vole

In the absence of quantitative data on populations of water vole a detailed assessment of the impact in Harden Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, burrows may potentially become exposed leading to an increased susceptibility to predators such as stoat and weasels.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.39.** The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.39 Impacts on water vole in Harden Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Water vole	• Species has a preference for waterbodies that do not have extreme fluctuations in water level[35]. • Increased predation as a result of decreased water width and exposure of burrows. • The reduction in wetted width could result in an increased distance between water vole food source and the burrows. • Impacts could occur throughout the breeding season for this species. • Alteration to food supply could occur although the species has been known to feed upon crayfish at times[36] and the potentially increased density of this species could lead to increased predation efficiency • Although the impacts are restricted to the reach, the effects of increased predation upon the species could have long-term impacts. • There are uncertainties relating to the presence of this species with the impacted reach.	National	Low	Moderate

35 English Nature, the Environment Agency and the 1998 Wildlife Conservation Research Unit Water vole Conservation Handbook. George Street Press Ltd.

36 Strachan, R. and Moorhouse, T. (2006) Water Vole Conservation Handbook. 2nd Edition. Wildlife Conservation Research Unit, Oxford.

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.40.**

Table B4.40 Impacts on NERC and notable fish in Harden Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration. • Mortality as a result of water quality deterioration. • Stranding of individuals is unlikely as longitudinal connectivity will not be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[37]	National	Medium	Moderate
Grayling		Regional	Medium	Moderate
Bullhead		Regional	Medium	Moderate

B4.9.3.3 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs; the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. Water quality deterioration as a result of the drought option may potentially have a medium-term chronic, regular, temporary water quality pressures downstream of Harecroft wastewater treatment works (WwTW), as indicated in **Appendix A.**

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027062870 Harden Beck from Source to River Aire waterbody (associated with Harden Beck 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in

[37] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

macroinvertebrates[38'39]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

Drought option impacts on the physical environment are summarised in **Appendix A**. Reductions in wetted width, depth and flow velocity may lead to stranding of individuals. Spawning and juvenile nursery habitat is considered likely to be present, the integrity of these important habitats identified as potentially present may become compromised (e.g. siltation of spawning gravels), the significance of barriers may become more significant and higher densities of fish will attract increased predation.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a moderate risk to the WFD status in waterbody GB104027062870 Harden Beck from Source to River Aire (associated with Harden Beck 1). The duration of impacts could be up to 6 months. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

B4.9.4 Summary of Impacts

Table B4.41 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

38 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

39 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Table B4.41 Summary of impacts identified in Harden Beck 1's environmental features assessment

Reach	Harden Beck 1	
	Significance of Impact	**Mitigation Required** (Y/N)
Statutory designated sites/Local wildlife sites		
Harden Beck LWS	Moderate	Yes
NERC and Notable Species Receptors		
White-clawed crayfish	Moderate	Yes
Otter	Negligible	No
Water vole	Moderate	Yes
Brown Trout	Moderate	Yes
Bullhead	Moderate	Yes
Grayling	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027062870 Harden Beck from Source to River Aire	
Fish	Moderate	Yes
Invertebrates	Moderate	Yes

B4.10 Loadpit Beck 1

B4.10.1 Feature Assessment

B4.10.1.1 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Loadpit Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the drought option are identified in **Table B4.37**. The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.42 Impacts on White-clawed Crayfish in Loadpit Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources as habitat availability reduces. • Mortality as a result of water quality deterioration.	National	Medium	Moderate

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.43.**

Table B4.43 Impacts on otter in Loadpit Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.44**.

Table B4.44 Impacts on NERC and notable fish species in Loadpit Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals due to risks to longitudinal connectivity. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[40] and the species is also widespread within the catchment	National	High	Major
Bullhead		Regional	Medium	Moderate

B4.10.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a major reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a considerable variation of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. Furthermore, there are no significant flow pressures, either abstractions or discharges, influencing flow in Loadpit Beck 1, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027063034 River Aire (River Worth to Gill Beck) waterbody (associated with Loadpit Beck 1), although limitations in the available baseline data increase the uncertainty associated with this risk. The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in

[40] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

macroinvertebrates[41'42]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate,** however, there are uncertainties relating to the fish community within the impacted reach as limited survey data is available.

Fish

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a **moderate** risk to the fish component of the WFD GB104027063034 River Aire (River Worth to Gill Beck) (associated with Loadpit Beck 1).

B4.10.2 Summary of Impacts

Table B4.45 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.45 Summary of impacts identified in Loadpit Beck 1's environmental features assessment

Reach	Loadpit Beck 1	
	Significance of Impact	**Mitigation Required** (Y/N)
NERC and Notable Species Receptors		
White-clawed crayfish	Moderate	Yes
Otter	Negligible	No
Brown trout	Major	Yes
Bullhead	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027063034 River Aire (River Worth to Gill Beck)	
Invertebrates	Moderate	Yes
Fish	Moderate	Yes

B4.11 Gill Beck 1

B4.11.1 Feature Assessment

B4.11.1.1 Statutory designated sites/Local wildlife sites

Hawksworth Spring Wood LWS

Hawksworth Spring Wood is situated within the Gill beck valley between Baildon and Hawksworth is a mosaic of natural habitats. Tributaries of the beck arise on the flanks of Baildon and Hawksworth Moors, run through farmland and into the wooded valley leading to the floodplain of the Aire. The woods down the centre of the valley consist of semi-natural deciduous woodland. Spring Wood includes

41 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

42 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Pedunculate Oak, Sycamore, Silver and Downy Birch, Holly and Alder (along banksides) are the main trees, along with a few Rowan, Yew and Field Maple. The herb layer in these areas tends to be dominated by bramble. Bluebells and Wild Garlic are plentiful, along with wood millet, hedge woundwort and ferns. The small woodland supports long-term viable populations of Redstart, Wood Warbler or Pied Flycatcher. Spotted Flycatcher, Marsh Tit, Willow Tit, Lesser Spotted Woodpecker and Hawfinch. The site is home to good populations of Common Toads, Common Frogs and Smooth Newts. A good range of riparian fauna includes Dipper, Kingfisher, Grey Wagtail , Grey Heron, Otter, Mink, Brown Trout and Bullhead.

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach for aquatic receptors. As such, the risk from the implementation of the drought option to Hawksworth Spring Wood LWS is deemed to be **moderate** on the aquatic receptors.

Tong Park LWS

Tong Park is located downstream of the impacted reach, Gill Beck 1 and as such, the risk from the implementation of the drought option to the Tong Park LWS is deemed to be **negligible**.

B4.11.1.2 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Gill Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.46**.

Table B4.46 Impacts on White-clawed Crayfish in Gill Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources due to reduced suitability of habitat. • Water quality risks are considered moderate and water quality related impacts are considered likely	National	High	Major

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.47**.

Table B4.47 Impacts on otter in Gill Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.37.**

Table B4.48 Impacts on NERC and notable fish species in Gill Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered major • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals due to risk to longitudinal connectivity. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[43] and the species is also widespread within the catchment	National	High	Major
Bullhead		Regional	High	Moderate

B4.11.1.3 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the

[43] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs; the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. There are no significant flow pressures, either abstractions or discharges, influencing flow in Gill Beck 1, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027062940 Gill Beck (Baildon) from Source to River Aire waterbody (associated with Gill Beck 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[44'45]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the fish component of the WFD GB104027062940 Gill Beck (Baildon) from Source to River Aire (associated with Gill Beck 1). The duration of impacts could be up to 6 months. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate** however, there are uncertainties relating to the fish community within the impacted reach as limited survey data is available.

B4.11.2 Summary of Impacts

Table B4.49 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.49 Summary of impacts identified in Gill Beck 1's environmental features assessment

Reach	Gill Beck 1	
	Significance of Impact	**Mitigation Required (Y/N)**
Statutory designated sites/Local wildlife sites		
Hawksworth Spring Wood LWS	Moderate	Yes
Tong Park LWS	Negligible	No
NERC and Notable Species Receptors		
White-clawed crayfish	Major	Yes
Otter	Negligible	No
Brown trout	Major	Yes
Bullhead	Moderate	Yes

44 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

45 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Reach	Gill Beck 1	
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027062940 Gill Beck (Baildon) from Source to River Aire	
Fish	Moderate	Yes
Invertebrates	Moderate	Yes

B4.12 Gill Beck 2

B4.12.1 Feature Assessment

B4.12.1.1 Statutory designated sites/Local wildlife sites

Hawksworth Spring Wood LWS

Hawksworth Spring Wood is situated within the Gill beck valley between Baildon and Hawksworth is a mosaic of natural habitats. Tributaries of the beck arise on the flanks of Baildon and Hawksworth Moors, run through farmland and into the wooded valley leading to the floodplain of the Aire. The woods down the centre of the valley consist of semi-natural deciduous woodland. Spring Wood includes Pedunculate Oak, Sycamore, Silver and Downy Birch, Holly and Alder (along banksides) are the main trees, along with a few Rowan, Yew and Field Maple. The herb layer in these areas tends to be dominated by bramble. Bluebells and Wild Garlic are plentiful, along with wood millet, hedge woundwort and ferns. The small woodland supports long-term viable populations of Redstart, Wood Warbler or Pied Flycatcher. Spotted Flycatcher, Marsh Tit, Willow Tit, Lesser Spotted Woodpecker and Hawfinch. The site is home to good populations of Common Toads, Common Frogs and Smooth Newts. A good range of riparian fauna includes Dipper, Kingfisher, Grey Wagtail , Grey Heron, Otter, Mink, Brown Trout and Bullhead.

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach for aquatic receptors. As such, the risk from the implementation of the drought option to Hawksworth Spring Wood LWS is deemed to be **moderate** on the aquatic receptors.

Tong Park LWS

Tong Park is located in the mid-section of Gill Beck 2 and span both sides of the valley. The site includes areas of woodland, meadows and the Tong Park dam. The site includes to areas of Marsh with species such as Bulrush, Marsh Marigold, Marsh Thistle, Angelica, Hemlock water dropwort, Ragged Robin, Water Mint present. The wildflower meadows at Tong Park are noted to be an important habitat and community at the site. The site includes a section of Gill beck and Tong Park dam which is home to good populations of Common Toads, Common Frogs and Smooth Newts. A good range of riparian fauna includes Dipper, Kingfisher, Grey Wagtail , Grey Heron, Otter, Mink, Brown Trout and Bullhead.

As such, the risk from the implementation of the drought option to the Tong Park LWS is deemed to be **minor**.

B4.12.1.2 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Gill Beck 2 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in

Table B4.50. The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.50 Impacts on White-clawed Crayfish in Gill Beck 2

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Mortality as a result of water quality deterioration (especially oxygen stress) due to moderate risk to water quality. • Increased mortality (density dependant) as a result of increased predation. • Increased competition due to reduction in habitat availability and food source.	National	Medium	Moderate

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.51**.

Table B4.51 Impacts on otter in Gill Beck 2

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.52**.

Table B4.52 Impacts on NERC and notable fish species in Gill Beck 2

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered minor • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is likely as longitudinal connectivity will possibly be impacted. • Increased mortality (density dependant) as a result of increased predation	National	Medium	Moderate
Bullhead		Regional	Low	Minor

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
	• It is noted that depth of water is not critical to bullhead[46].			

B4.12.1.3 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a major reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. Furthermore, there are no significant flow pressures, either abstractions or discharges, influencing flow in Gill Beck 2, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027062940 Gill Beck (Baildon) from Source to River Aire waterbody (associated with Gill Beck 2). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[47'48]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

Impacts to the fish population of the waterbody has been detailed above in **Section B4.12.1.2**and are assessed as having a moderate impact magnitude for brown trout and minor impact magnitude for bullhead.

Considering the hydrological impacts and the moderate risk of water quality deterioration in the reach, the risk to the WFD status of the fish elements of waterbody WFD GB104027062940 Gill Beck (Baildon) from Source to River Aire (associated with Gill Beck 2) is considered to be **moderate**.

B4.12.2 Summary of Impacts

Table B4.53 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

46 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

47 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

48 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Table B4.53 Summary of impacts identified in Gill Beck 2's environmental features assessment

Reach	Gill Beck 2	
	Significance of Impact	**Mitigation Required (Y/N)**
Statutory designated sites/Local wildlife sites		
Hawksworth Spring Wood LWS	Moderate	Yes
Tong Park LWS	Minor	No
NERC and Notable Species Receptors		
White-clawed crayfish	Moderate	Yes
Otter	Negligible	No
Brown trout	Moderate	Yes
Bullhead	Minor	No
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027062940 Gill Beck (Baildon) from Source to River Aire	
Fish	Moderate	Yes
Invertebrates	Moderate	Yes

B4.13 Jum Beck 1

B4.13.1 Feature Assessment

B4.13.1.1 NERC and other protected species

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.54**.

Table B4.54 Impacts on otter in Jum Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.55**.

Table B4.55 Impacts on NERC and notable fish species in Jum Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is likely as longitudinal connectivity could be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[49]	National	High	Major
Bullhead		Regional	Medium	Moderate

[49] Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

B4.13.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs; the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. There are no significant flow pressures, either abstractions or discharges, influencing flow in Jum Beck 1, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a moderate risk to the macroinvertebrate component of the GB104027062940 Gill Beck (Baildon) from Source to River Aire waterbody (associated with Jum Beck 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[50'51]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

Fish

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option, the risk to the WFD status the fish component of the WFD GB104027062940 Gill Beck (Baildon) from Source to River Aire (associated with Jum Beck 1) is considered to be **moderate**, however, there are uncertainties relating to the fish community within the impacted reach as limited survey data is available.

50 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

51 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

B4.13.2 Summary of Impacts

Table B4.56 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to Statutory designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.56 Summary of impacts identified in Jum Beck Reach 1's environmental features assessment

Reach	Jum Beck 1	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
Otter	Negligible	No
Brown trout	Major	Yes
Bullhead	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027062940 Gill Beck (Baildon) from Source to River Aire	
Fish	Moderate	Yes
Invertebrates	Moderate	Yes

B4.14 Aire 1

B4.14.1 Feature Assessment

B4.14.1.1 NERC and other protected species

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.57**.

Table B4.57 Impacts on otter in Aire 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table 4.58.**

Table 4.58 Impacts on NERC and notable species in Aire 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered negligible • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is unlikely as longitudinal connectivity will not be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[52] and the species is also widespread within the catchment • Exposure/loss of important habitats (wetland habitats for juveniles and adults) eel	National	Medium	Moderate
Grayling		Regional	Medium	Minor
Bullhead		Regional	Low	Minor
Barbel		County	Medium	Minor
European eel		National	Medium	Moderate

52 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

B4.14.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in moderate reduction in flow and will lead to a moderate reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good to high level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by high $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a moderate risk. Water quality deterioration as a result of the drought option may potentially have a short-term acute impact on invertebrate community, associated with additional temporary water quality pressures locally downstream of three listed CSOs during rainfall events. The risk of water quality deterioration is moderate as identified in **Appendix A.**

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a moderate risk in summer/autumn and a minor risk in winter to the macroinvertebrate component of the GB104027063034 Aire (River Worth to Gill Beck) waterbody (associated with Aire 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[53'54]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **minor**.

Fish

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a moderate risk in summer/autumn and a minor risk in winter to the WFD status in waterbody WFD GB104027063034 Aire (River Worth to Gill Beck) (associated with Aire 1). The duration of impacts could be up to 6 months. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **minor**.

B4.14.2 Summary of Impacts

Table B4.59 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

53 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

54 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Table B4.59 Summary of impacts identified in Aire 1's environmental features assessment

Reach	Aire 1	
	Significance of Impact	**Mitigation Required** (Y/N)
NERC and Notable Species Receptors		
Otter	Negligible	No
Grayling	Minor	No
Barbel	Minor	No
European eel	Moderate	Yes
Brown trout	Moderate	Yes
Bullhead	Minor	No
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027063034 Aire (River Worth to Gill Beck)	
Invertebrates	Minor	No
Fish	Minor	No

B4.15 Aire 2

B4.15.1 Feature Assessment

B4.15.1.1 NERC and other protected species

Otter

In the absence of quantitative data on population of otter, a detailed assessment of impact in Aire 2 as a result of the implementation of the drought option is not feasible.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.60**.

Table B4.60 Impacts on otter in Aire 2

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches. • There are uncertainties relating to the presence of this species with the impacted reach.	International	Negligible	Negligible

Water vole

In the absence of quantitative data on populations of water vole a detailed assessment of the impact in Aire 2 as a result of the implementation of the drought option is not feasible.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.60.** The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.61 Impacts on water vole in Aire 2

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Water vole	• Risk of deterioration in water quality has been identified as minor and will not impact on this feature • Species has a preference for waterbodies that do not have extreme fluctuations in water level[55]. • Increased predation as a result of decreased water width and exposure of burrows. • The reduction in wetted width could result in an increased distance between water vole food source and the burrows. • Impacts could occur throughout the breeding season for this species. • Alteration to food supply could occur although the species has been known to feed upon crayfish at times[56] and the potentially increased density of this species could lead to increased predation efficiency • Although the impacts are restricted to the reach, the effects of increased predation upon the species could have long-term impacts. • There are uncertainties relating to the presence of this species with the impacted reach.	National	Low	Moderate

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.61**.

55 English Nature, the Environment Agency and the 1998 Wildlife Conservation Research Unit Water vole Conservation Handbook. George Street Press Ltd.

56 Strachan, R. and Moorhouse, T. (2006) Water Vole Conservation Handbook. 2nd Edition. Wildlife Conservation Research Unit, Oxford.

Table B4.62 Impacts on NERC and notable fish species in Aire 2

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered negligible • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is unlikely as longitudinal connectivity will not be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[57] and the species is also widespread within the catchment • Exposure/loss of important habitats (wetland habitats for juveniles and adults) eel	National	Low	Moderate
Grayling		Regional	Low	Minor
Bullhead		Regional	Low	Minor
European eel		National	Low	Moderate

B4.15.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in moderate reduction in flow in summer/autumn and a minor reduction in flow in winter. This will lead to a minor reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows considerable variation of diversity, and consequently, loss of habitat may further reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by moderate $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a minor risk. Furthermore, there are no significant flow pressures, either abstractions or discharges, influencing flow in Aire 2, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a minor risk to the macroinvertebrate component of the GB104027063032 Aire from Gill Beck (Baildon) to River Calder waterbody (associated with Aire 2). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[58,59]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **minor**.

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57 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

58 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

59 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Fish

The fish community element of GB104027063032 Aire from Gill Beck (Baildon) to River Calder (associated with Aire 2) is not classified, the risk to deterioration of the WFD status of the waterbody is considered to be **minor**.

B4.15.2 Summary of Impacts

Table B4.62 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.63 Summary of impacts identified in Aire 2's environmental features assessment

Reach	Aire 2	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
Otter	Negligible	No
Water vole	Moderate	Yes
Brown trout	Moderate	Yes
Bullhead	Minor	No
European eel	Moderate	Yes
Grayling	Minor	No
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027063032 Aire from Gill Beck (Baildon) to River Calder	
Fish	Minor	No
Invertebrates	Minor	No

B4.16 Dibb 1

B4.16.1 Feature Assessment

B4.16.1.1 NERC and other protected species

White-clawed Crayfish

In the absence of quantitative data on populations of white-clawed crayfish a detailed assessment of impact in Dibb 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, it is possible that individuals will become stranded as river levels reduce and habitats become exposed.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.64**.

Table B4.64 Impacts on White-clawed Crayfish in Dibb 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources due to reduced suitability of habitat. • Water quality risks are considered minor and water quality related impacts are considered unlikely	National	High	Major

Otter

In the absence of quantitative data on population of otter, a detailed assessment of impact in Dibb 1 as a result of the implementation of the drought option is not feasible. The likely impacts arising from the hydrological changes as a result of the drought option are identified in **Table B4.65**.

Table B4.65 Impacts on otter in Dibb 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches. • There are uncertainties relating to the presence of this species with the impacted reach.	International	Negligible	Negligible

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.65.**

Table B4.66 Impacts on NERC and notable fish species in Dibb 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered minor • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of salmonids and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals is likely as longitudinal connectivity will possibly be impacted. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[60]	National	High	Major
Atlantic salmon		National	High	Major
Bullhead		Regional	Medium	Moderate

B4.16.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a major reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good level of diversity, and consequently, loss of habitat may reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by good to high $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a minor risk. Furthermore, there are no significant flow pressures, either abstractions or discharges, influencing flow in Dibb 1, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027064120 Barben Beck/River Dibb Catchment (trib of Wharfe) waterbody (associated with Dibb 1)). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[61'62]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate**.

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60 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

61 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

62 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Fish

Impacts to the fish population of the waterbody has been detailed above in Section B4.16.1.1 and are assessed as having a **major** impact magnitude for brown trout and Atlantic salmon, while moderate impact magnitude for bullhead.

Considering the hydrological impacts and the major risk of water quality deterioration in the reach, the risk to the WFD status of the fish elements of waterbody WFD GB104027064120 Barben Beck/River Dibb Catchment (trib of Wharfe) (associated with Dibb 1) is considered to be **major**.

B4.16.2 Summary of Impacts

Table B4.67 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

Table B4.67 Summary of impacts identified in Dibb 1's environmental features assessment

Reach	Dibb 1	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
White-clawed crayfish	Major	Yes
Otter	Negligible	No
Brown trout	Major	Yes
Bullhead	Moderate	Yes
Atlantic salmon	Major	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027064120 Barben Beck/River Dibb Catchment (trib of Wharfe)	
Fish	Major	Yes
Invertebrates	Moderate	Yes

B4.17 Carr Beck 1

B4.17.1 Feature Assessment

B4.17.1.1 NERC and other protected species

White-clawed Crayfish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.68**. The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.68 Impacts on White-clawed Crayfish in Carr Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
White–clawed crayfish	• Stranding and mortality as a result of a reduction in velocity, depth and/or wetted width. • Increased mortality (density dependant) as a result of increased predation. • Increased competition for resources as habitat availability reduces. • Water quality risks are considered minor and water quality related impacts are considered unlikely.	National	Low	Moderate

Otter

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.69**.

Table B4.69 Impacts on otter in Carr Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Otter	• Increased efficiency in predation as a result of higher densities of prey species (fish and white-clawed crayfish) as species are forced into smaller areas. • Species could remain within the reach for longer. • Otter likely to move to unaffected reaches.	International	Negligible	Negligible

Water vole

In the absence of quantitative data on populations of water vole a detailed assessment of the impact in Carr Beck 1 as a result of the implementation of the drought option is not feasible. However, as suitable habitat is present within the reach, in particular suitable habitat in the banks, burrows may potentially become exposed leading to an increased susceptibility to predators such as stoat and weasels.

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.70.** The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are considered to be short-term and reversible.

Table B4.70 Impacts on water vole in Carr Beck 1

Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Water vole	• Risk of deterioration in water quality has been identified as minor and will not impact on this feature • Species has a preference for waterbodies that do not have extreme fluctuations in water level[63]. • Increased predation as a result of decreased water width and exposure of burrows. • The reduction in wetted width could result in an increased distance between water vole food source and the burrows. • Impacts could occur throughout the breeding season for this species. • Alteration to food supply could occur although the species has been known to feed upon crayfish at times[64] and the potentially increased density of this species could lead to increased predation efficiency • Although the impacts are restricted to the reach, the effects of increased predation upon the species could have long-term impacts. • There are uncertainties relating to the presence of this species with the impacted reach.	National	Medium	Moderate

Fish

The likely impacts arising from the hydrological changes as a result of the implementation of the drought option are identified in **Table B4.71**.

Table B4.71 Impacts on NERC and notable fish species in Carr Beck 1

NERC/ notable Feature	Impact	Ecological Value of Feature	Impact Magnitude	Significance of Impact
Brown trout	• The risk to siltation of spawning gravels is considered moderate • Reduced flow and wetted width could result in exposure/loss of important habitats (spawning gravels, nursery habitat, resting pools) • Reduced flow during downstream and upstream migration of brown trout and movement from spawning to nursery areas could be impeded due to lower flows. As flows could be reduced at any time of the year, all life stage are considered to be at risk. • Increased stress and competition could result in decreased growth, morphological change and/or alteration to feeding and migration • Stranding of individuals due to risks to longitudinal connectivity. • Increased mortality (density dependant) as a result of increased predation • It is noted that depth of water is not critical to bullhead[65]	National	High	Major
Bullhead		Regional	Medium	Moderate

63 English Nature, the Environment Agency and the 1998 Wildlife Conservation Research Unit Water vole Conservation Handbook. George Street Press Ltd.

64 Strachan, R. and Moorhouse, T. (2006) Water Vole Conservation Handbook. 2nd Edition. Wildlife Conservation Research Unit, Oxford.

65 Tomlinson, M. L. and Perrow, M. R. (2003) Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough.

B4.17.1.2 WFD Features

Invertebrates

The potential changes to river flows is likely to result in major reduction in flow and will lead to a major reduction in wetted width and depth which will directly reduce the overall habitat availability within the reach. As indicated by the $WHPT_{NTAXA}$ EQRs, the macroinvertebrate community shows a good level of diversity, and consequently, loss of habitat may further reduce the diversity of the community as a result of habitat loss for certain species. Furthermore, the increased friction between flow and channel bed may reduce flow velocity, as the macroinvertebrate community is sensitive to flow velocity reductions, as indicated by high LIFE scores. This may reduce the suitability of the reaches to species which require high flow velocities. The community is considered to be sensitive to water quality pressures as indicated by good $WHPT_{ASPT}$ EQRs, however the water quality changes as a result of the implementation of the drought option are predicted to present a minor risk. Furthermore, there are no significant flow pressures, either abstractions or discharges, influencing flow in Carr Beck 1, as indicated in **Appendix A**.

The combined physical environment changes (river flows, river habitat and water quality) as a result of the implementation of the drought option are predicted to present a major risk to the macroinvertebrate component of the GB104027064258 Wharfe from Hundwith Beck to River Washburn waterbody (associated with Carr Beck 1). The duration of impacts could be up to 6 months. However, the macroinvertebrate community recovery is expected to be relatively quick due to effective re-colonisation strategies in macroinvertebrates[66'67]. Therefore, the risk to deterioration of the WFD status of the waterbody is considered to be **moderate** however, there are uncertainties relating to the invertebrate community within the impacted reach as limited survey data is available.

Fish

Impacts to the fish population of the waterbody has been detailed above in Section B4.17.1.1 and are assessed as having a major impact magnitude for brown trout, and moderate impact magnitude for bullhead.

Considering the hydrological impacts and the risk of water quality deterioration in the reach, the risk to the WFD status the fish component of the WFD GB104027064258 Wharfe from Hundwith Beck to River Washburn (associated with Carr Beck 1) is considered to be **moderate**, however, there are uncertainties relating to the fish community within the impacted reach as limited survey data is available.

B4.17.2 Summary of Impacts

Table B4.71 summarises the outcomes of the environmental features assessment and includes deterioration to fish and invertebrate features within WFD waterbodies and significance of impacts to designated sites, NERC Act Section 41 features and other significant receptors.

66 Williams, D. D. (1977) Movements of benthos during the re-colonisation of temporary streams. *Oikos* 29, pp 306 – 312.

67 Mackay, R. J. (1992) Colonisation by lotic macroinvertebrates: a review of process and patterns. *Canadian Journal of Fisheries and Aquatic Science* 49, pp 617 – 628.

Table B4.72 Summary of impacts identified in Carr Beck 1's environmental features assessment

Reach	Carr Beck 1	
	Significance of Impact	**Mitigation Required (Y/N)**
NERC and Notable Species Receptors		
White-clawed crayfish	Moderate	Yes
Otter	Negligible	No
Water vole	Moderate	Yes
Brown trout	Major	Yes
Bullhead	Moderate	Yes
WFD Status Receptors	**Risk of Deterioration**	
WFD Waterbody	GB104027064258 Wharfe from Hundwith Beck to River Washburn	
Fish	Moderate	Yes
Invertebrates	Moderate	Yes

B5. Monitoring & mitigation

Onset of drought, in-drought and post-drought monitoring and mitigation has been specified for all impacted reaches following identification of environmental features within in the reaches susceptible to the drought option(s) implementation. Where applicable YWSL have undertaken onset monitoring in advance of the drought permit application.

The baseline monitoring programme to inform the susceptibility, sensitivity and assessment of environmental features has been specified and requirements have been included in YWSL's ongoing baseline monitoring programme.

On the assumption that otter and water vole can be potentially be present in all impact reaches, no further baseline monitoring surveys have been included for these species. Mitigation measures and protection for sensitive species such as brown trout which are screened in should provide adequate protection where required of water levels and flows to ensure that riparian species such as water vole and otter are adequately protected for the duration of the drought permits in the impacted reaches.

Walkover surveys and non-invasive techniques are the preferred method to establish the impacts of drought options and to target mitigation. Where appropriate this will be supplemented by quantitative survey during the on-set of drought and post-drought; but in the interests of avoiding further distress to the riverine ecology, not in-drought. Existing long-term monitoring of the physical environment will continue (flow gauging and water quality monitoring).

The onset of drought, in-drought and post-drought monitoring would establish the need for and appropriate type of mitigation for drought option impacts.

Full details of monitoring and mitigation requirements for all impacted reaches can be found in Appendix A.2 of YWSL's Drought Plan 2022 EMP and a summary is provided in the main EAR Section 6.2.

Reach specific actions are included in Appendix A.2 for significant water quality pressures related to YWSL WwTWs:

- **Bridgehouse Beck 1: Worth 2:** the assessment has identified a significant water quality pressure in these reaches associated with Oxenhope WwTW.
- **Harden Beck 1:** the assessment has identified a significant water quality pressure associated with Harecroft WwTW.

YWSL have identified that for the period of implementation of the drought option, sewage treatment can be enhanced, reducing the water quality pressure on the impacted features from ammonia, and oxygen balance. Further information can be found in the YWSL WwTW optimisation plan[68] which provides details on enhancement for WwTW that discharge into rivers where compensation flows may be reduced under drought permit implementation.

During any future on-set of drought periods (14 weeks before drought control lines are crossed) YWSL will consult with the Environment Agency regarding any WwTWs not identified as significant water quality pressures at the time of the writing of this EAR, but which may be a cause for concern. Additional sites will be added to the priority list of sites for optimisation as required.

A 'Combined Sewer Overflows Optimisation and Maintenance for Drought Plan' has also been developed by YWSL and in consultation with the Environment Agency. This has been updated in 2022 in support of the drought permit application[69] and includes all significant intermittent water quality pressures identified in this EAR.

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68 YWSL (2022) Wastewater Treatment Works Optimisation and Maintenance for Drought Plan.

69 YWSL (2022) Combined Sewer Overflows (CSOs) Optimisation and Maintenance for Drought Plan.

Appendix C Monitoring and ecological mitigation measures

Table C1.1 Monitoring and mitigation measures included in the YWSL Drought Plan 2022 EMP

Baseline Monitoring - to ensure an adequate baseline dataset exists to describe non-drought conditions for those receptors likely to be impacted by drought permit implementation and to fill any data gaps and reduce uncertainty identified during the environmental assessment	
Routine baseline monitoring	
BMON_1	EA/YWSL to continue monitor river flows and levels/reservoir levels and spill at key monitoring sites
BMON_2	EA to continue routine water quality monitoring at existing network of sites on current monthly programme, which includes those on un-impacted reaches suitable as control sites.
BMON_3	Macroinvertebrate monitoring at a number of locations, including rivers potentially affected by drought measures; to continue in low flow/drought years pending agreement with the EA regarding aquatic species welfare.
BMON_4	Fish monitoring at a number of locations, including rivers potentially affected by drought measures; to continue in low flow/drought years pending agreement with the EA regarding aquatic species welfare.
Targeted baseline monitoring	
BMON_5	White-clawed crayfish surveys to determine distribution and abundance in reaches under serious (i.e. moderate or major) hydrological stress
BMON_6	Fine-lined pea mussel survey to determine distribution and abundance in reaches under serious hydrological stress
BMON_7	Targeted juvenile lamprey surveys to identify distribution of habitat and an indicative population status within reaches subject to serious hydrological stress
On-set of Environmental drought – monitoring leading to selection and implementation of appropriate mitigation measures	
ODMON_1	Walkover surveys of habitat quality and identification of drought sensitive habitats such as areas of riffle, pools and artificial features such as weirs and sluices that may be isolated or impassable during low flows. Results to be captured by annotated walkover maps and completion of a 'River Conditions Observation Form - Low Flows' form.
In-Drought (during drought option implementation) – monitoring leading to selection and implementation of appropriate mitigation measures	
IDMON_1	Surveillance walkover surveys of habitat quality and ecological stress, recording signs of environmental problems (reaches to match those in OMON_1)
IDMON_2	Targeted surveillance walkover surveys of water quality and ecological stress local to 'significant' water quality pressures', to include water quality spot sampling in priority areas such as pools and weirs where aquatic species may become isolated during low flows.
IDMON_3	Storm intensity forecasting to predict likely CSO spill events and the need for pre-emptive mitigation
In-Drought (During Drought Option Implementation) – Mitigation	
IDMIT_1	Negotiation with the licence holder of a temporary reduction of third party abstractions presenting 'significant' impacts to sensitive features, including financial compensation by Yorkshire Water.
IDMIT_2	At identified SSSIs, mitigation would comprise the temporary cessation of impacting drought options by Yorkshire Water.
IDMIT_3	Improving the effluent quality from Yorkshire Water WwTWs presenting 'significant' impacts to sensitive features, thereby reducing the water quality pressure (ammonia and oxygen balance) on the impacted features.
IDMIT_4	Artificial freshet release to dilute/displace water quality reduction
IDMIT_5	Negotiation with permit holder and aeration of discharge from third party facility identified as a 'significant' water quality pressure
IDMIT_6	Gradual phase-in of reduction in water volume/flow to avoid stranding of individuals (fish, white-clawed crayfish, fine-lined pea mussel)

IDMIT_7	Gradual phase-in of compensation release increases to avoid stranding or displacement of individuals (macroinvertebrates, fish, white-clawed crayfish, fine-lined pea mussel)
IDMIT_8	Temporary reduction in volume of abstraction or increase in compensation release (fish)
IDMIT_9	Artificial freshet release to provide temporary variation in the flow regime (fish, white-clawed crayfish, fine-lined pea mussel, water vole, otter)
IDMIT_10	Creation of alternative refuges in deeper water where walkover surveys identify the loss of important deep water habitat or high densities of fauna in refuges (fish, white-clawed crayfish, water vole)
IDMIT_11	Provision of in-stream structures and flow baffles to create functional refuges to support flow sensitive species where walkover surveys identify a projected loss of habitat inundation (macroinvertebrates, fish, white-clawed crayfish, water vole, otter)
IDMIT_12	Artificial channel narrowing to provide functional refuges and support habitat requirement for species, enabling a quick natural recolonisation of the reach post-drought (fish, macroinvertebrates, white-clawed crayfish, fine-lined pea mussel, otter, water vole)
IDMIT_13	Provision of piscivorous “visual” bird scaring measures (e.g. using streamers in riparian trees) to control predation upon species using refuges (fish). These visual measures would only be implemented following consultation with the EA, Natural England and bird specialists, particularly taking account of protected species under the 1981 Wildlife and Countryside Act. Implementation would follow best practice guidance.
IDMIT_14	Gravel washing of spawning habitats where walkover surveys and routine monitoring identifies likely habitat degradation as a result of sedimentations (fish)
IDMIT_15	Aeration of watercourse where significant mortality or change in species abundances are likely to be attributed to water quality deterioration
IDMIT_16	Modification of flow structure across barriers to retain favourable conditions to facilitate the movement/migration of species (fish)
IDMIT_17	Provision of freshet releases to enable migration of fish across significant obstacles (fish)
IDMIT_18	Regular inspection and clearing of screens to ensure they retain their correct working function (fish, white-clawed crayfish)
IDMIT_19	Capture and relocate individuals across significant barriers, taking into account migratory periods (immigration and emigration) (fish) and ensuring biosecurity measures are in place at all times.
IDMIT_20	Rescue of individuals or groups, in consultation with the EA or NE as appropriate, and relocation to suitable habitat where they are seen to be in distress or where artificially high densities are likely to result in significant impacts (fish, white-clawed crayfish). Measures will be taken to ensure biosecurity at all times. It should be noted that movement of crayfish requires licensing which can take up to 8 weeks. Movement of crayfish would only take place after consultation agreeing that this was the best course of action.
IDMIT_21	Rescue of individuals or groups, in consultation with the EA or NE as appropriate, and retention for later release where they are seen to be in distress or where artificially high densities are likely to result in significant impacts (fish, white-clawed crayfish). Measures will be taken to ensure biosecurity at all times. It should be noted that movement of crayfish requires licensing which can take up to 8 weeks. Movement of crayfish would only take place after consultation agreeing that this was the best course of action
IDMIT_22	Implementation of navigation controls in the channel to reduce disturbance damage upon vulnerable species and/or populations.
IDMIT_23	For CSOs identified as significant water quality, prioritise planned maintenance work on and reactive pollution prevention work, including visits by operators.
IDMIT_24	Cessation of water transfer should it be identified that fish disease has been spread between catchments and notify the EA and Cefas
Post-Drought (Drought Options Removed) – Monitoring	
PDMON_1	White-clawed crayfish sampling to monitor recovery of their distribution and abundance

PDMON_2	Fine-lined pea mussel sampling to monitor recovery of their distribution and abundance
Post-Drought (Drought Options Removed) – Mitigation	
PDMIT_1	Enhancement of habitat beyond the impacted reach (macroinvertebrates, fish, fine-lined pea mussel, white-clawed crayfish, water vole)
PDMIT_2	Provision of artificial freshets to ensure fish are capable of migrating where survey identifies insufficient water depth or volume across structures to facilitate migration (fish)
PDMIT_3	Modification to barriers and/or flows to improve passage where walkover survey identifies insufficient water depth or volume at obstacles (fish)
PDMIT_4	Capture and relocate across barrier (taking migratory period into account) where significant numbers of migratory fish congregate at obstacles (fish)
PDMIT_5	Relocation of juveniles where walkover surveys identify the likely desiccation of marginal habitats or loss of water depth at important habitats (fish, fine-lined pea mussel)
PDMIT_6	Restocking using juvenile lamprey ammocoetes within the catchment where monitoring indicates loss of fish abundance or recruitment (fish)
PDMIT_7	Restocking using offspring from broodstock from the catchment where monitoring indicates loss of fish abundance or recruitment (fish)
PDMIT_8	Restocking of coarse fish from the catchment where monitoring indicates loss of fish abundance or recruitment (fish)
PDMIT_9	Removal/treatment of giant hogweed where monitoring indicates an increase in abundance or distribution

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