

**Official Sensitive**

# Drought Plan 2022

## Updated Environmental Monitoring Plan

### 2022 Version

Version	Publication date	Author	Content/ changes
1.0	2013	Cascade Consulting, Arup	First EMP
2.0	February 2016	YWS	Updated post start of AMP6 baseline data monitoring. Integrated methodology agreed with EA in (Appendix A) January 2016
2.1	February 2016	YWS	Updated baseline methodology section to reflect Appendix A
2.2	July 2016	YWS	Final updates to Appendix A
3	June 2017	Cascade Consulting, Arup	Updated EMP following updating of the 2017 DP and associated EARs
3.1	July 2018	Ricardo, Arup	Minor modifications as part of Drought Plan 2018 finalisation
4.0	August 2020	Ricardo	First draft of updated EMP for Draft DP 2021 and associated EARs
4.1	February 2021	Ricardo	Updated following EA comments and completion of EAR updates
4.2	September 2021	Ricardo	Minor updates following Draft Drought Plan 2022 consultation
5.0	August 2022	Ricardo	Final for application
5.1	September 2022	Ricardo	Minor updates following pre-application consultation

# Contents

1.	Introduction .....	1
1.1.	Purpose of the Environmental Monitoring Plan.....	1
1.2.	Background and Basis of the Environmental Monitoring Plan.....	4
1.3.	Mitigation and Monitoring Key .....	5
1.4.	Biosecurity .....	6
1.5.	Report Structure .....	6
2.	Baseline Monitoring.....	7
2.1.	Routine Baseline Monitoring.....	7
2.2.	Targeted Baseline Monitoring.....	13
2.3.	Baseline Monitoring Location, Timing and Responsibility .....	14
2.4.	Construction Related Surveys .....	15
3.	On-set, In Drought and Post Drought Mitigation-led Monitoring and Mitigation ..	17
3.1.	Introduction .....	17
3.2.	On-set Environmental Drought Mitigation-led Monitoring.....	18
3.3.	In Drought (During Drought Option Implementation) Mitigation-led Monitoring ..	19
3.4.	In Drought Mitigation Options .....	20
3.5.	Post Drought Mitigation Options .....	23
3.6.	Post Drought Monitoring.....	23
3.7.	Mitigation measures: Permits and approvals .....	25
3.8.	Monitoring and mitigation measures: ensuring environmental protection .....	28
3.9.	On-set, In and Post Drought Monitoring Location, Timing and Responsibility ....	28
4.	Monitoring Plan for Each Impacted Reach .....	30

## Appendices

APPENDIX A - Monitoring Plan for Impacted Reaches

APPENDIX B.1 - Existing Baseline Survey Sites

APPENDIX B.2 - Ecology Surveys Methodologies

APPENDIX C - Surveillance Walkover Assessment Specification

APPENDIX D - Mitigation Measures: Guidance for Ecological Actions

## Executive Summary

This Environmental Monitoring Plan (EMP) accompanies Yorkshire Water's Final Drought Plan 2022 and provides a framework for monitoring and mitigation that would be followed during preparation for a drought permit / order. It outlines the methods through which Yorkshire Water will ensure it understands and manages the effects of its drought management actions on the environment. The report has been prepared in accordance with the Environment Agency Water Company Drought Plan Guideline (2020).

The EMP is comprised of the following components:

- An assessment of additional survey requirements to support/inform decisions on environmental sensitivity and likely impact, including the establishment of baseline conditions.
- Identification of in-drought monitoring requirements to assess impacts arising from drought management actions and to assess the effectiveness of mitigation options put in place to manage any impacts.
- Identification of post-drought monitoring requirements to assess the recovery of a site, along with mitigation options to aid the recovery from drought management actions.

The EMP draws on the conclusions and recommendations identified in the accompanying Environmental Assessment Reports (EARs) and preliminary environmental assessment and screening reports for drought options in a third consecutive year of drought. The development of mitigation and monitoring requirements have been based upon the assessment of sensitive features identified as having a significant risk of impact as a result of implementing any proposed drought management actions. Following the Environment Agency guidance, significant risk has been considered to be where the significance of impacts is identified as being moderate or major.

As environmental conditions will naturally change and evolve over time, and thus the potential for significant impacts upon sensitive features may change, baseline monitoring has been identified to address this, with all sensitive features considered for monitoring.

Monitoring proposals for the baseline, on-set of drought, in-drought and post-drought conditions address a range of factors, including: the identification of sensitive features to be monitored; recommendations for specific methods to be utilised for monitoring; timing and frequency of monitoring; and identification of parties who would be responsible for undertaking the monitoring. Although exact locations of monitoring sites have not been established, a plan of action for their identification has been established.

Throughout the development of the EMP and the supporting environmental assessment process, Yorkshire Water have proactively engaged key stakeholders, Environment Agency and Natural England.

The EMP will be periodically reviewed to ensure the conclusions and recommendations remain valid and lessons learnt from the implementation of drought management actions are incorporated. Key stakeholders will be further consulted as part of the overall drought permit/order application process during any drought event.

## Glossary

<b>Biochemical Oxygen Demand (referred to as BOD)</b>	The amount of oxygen that would be consumed if all the organic material in one litre of water were oxidised by bacteria and protozoa.
<b>Compensation Releases</b>	Water company licences that authorise abstractions from a reservoir may have conditions imposed, whereby a specified amount of water has to be released into the watercourse, downstream of the reservoir in order to compensate the river for the abstraction.
<b>Drought Order</b>	An authorisation granted by the Secretary of State under Section 73 of the Water Resources Act (199) when there are drought conditions, which impose restrictions upon the use of water, and/or allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis. A drought order can be applied for by the Environment Agency for environmental reasons and by a Water Undertaker for Public Supply reasons. A drought order lasts for 6 months but can be extended for a total of one year.
<b>Drought Permit</b>	An authorisation granted by the Environment Agency under drought conditions which allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis (generally for 6 months, but can be extended up to a total of one year) under Schedule 8 of the Water Resources Act (1991).
<b>Environmental Drought</b>	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.
<b>European Protected Species</b>	European Protected Species and their habitats receive full protection through inclusion within Schedule II of the Conservation of Habitats and Species Regulations 2010 (as amended), which transposes Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora into national statute.
<b>Level of service</b>	Water resource availability is dependent on factors such as precipitation, that vary through time. During periods of scarcity, restrictions, such as hosepipe bans, can be introduced that help maintain depleted water resources so that Yorkshire Water can fulfil their responsibility to customers over the frequency of restrictions, e.g. drought order implementation would be limited to a frequency of 1 year in 25.
<b>Lotic-Invertebrate Index Flow Evaluation (referred to as LIFE)</b>	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 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.
<b>Macroinvertebrate</b>	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.
<b>pH</b>	A measure of the acidity or alkalinity of a liquid based on a logarithmic scale of concentration of hydrogen ions. < 7 is acidic, > 7 is alkaline.
<b>Protection of Habitats and Species</b>	<p>Certain habitats and species receive protection in the UK as a result of inclusion within legislative or policy frameworks. The hierarchy of protection is:</p> <ul style="list-style-type: none"> <li>■ European Protected: Natura 2000 sites (Ramsar, Special Area of Conservation and Special Protection Area) and European Protected Species.</li> <li>■ National Protection: Sites of Special Scientific Interest and species included under national legislation (including, but not limited to, the Wildlife and Countryside Act 1981 (as amended))</li> <li>■ NERC Act Section 41 Priority Species: Species “of principal importance for the purpose of conserving biodiversity” covered under section 41 (England) of the 2006 Natural Environment and Rural Communities (NERC) Act.</li> </ul>
<b>Ramsar site</b>	Ramsar sites support internationally important wetland habitats and species and are listed under the Convention on Wetlands of International Importance, especially as waterfowl habitat (Ramsar Convention, 1971). Nationally planning policy indicates that Ramsars should be afforded the same level of protection as Special Areas of Conservation and Special Protection Areas.
<b>Site of Special Scientific Interest</b>	Designated under the Wildlife and Countryside Act 1981 (as amended), with additional protection afforded through the Countryside and Rights of Way Act (2000) and Environmental Damage (Prevention and Remediation) Regulations (2009), to protect habitats and the habitats of species that are considered to be of national importance.
<b>Special Area of Conservation</b>	Designated under the Habitats Directive and implemented through the Habitats Regulations (1994) to protect important European Habitat, especially those of threatened species, in sites of community importance.
<b>Special Protection Area</b>	Designated under the Birds Directive and implemented through the Wildlife and Countryside Act (1991) to protect important European Habitat for birds.



<b>WRAPsim</b>	The water resources model used by Yorkshire Water. Within WRAPsim each of the reservoir sources or groups has defined control lines. The level of service is achieved by ensuring that the storage within the system is balanced. WRAPsim prioritises the use of water in the system depending on each reservoir's storage in relation to the control lines. Levels are further defined within the model for greater sensitivity and assigned costs such that the least cost solution in one case would be to use a reservoir at a given time, but in another situation, with stocks just below a control line, the least cost solution would be to use a river abstraction.
<b>WHPT</b>	The Whalley, Hawkes, Paisley & Trigg (WHPT) metric is used in River Invertebrate Classification Tool (RICT). This classification method enables the assessment of invertebrates in rivers (in relation to general degradation, including organic pollution) according to the requirements of the WFD. WHPT metrics replace the BMWP (Biological Monitoring Working Party) metrics used for status classifications in the first river basin planning cycle. The classification comprises two metrics that are assessed separately and then combined in a "worst of" approach to provide the overall invertebrate classification; WHPT ASPT (Average Score Per Taxon) WHPT NTAXA (Number of taxa contributing to the assessment). RICT output includes an EQR, a face value classification and an estimate of the probability of the result belonging to any of the WFD classes. This is provided individually for both of the metrics.
<b>RICT</b>	The River Invertebrate Classification Tool (RICT) is used to contextualize WHPT scores, by using a RIVPACS (River Invertebrate Prediction and Classification System) model to predict site specific reference values and provide a WFD compliant probabilistic classification. The RIVPACS models are based on a database of reference samples from streams and rivers across the UK. These were collected between 1978 and 2002. The Regulatory Agencies for surface waters in the UK have recently begun to use the new web-based River Invertebrate Classification Tool (RICT) to classify the ecological quality of rivers.
<b>FCS2</b>	The Fisheries Classification Scheme (2) method enables the assessment of fish in rivers according to the requirements of the Water Framework Directive (WFD). It encompasses fish abundance, taxonomic composition and age structure. There are two parts, or sub-models, to the FCS2 species models. The first, the calibration submodel, predicts the expected numbers of a species to be found at a given site (based on physical, chemical and geographical attributes) if it were at reference conditions. The second, the application sub-model, compares the actual number of fish observed on a survey with the expectation predicted by the calibration mode. The result is an individual species EQR which is interpreted as the probability of observing the number of individuals which





	were actually observed, or less, if the site were at reference conditions.
<b>BQE</b>	The Water Framework Directive specifies the quality elements that are used to assess the ecological status of a water body. These are referred to as Biological Quality Elements (BQE) and form a component of this ecological status include fish, invertebrates, macrophytes etc.
<b>EQR</b>	The classification tools are designed to calculate the current condition of a particular BQE. They do this by calculating an environmental quality ratio (EQR). This is achieved by comparing the observed value of the metric calculated from samples with the value of the same metric expected at WFD reference state. This is expressed as a decimal fraction of the observed against the reference value. Each BQE, has an EQR value that is considered to represent reference state or High Ecological Status (HES). For most BQEs this is close to 1.0. The closer the EQR value is to this value the closer that BQE is to being at reference state or HES. EQR values exceeding the HES value are considered to be at HES. The specific methods for calculating the EQRs for each BQE are detailed in method statements for each of the methods.



## Abbreviations

BOD	-	Biochemical Oxygen Demand
BQE	-	Biological Quality Element
CEH	-	Centre for Ecology and Hydrology
CPUE	-	Catch Per Unit Effort
CSO	-	Combined Sewer Overflow
EA	-	Environment Agency
EMP	-	Environmental Monitoring Plan
EQI	-	Ecological Quality Index
EQR	-	Ecological Quality Ratio
FCS2	-	Fisheries Classification System 2
JNCC	-	Joint Nature Conservation Committee
LIFE	-	Lotic invertebrate Index for Flow Evaluation
LNR	-	Local Nature Reserve
NE	-	Natural England
NERC	-	Natural Environment and Rural Communities
MMR	-	National Nature Reserve
RBMP	-	River Basin Management Plan
RHS	-	River Habitat Survey
RICT	-	River Invertebrate Classification Tool
RIVPACS	-	River Invertebrate Prediction and Classification System
SAC	-	Special Area of Conservation
SPA	-	Special Protection Area
SSSI	-	Site of Special Scientific Interest
STW	-	Sewage Treatment Works
UKAS	-	United Kingdom Accreditation Service
WFD	-	Water Framework Directive
WHPT	-	Whalley, Hawkes, Paisley & Trigg





# 1.Introduction

## 1.1.Purpose of the Environmental Monitoring Plan

This Environmental Monitoring Plan (EMP) accompanies Yorkshire Water's Final Drought Plan 2022 and provides a framework for monitoring and mitigation that would be followed during preparation for a drought permit or order. As the water company, Yorkshire Water is responsible under the "Water Company Drought Plan Guideline" (Environment Agency (EA), 2020) for understanding the effects of its drought management actions on the environment. Where possible the EMP presents a monitoring framework to differentiate the impacts of implementing the drought measure from those caused by environmental drought conditions. The EMP builds on the information presented in the previous EMP, prepared for the previous Yorkshire Water drought plans (Yorkshire Water, 2011, 2019).

The EMP is a working document and Section 4.2.1 of the EA Drought Plan Guideline (DPG)<sup>1</sup> suggests that the EMP is subject to a regular review to ensure that it remains fit for purpose, especially where new data/ evidence becomes available.

Figure 1 indicates the Yorkshire Water Operational Area and the potential drought options discussed within the EMP, including those alternative options for a longer-term drought (marked in red or shown in the inset map). Detailed maps of each drought option and the impacted reaches are available within each of the individual Environmental Assessment Reports (EARs):

- North Area Reservoirs
- North West Area Reservoirs
- South Area Reservoirs
- South West Area Reservoirs
- River Ouse at Moor Monkton intake
- River Ure at Kilgram Bridge intake
- River Wharfe at Lobwood intake
- River Wharfe Annual Abstraction Increase
- River Derwent Annual Abstraction Increase
- River Hull at Hempholme intake.

This document encompasses all 53 of these potential drought options within the Yorkshire Water water supply system.

In addition, a range of schemes have been reviewed as those suitable for consideration in the third consecutive year of a drought. These schemes have been subject to sensitivity screening:

- Tees-Swale River Transfer

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<sup>1</sup> Environment Agency (2020) Water Company Drought Plan Guideline, April 2020.



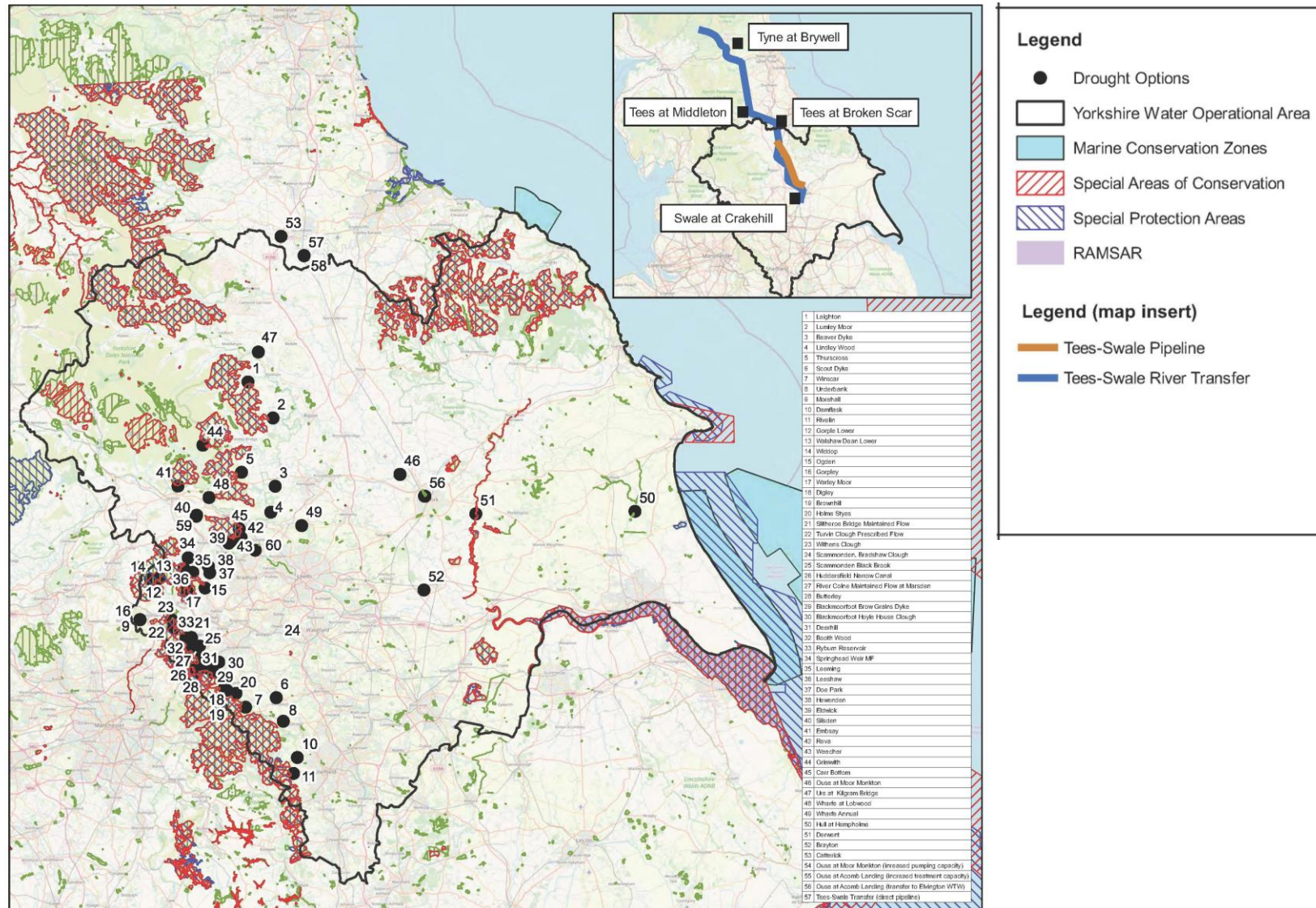
- River Tees Transfer (direct pipeline).
- River Aire at Bingley (new river abstraction)
- River Ouse at Acomb Landing (licence optimisation with local treatment)
- River Ouse: Acomb Landing (licence optimisation with transfer to Elvington WTW for treatment)
- River Ouse at Moor Monkton (increase pumping station capacity)
- Catterick boreoles
- Brayton borehole.

During a drought, those drought options for a third year of drought which are to be considered for progression would be subject to further work. This includes additional monitoring to better inform the preliminary assessments that have been carried out to date, reducing the uncertainties as to potential impact. Further work would include re-screening of the schemes in collaboration with the Environment Agency and Natural England and the setting out of a robust baseline monitoring programme, including for any construction impacts. After collection of this baseline data, full EARs would be prepared. These EAR documents would set out in detail any mitigation requirements and associated monitoring. This includes consideration of SSSIs potentially influenced by the long term drought options:

- Leeds-Liverpool Canal SSSI
- Mickletown Ings SSSI
- Bingley South Bog SSSI
- Tophill Low SSSI
- Leven Canal SSSI.



Figure 1.1 Yorkshire Water Drought Plan Option Location Map (with location of Tyne-Tees system, Tees abstraction point and Tees-Swale Transfer as inset map)



## 1.2. Background and Basis of the Environmental Monitoring Plan

The EMP has been prepared in support of Yorkshire Water's Drought Plan and in compliance with the requirements of Section 6 (Environmental Assessment, Monitoring and Mitigation) of the DPG.

This detailed EMP and the encompassing Yorkshire Water Final Drought Plan 2022 should be viewed in conjunction with the relevant Environment Agency Drought Plans, which aim to reconcile the interests of public water supplies, other abstractors and the environment during a drought, at both national and regional/ local levels. Like water company Drought Plans, the Environment Agency's Drought Plan is also reviewed on an annual basis. The Environment Agency's Drought Plan will not, however, specify additional ecological monitoring to track the onset or severity of drought such as that covered by this EMP.

Guidance states that in a Drought Plan, a water company must describe the measures they may need to take to restrain the demand for water within their water supply system, obtain extra water from other sources, and how the effects of an environmental drought and those resulting from the application of a drought permit/order are to be monitored.

### 1.2.1. Environmental Monitoring Plan Guidance

Guidance on the objectives and content of the EMP is given in Section 4 and 5 of the Environment Agency "Drought Plan Guideline Extra Information: Environmental Assessment for Water Company Drought Plans". The issues specified are addressed in subsequent sections of this report.

The guidance states that an EMP should include details of the monitoring required and states this should include:

**Baseline monitoring** – collection and maintenance of baseline monitoring datasets help understand the nature of the environment under 'normal' circumstances, along with establishing the sensitivity of the environment to changes in flow and any especially sensitive features of interest. Baseline monitoring is also essential in enabling understanding of the actual environment impact of supply side drought management actions. It allows comparison between the environment under 'normal' conditions against observed environmental datasets during and after a drought.

**Onset and In-drought monitoring** - to help assess the immediate environmental impacts of drought action during a drought along with informing choices and implementation of mitigation measures. This can be split between pre-permit/order application (**Onset**) and post-permit/order implementation (**In-drought**) stages.

**Post-drought (recovery) monitoring** - to help assess any longer term environmental impacts of, or recovery from, the implementation of drought actions.

The guidance states the EMP should include for each stage:

- the elements/features of the environment you will monitor
- the location, in-year and between year frequency of monitoring, sampling/survey methods





- any changes in approach between stages (for example, increasing the frequency of sampling during the in-drought stage)
- who is responsible for carrying out this monitoring

It may be possible to mitigate or reduce adverse effects on the environment. The guidance states a drought plan should, therefore, identify:

- pre-drought mitigation actions: actions you will implement before or whilst the drought is developing to reduce the likely environmental impact of your proposed actions
- in-drought mitigation actions: actions you will implement during a drought to minimise the environmental impact of your proposed actions
- post drought mitigation actions: actions you will implement following a drought to reduce any environmental impacts that may occur as a result of the actions you implement

The DPG also indicates that a drought plan should provide evidence that the mitigation measures that are proposed will be effective for the features that could be at risk from a drought option. The EMP should show how this will be monitored. The drought plan should also include details of any additional permits or approvals needed to carry out the mitigation measures.

In some cases, mitigation actions may be necessary to prevent derogation of other abstractions (for example, by providing alternative supplies or releasing compensation water into watercourses to limit the impact of reduced flows).

### 1.2.2. Consultation

A wide-ranging consultation process has been undertaken in the preparation of the Final Drought Plan 2022 and in previous drought plans. The Environment Agency has been fundamental to this process and the text presented in this EMP reflects discussion and understanding with regard to monitoring methodologies and locations. This included consultation between the Environment Agency and Yorkshire Water during August and December 2011 and following the Addendum to the Draft Drought Plan in January to March 2013 to review the proposed mitigation and monitoring recommendations. It was agreed, for example, that monitoring stations should match existing Environment Agency and Yorkshire Water monitoring sites and standard methodologies used in data collection, where possible, to ensure maximum compatibility with existing data. Yorkshire Water's 2018 draft Drought Plan, accompanied by the EMP, was published for open consultation in summer 2019.

## 1.3. Mitigation and Monitoring Key

For ease of reference and identification, the mitigation and monitoring options identified at each stage of the process (baseline, on-set of drought, in-drought and post-drought) have been assigned a prefix code to distinguish between them. The following abbreviations have been used:

- Baseline Monitoring - BMON
- On-set of Drought Monitoring- ODMON



- In-drought Monitoring - IDMON
- In-drought Mitigation - IDMIT
- Post-drought Monitoring – PDMON
- Post-drought Mitigation – PDMIT.

#### 1.4.Biosecurity

Biosecurity is a major issue across the UK to prevent disease and pathogen transfer and the spread of invasive species. It is therefore important that prior to commencing any monitoring or mitigation measures, a biosecurity plan is completed to highlight risks associated with monitoring or mitigation activity and ensure good working practice is followed. It is recommended that biosecurity is included in site risk assessment procedures alongside other environmental and health and safety risks.

During a drought, biosecurity risks may be elevated. If drought permits or orders are implemented, Yorkshire Water will work with the Environment Agency, Natural England, land owners (e.g. CLA) and the agriculture sector (e.g. NFU) to promote the importance of biosecurity measures at times of low flows. This could include joint press releases and website messages, as well as articles in appropriate magazines and journals. A joint message is likely to have the greatest impact, rather than one organisation working in isolation.

#### 1.5.Report Structure

This EMP comprises the following sections:

- Baseline monitoring outside of drought conditions
- Mitigation-led monitoring (on-set, in and post drought) and mitigation)
- Monitoring specific to each impacted reach

Four appendices have been included. Appendix A sets out the detailed monitoring and mitigation for each reach. Appendix B.1 comprises a spreadsheet embedded into this report which sets out information on existing baseline monitoring sites; Appendix B.2 provides details for ecology survey methodologies. Appendix C provides a detailed specification for surveillance walkover monitoring. Appendix D provides additional guidance for ecological actions .



## 2. Baseline Monitoring

### 2.1. Routine Baseline Monitoring

Baseline monitoring is required to identify impacts of the drought options over and above the effects of environmental drought. A comprehensive review of existing baseline information relating to Yorkshire Water supply-side drought options has been carried out in preparation of the Yorkshire Water Drought Plan and accompanying documents. The adequacy of these data have been reviewed and consideration has been made as to whether there is a need for further baseline monitoring to reduce uncertainty regarding the presence or distribution of important features, which will be updated through the review of the assessment. The following sections provide details of the agreed approach for baseline monitoring. The monitoring codes used in the reach specific specifications are identified as appropriate throughout the section.

The use of existing monitoring sites and standard methodologies applied in data collection are recommended, where possible and where relevant additional requirements are described. It should be noted, however, that not all existing monitoring sites are necessarily proposed. This baseline monitoring programme is customised to the individual sites associated with a particular drought option and the sensitive features known to be present within proximity to the site. Where initial assessment of sensitive features (following the EA DPG) identified a lack of data to inform full assessment and subsequent sensitivity was classed as 'uncertain', further surveys may be recommended to inform detailed assessment. It should be noted, however, that in some cases professional expert judgement is accepted in the absence of detailed data and further surveys are only recommended where uncertainty remains.

The long-term water resource drought options have not been subject to the same rigorous review of baseline monitoring data, but a screening exercise has been carried out to identify the key data required and available. It is considered that there would adequate time to review existing baseline data at the onset of a water resources drought given the lead time associated with these options.

#### 2.1.1. Control Site Selection

The use of control sites during impact monitoring is essential to assess additional impacts of implementing drought options over and above that of environmental drought conditions alone. These un-impacted sites form a comparison with impacted sites following a drought. The precise location of these control sites should be determined in discussion with the regulators. It will be possible however, to identify potential sites during the walkover survey. Ideally control sites will be located on un-impacted reaches within the same catchment, but this may not be possible in all cases, and comparable sites in other catchments can constitute valid control sites in these circumstances. The total number of sampling sites should ideally be split equally between control and impact locations to provide a balanced statistical design to give the most robust assessment. However, in reality the number of sites required to provide this will be difficult to achieve in the context of the EMP. Water quality monitoring control sites will be selected from the EA routine monitoring network, undertaken by the EA with no increase in monitoring frequency.





## 2.1.2. Physical Environment

### 2.1.2.1. Environment Agency Surveys

The EA routinely monitor a number of sites within impacted reaches as part of EU Water Framework Directive (WFD) monitoring programmes. These monitoring surveys can also be utilised for in-drought and post-drought assessments. Monitoring includes the following key elements:

- River flow monitoring at a series of gauging stations
- Physico-chemical water quality monitoring at sites on all the main rivers for parameters outlined in the 2010 Defra Directions (carried out for WFD and other purposes).

### 2.1.2.2. Hydrology (River Flows and Water levels)

River flow data assist the baseline understanding of the river catchment, establish the zone of influence of the drought options and assist in the differentiation of drought-related impacts and drought options on hydrology and hydro-ecology.

To ascertain the hydrological impacts of the various drought options, a variety of different hydrological/hydrometric datasets were obtained. These generally came from either the EA or Yorkshire Water. The existence of each data type, around each of the drought options, was dependent on the site specific details of each of the drought options. The following data types were obtained:

- Continuous river stage/level gauging
- River spot flow data
- Reservoir outflow measurements (including compensation flows)
- Reservoir level data, providing an indication of the frequency of the spill of excess water from Yorkshire Water's reservoirs
- River abstraction data for Yorkshire Water's intakes
- WRAPsim water resource modelling data
- Precipitation.

Flow data was obtained for a number of watercourses. Data was generally obtained from the EA and Yorkshire Water although some data was obtained from the Centre of Ecology and Hydrology's (CEH) national river flow archive website. Flow data provide an indication of the amount of water (specifically discharge or volume rate of flow) that flows past the gauge at that moment in time.

When a gauge is measuring and recording flow data for a number of years, and is located in the same place, long terms flow records can be obtained. Long-term flow records show the typical variation of flow within a watercourse over time. Statistics on flow can be obtained for long term datasets. Typical statistics include median flow and infrequent high and low flows. Of relevance for drought studies are the low flow statistics, such as  $Q_{95}$  which represents flow equalled or exceeded for 95% of days in the measured record (equivalent to an average of all but 18 days per year). Obtained flow data included compensation flow data for the drought options reservoirs.



River stage/level measured data (obtained from the EA) are generally long-term measurements of the depth of a watercourse at a fixed location. Stage refers to elevation above ordnance datum whilst level is relative to a nearby local datum (such as bed level). Stage/level measurements are a coarser approximation of the variability of a river over time in that higher levels are generally associated with higher discharges. In the absence of local flow data, stage/levels have been used in the assessment generally to show if the variability in stage/level experienced nearer to a potentially impacted reach is similar to that of flow gauge further upstream/downstream. If the local stage/level is similar to the more distant flow gauge, then the measured flow gauge data may be used to derive approximate flows (through catchment apportioning) in the vicinity of where the drought option, and any impact of it, is focussed.

Reservoir spill and level data were obtained from Yorkshire Water. Reservoir level data are measured at regular intervals (typically daily or weekly) and provides an indication of how full the reservoir is. When a reservoir is full, excess water flowing into the reservoir will overflow (or spill) into the downstream watercourse. Generally daily spill measurements can be obtained or derived from measurements taken as part of the compensation flow recording immediately downstream of the reservoir.

Water resource modelling, using WRAPsim, has also been obtained from Yorkshire Water and used as part of the hydrological assessment. Within WRAPsim, Yorkshire Water's supply options are included and how the supply options behave under drought conditions can be simulated. Simulations would include aspects such as compensation releases. The WRAPsim outputs characterised two dry periods (one in the late 1920s and the other between 1995/97). The simulations provide an indication of the time of year when drought options would likely occur (the timing), how long the drought option may be in place and how long the impacts of the drought option would occur (the duration).

Within WRAPsim each of the reservoir sources or groups has defined control lines. The level of service is achieved by ensuring that the storage within the system is balanced. WRAPsim prioritises the use of water in the system depending on each reservoir's storage in relation to the control lines. Levels are further defined within the model for greater sensitivity and assigned costs such that the drawing of water is penalised as reservoir storage falls. Model outputs are therefore highly sensitive to reservoir storage, meaning that the least cost solution in one case would be to use a reservoir at a given time, but in another situation, with stocks just below a control line, the least cost solution would be to use a river abstraction.

There is an adequate coverage of hydrometric data in the study area. In order for this to remain the case, the existing monitoring regime, undertaken by Yorkshire Water and the EA, should continue as at present.

BMON\_1 - Environment Agency/YWSL to continue monitor river flows and levels/reservoir levels and spill at key monitoring sites.

#### *2.1.2.3. River Habitats / Geomorphology*

In order to understand the impacts of changes in flow on habitats and geomorphology, existing river habitat and geomorphological data was sought. The characterisation of the river habitats of the reaches is informed by bespoke walkover surveys undertaken



by Yorkshire Water and the EA, River Habitat Surveys (RHS) undertaken by the EA and supplementary mapped/aerial imagery information.

The bespoke walkover surveys were undertaken by Yorkshire Water and the EA during late summer 2018 in specified 500m walkover reaches (lengths of each impacted reach deemed particularly sensitive or representative sections of the entire reach). Additional walkovers were undertaken in summer 2020 to complete the dataset for all reaches. These walkovers were undertaken using the River Conditions Observation Form - Low Flows developed by the EA (see Appendixal C for further details). An appreciation of the adequacy of the data used throughout the assessment is provided in the river habitat section of the Physical Environment descriptions within the EARs. Generally, geomorphology data are affected by spatial distribution and variability, temporal issues and visibility of the river.

RHS data were obtained from the EA for the areas investigated. This data is collected along a 500m section of river using 10 spot sites and a “sweep-up” of the features within and around the river not included in the 10 spot sites. The survey contains a range of ecological, hydrological, geomorphological data for the channel bed and banks, flow and surrounding land. The survey also collects information on the anthropogenic modifications present within and around the channel and the land-use around the channel. This data is generally semi-quantitative with some quantitative data describing channel width and depth. The spatial distribution of the RHS data obtained for the geomorphological assessment was limited, particularly in the smaller reaches where it was common for there to be no RHS data. In addition, the limited spatial distribution of sites has meant that no more than a general overview of geomorphology could be obtained for most reaches. This was reinforced where riparian tree cover obscured the channel and no geomorphological information on the channel could be obtained.

Aerial imagery data of the impacted reaches were viewed using Google Earth. The aerial images were used to assess the impacted reaches by deriving counts of geomorphological features in the channel (e.g. sediment bars, riffles, pools, bank erosion etc.), the presence of anthropogenic structures in and around the channel, particularly weirs, bridges and reinforced or resectioned banks and the surrounding land use. In addition, the images were used to acquire measurements of channel length and width and the width of weirs. Aerial imagery may be limited in some cases due to the presence of riparian vegetation obscuring the channel, which means features and channel dimensions could not be directly assessed. This limitation was particularly important where there was no walkover or RHS data, hence no geomorphological interpretation could be undertaken at such sites. This can be more common in smaller rivers at altitudes between the steepest upland channels and the widest lowland channels.

In general the river habitat data and aerial imagery is limited by the dates of survey/imagery. Due to the dynamic nature of rivers it is expected that the data contained in the walkovers, RHS and aerial imagery is unlikely to be the most current data. This may lead to an assessment of the river habitats and geomorphology of the impacted river reach which is less representative than the current day.

Given the potential changes in habitat in the period leading up to a future drought it was agreed with the EA during consultation in March 2020 that no further baseline walkovers should be specified. Walkovers are specified for the drought onset period (see Section 3 below).



#### 2.1.2.4. Water Quality

##### Routine River Water Quality Surveys

The EA routinely monitor a number of river sites within impacted reaches as part of WFD monitoring programmes. These monthly monitoring surveys can also be utilised for in-drought and post-drought assessments.

Monitoring includes the following key water quality elements:

- General water quality parameters: water temperature and pH
- Sanitary water quality parameters: Dissolved oxygen concentration, dissolved oxygen saturation, total ammonia, un-ionised ammonia
- Nutrient quality: soluble reactive phosphate.

These datasets have been reviewed and their suitability discussed between Yorkshire Water and the EA. An appreciation of the adequacy of the data used throughout the assessment is provided in the Water Quality section of the Physical Environment description of each scheme (within the EARs). Generally, there is adequate coverage of water quality data in the study areas. In order for this to remain the case, the existing monitoring regime, undertaken by the EA, should continue as at present:

- BMON\_2 - Environment Agency routine water quality monitoring at existing network of sites on current monthly programme, which includes those on un-impacted reaches suitable as control sites.

Yorkshire Water will continue to review the EA monitoring programme to ensure it provides an adequate data set.

##### Yorkshire Water WwTW Final Effluent Quality

In order to ascertain the water quality risks presented by Yorkshire Water wastewater treatment works (WwTW) in the study areas of each drought option, discharge consent conditions were obtained. For selected WwTW where mitigation of final effluent quality is under consideration, Yorkshire Water have reviewed WwTW performance against consent conditions (informed by final effluent monitoring data where available) to express the potential for such mitigation. This action is included under the in drought mitigation measure 'IDMIT\_3' (see Section 3.4 below). The May 2019 Yorkshire Water 'Wastewater Treatment Works Optimisation and Maintenance for Drought Plan' sets out the mitigation actions for these works<sup>2</sup>.

During any future on-set of drought periods (14 weeks before drought control lines are crossed) Yorkshire will consult with the EA regarding any WwTWs not identified as significant water quality pressures at the time of the writing of the current EARs, but which may be a cause for concern. Additional sites will be added to the priority list of sites for optimisation as required.

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<sup>2</sup> YWSL (2022) Wastewater Treatment Works Optimisation and Maintenance for Drought Plan.



A 'Combined Sewer Overflows Optimisation and Maintenance for Drought Plan'<sup>3</sup> has also been developed by YWSL, which identifies all significant intermittent water quality pressures identified in this EAR. During any future drought onset period YWSL will also consult with the Environment Agency and additional sites could be identified as required.

WwTW final effluent monitoring data have not been used directly in the assessment of impacts to sensitive features.

### 2.1.3. Ecology

#### 2.1.3.5. Macroinvertebrate and Fish Monitoring Surveys

The EA routinely monitor a number of sites within impacted reaches as part of WFD monitoring programmes. These monitoring surveys can also be utilised for in-drought and post-drought assessments. To ensure a sufficient dataset to inform the environmental baseline for environmental assessment Yorkshire Water also carry out further macroinvertebrate and fish monitoring. These datasets are used in the preparation of the EARs. The full list of monitoring sites for the macroinvertebrate and fish monitoring programme are included as Appendix B.1.

For all available macroinvertebrate data where environmental variables were available, EQRs were calculated using RICT for WHPTN<sub>TAXA</sub> and WHPT<sub>ASPT</sub> indices which are directly relate the macroinvertebrate community to WFD status over the monitoring period. Baseline conditions for sites within the zone of influence of the drought option was also established through existing data. These included graphing the hydrology, water quality, habitat and macroinvertebrate (LIFE scores and WHPT EQRs) variation temporally over the monitored period. This information was used to inform the assessment of any potential impacts on the macroinvertebrate community

As part of the WFD assessment of the fish element the EA undertakes a FCS2 assessment for most WFD waterbodies. The assessment within each EAR considered the scale and longevity of any fish status impacts and determined the severity and duration of impacts to the physical environment as a result of the drought permit/order and the specific requirements of the fish population present. These assessments were informed by the last FCS2 data available for sites within impacted reaches associated with each drought option.

Datasets have been reviewed and their suitability discussed between Yorkshire Water and the EA. Data for those sensitive features identified to be at risk of impacts at a moderate or major significance as a result of the drought options should be reviewed and updated, where appropriate, prior to future drought permit/order applications.

Monitoring includes the following key elements which should continue:

- BMON\_3 - Macroinvertebrate monitoring at a number of locations, including rivers potentially affected by drought measures; to continue in low

<sup>3</sup> YWSL (2022) Combined Sewer Overflows Optimisation and Maintenance for Drought Plan.





flow/drought years pending agreement with the Environment Agency 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 Environment Agency regarding aquatic species welfare.

#### 2.1.3.6. West Yorkshire Ecology Records Search

A biodiversity records search was undertaken with West Yorkshire Ecology and data reviewed in preparation of the drought plan (Cascade Consulting, 2009) to provide information on the distribution of NERC Act Section 41 Priority species such as fine-lined pea mussel *Pisidium tenuilineatum*, otter *Lutra lutra*, water vole *Arvicola amphibius*, white-clawed crayfish *Austropotamobius pallipes* and great crested newt *Triturus cristatus*. In 2016 the EA also provided anecdotal information regarding the distribution of certain species (such as white-clawed crayfish, water vole and otter).

## 2.2. Targeted Baseline Monitoring

Consultation with the EA acknowledged that although potential impacts to NERC Act Section 41 Priority species would be considered, the requirement for further supplementary surveys where data gaps are apparent is only applicable for features identified as having a sensitivity of moderate or major.

The available data provided from EA, Yorkshire Water and West Yorkshire Ecology provide a significant amount of data for the Yorkshire Water water supply system. However there remain gaps for the following sensitive features within some reaches:

- Distribution and abundance of fine-lined pea mussel
- Abundance of white-clawed crayfish
- Distribution and abundance of juvenile lamprey.

Although consideration of impacts has only been given to features identified as likely to be present, it is recommended that baseline surveys are undertaken for these features in reaches with a moderate or major hydrological impact to ensure all of the sensitive features present are given due consideration. In many cases, however, the baseline surveys have the potential to reduce the number of sensitive features within the reach.

On the assumption that otter and water vole can be potentially be present in all impact reaches, no 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/orders in the impacted reaches. In addition, post-drought monitoring for otter is not considered to be necessary, as the species may not necessarily return to the watercourse naturally for a period of time owing to their large home ranges, which can extend up to 70km. Therefore, an absence of otter could be misinterpreted as a significant impact. In addition to this, intrusive surveys to determine the continued breeding status of a woodland will put further stress upon the rearing process of cubs and thus is likely to do more damage than good.



Where gaps in data have been identified and discussed in each individual EAR, targeted surveys are recommended for specific reaches too gain sufficient data for baseline assessment. The baseline surveys required for each specific drought option are detailed in Appendix A and could include a combination of the following suite of surveys:

- 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

Detailed discussion of the sampling methodology, together with the site selection criteria, is given in Appendix B.2.

### 2.3. Baseline Monitoring Location, Timing and Responsibility

Yorkshire Water is responsible for ensuring that the necessary data is collected to allow environmental assessment to inform the Drought Plan. Location, timing and frequency information for recommended further baseline monitoring surveys is summarised in Table 2.1. All surveys listed are the responsibility of Yorkshire Water.

**Table 2.1 Summary of location, timing, frequency and responsibility for baseline monitoring surveys**

Code	Monitoring Surveys	Location	Timing	Frequency	Responsibility
BMON_1	EA/ Yorkshire Water to continue monitor river flows and levels/reservoir levels and spill at key monitoring sites	Existing EA/ Yorkshire Water river flow and level gauge monitoring network	Continuous	Continuous (current programme)	EA / Yorkshire Water
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.	Existing EA and Yorkshire Water Sites	Year round	Monthly (current programme)	EA
BMON_3	Macroinvertebrate monitoring at a number of locations, including rivers potentially affected by drought measures; to continue in low flow/drought	At least one monitoring point within each reach	Spring, summer and autumn	Three surveys (spring, summer <sup>4</sup> and autumn) for three years followed by spring and autumn sampling one	EA / Yorkshire Water

<sup>4</sup> A representative selection sites to be included for summer surveys will be agreed with the EA.





Code	Monitoring Surveys	Location	Timing	Frequency	Responsibility
	years pending agreement with the EA regarding aquatic species welfare.			year in every three. Most recent survey identified in Appendix B.1	
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.	At least one monitoring point within each reach	July to September	Annual surveys for three consecutive years and then once every three years. Most recent survey identified in Appendix B.1	EA / Yorkshire Water
BMON_5	White-clawed crayfish surveys to determine distribution and abundance in reaches under serious (i.e. moderate or major) hydrological stress	One sample point in each reach with potential for WCC	July to September	One survey every six years.	Yorkshire Water
BMON_6	Fine-lined pea mussel survey to determine distribution and abundance in reaches under serious hydrological stress	One sample point in each reach with potential for FLPM	April to September	One survey every year for four years, then repeated one year in six. However, a data review after years two and three will determine the final programme.	Yorkshire Water
BMON_7	Targeted juvenile lamprey surveys to identify distribution of habitat and an indicative population status within reaches subject to serious hydrological stress	At least one monitoring point within each reach	July to September	One survey every year for four years, then repeated one year in six. However, a data review after years two and three will determine the final programme	Yorkshire Water

## 2.4. Construction Related Surveys

In addition to the drought related monitoring surveys, infrastructure construction activities related to the long-term water resource drought options will require prior ecological survey and assessment to ensure compliance with environmental legislation and statutory duties. The ecological features likely to require consideration have been identified in Tables 4.6 and 4.7 below, however this is not an exhaustive list. Prior assessment, through an Extended Phase 1 Habitat survey, will enable identification of the ecological features likely to be impacted upon by the construction phase. Completion of a baseline survey will be required to inform the construction process and should be completed a year prior to construction of the scheme. Therefore, surveys necessary to enable construction should be considered when the potential requirement for each scheme is identified after the onset of a water resources drought. As an up-to-date baseline is not required in the same timescales as for sensitive features to the drought-related impacts, monitoring for the baseline



has not been identified. Monitoring and mitigation has not been identified for terrestrial receptors relating to a construction impact at the on-set of drought, in-drought and post-drought timings as they are not sensitive to this.

As impacts associated with the construction of the necessary infrastructure are limited to the time in which the scheme is constructed, and lengthy monitoring requirements are likely to be avoided through appropriate route selection, it is necessary to keep these separate from impacts associated with implementation of the drought options. Furthermore, once the schemes have been constructed, the terrestrial impacts can be removed from future revisions of the EMP.



CUSTOMERS



WATER SUPPLY



ENVIRONMENT



TRANSPARENCY



BILLS

## 3. On-set, In Drought and Post Drought Mitigation-led Monitoring and Mitigation

### 3.1. Introduction

Section 4 of the DPG supplementary guidance states monitoring data is required to inform an environmental assessment in advance of a drought, and any in-drought and post-drought data requirements. This section of this EMP details the monitoring measures that will be undertaken during each progressive stage of a drought: on-set; in-drought; and post-drought. Following consultation with the EA as detailed in Section 1.2.2, monitoring leading to selection and implementation of appropriate mitigation measures will be undertaken. Section 7 of the DPG supplementary guidance states that it may be possible to mitigate or reduce adverse effects that drought actions have on the environment and the drought plan must identify in-drought and post drought mitigation measures (see Section 1.2.1 above).

Walkover surveys will monitor water quality, flow, levels and habitat available, providing immediate qualitative information on the effects of the drought measures, and allow decisions to be taken quickly regarding further monitoring and/or mitigation requirements. Further targeted surveys are recommended where walkover surveys identify potential serious significant impacts. These targeted surveys may result in implementation of mitigation measures where required.

Quantitative and qualitative monitoring surveys are recommended for different stages of the drought process where a reliable data set is required in order to determine impacts to sensitive features and reduce uncertainty in environmental assessment. This monitoring will provide data necessary to satisfy the requirement of Section 4.3 of the DPG for water companies to review the environmental impacts of the drought by analysing baseline, in-drought and post-drought data (where post-drought monitoring has been required). Location, timing and frequency information for recommended mitigation-led monitoring surveys is summarised in Section 3.10.

For those drought options that may need to be implemented in a third year of a drought, further work would be triggered during the development of a drought and in accordance with the triggers set out in the Final Drought Plan 2022. Scenario modelling reported in the Drought Plan indicates that in the spring of a second year of drought, discussions would take place with EA and NE on the instigation of environmental monitoring requirements associated with the relevant long-term options. These discussions would start prior to taking the decision to implement long term drought options to endeavour to provide a summer drought environmental baseline before a third summer of drought. A first step would be to carry out re-screening of the relevant schemes in collaboration with EA and NE, leading to mitigation requirements and associated monitoring being confirmed and included in a full EAR.

#### 3.1.1. Monitoring

Where possible the baseline monitoring program for hydrometric data, water quality, fisheries and macroinvertebrates will continue during the on-set, in drought and post drought option implementation periods in order to provide robust data on environmental conditions during and after the implementation of drought options.



Monitoring in any post drought option implementation period will need to prioritise survey of sites related to implemented drought options.

Data collected in the baseline, on-set and in drought this period can be compared to data collected in post-drought conditions to determine the rates of recovery and any further appropriate mitigation required. However, it should be noted that sensitive features are most likely to be experiencing stress during the on-set and in drought period and the use of invasive techniques will be avoided where possible. Biological surveys would only proceed if agreed with the EA following review of risk to stress on aquatic communities.

### 3.2. On-set Environmental Drought Mitigation-led Monitoring

The current Yorkshire Water drought plan is based on a modelled 1 in 80 years drought. Baseline monitoring is required to identify impacts of drought operations over and above the effects of environmental drought. The likely severity of drought conditions experienced during a 1 in 80 years scenario provides difficulties when attempting to establish baseline conditions. Current hydrological conditions will differ significantly from those conditions expected prior to the implementation of drought options, therefore data collected for monitoring purposes cannot sufficiently represent pre-implementation 'baseline' conditions. It is noted that the collection of data in the immediate period prior to a 1 in 80 years drought will provide data of some relevance (Section 2), however collection of data in this season will not provide directly comparable seasonal data (i.e. species ecology and sensitivity will vary seasonally as population dynamics change). Given these difficulties, the collection of pre-drought data for comparison with in-drought and post-drought will not be recommended in this EMP. Therefore, the following information should be collected during the on-set of drought to provide directly comparable information with the in-drought and post-drought.

#### 3.2.1. On-set of environmental drought walkovers

The identification of the extent and location of flow sensitive habitats is recommended using a walkover survey during the on-set of environmental drought prior to the implementation of drought options. During previous consultation the Environment Agency stated a preference for walkover surveys and non-invasive techniques to establish the impacts of the drought option and target mitigation, and for Yorkshire Water to carry out the required walkovers, with Environment Agency support if required. Walkover surveys during the onset of environmental drought will monitor the current hydrological, water quality and habitat conditions under low flow conditions and inform at an early stage any requirement for further survey and mitigation:

- 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.

Detailed discussion of the surveillance walkover survey methodology to be used for on-set and in-drought walkovers is given in Appendix C. The reach specific



specifications for the walkovers (i.e. recommended river reach for initial survey) are found in Appendix A.

These surveys are intended to provide a reliable, efficient and low impact method of assessing the current environmental situation within potentially impacted reaches and are not intended to be detailed quantitative surveys. The need for further quantitative monitoring surveys, with detailed parameter analysis, will be assessed following walkover surveys. Walkover surveys will be conducted by experienced field surveyors, with knowledge and understanding of walkover surveys, river habitats and ecological features associated with this environment. These initial walkover surveys will identify the 'monitoring/surveillance' reaches, based on selection of most significantly impacted reaches, which will remain consistent throughout the subsequent walkover surveys, although where impacts increase in magnitude or extent at later stages of the drought, the survey area may be widened to encompass this.

### 3.3. In Drought (During Drought Option Implementation) Mitigation-led Monitoring

In-drought surveys will be undertaken to monitor changes to sensitive features during implementation of drought option and to identify the need for mitigation measures. General mitigation measures are suggested based on the likely impacts to sensitive features and this current list should be updated where additional 'new' impacts are identified from walkover surveys. The mitigation specific to each impacted reach is detailed in Appendix A. It is recommended that in-drought monitoring programmes are initiated immediately once the drought options are implemented. Some mitigation measures may be applied more appropriately during post-drought conditions, when drought option measures are removed. In such cases these are described in Section 3.5.

#### 3.3.1. In drought walkover surveys

Surveillance walkover surveys will be conducted at sites identified during the on-set period as well as sites with water quality pressures which may be exacerbated during periods of low flow during the drought permit/order implementation (details for the specification for each reach are provided in Appendix A). Surveys will be undertaken throughout the drought option implementation period, including on the day of the flow change, the day after and then weekly thereafter until no further changes are noted.

- 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.

The surveys will comprise a visual assessment of the river and associated features and water quality spot sampling including a mapped record of channel parameters, and fixed-point photographic records. The surveys will identify the need for mitigation measures (see Section 3.4), and include an assessment of the effectiveness of any mitigation measures implemented in the impacted reaches prior to each survey. The



full specification for the walkovers, including triggers for mitigation, are included as Appendix C.

Sites that have been identified as particularly sensitive, or where the severity of the impact appears to be increasing or expanding in range, will be surveyed more frequently during the in-drought period to monitor the zone of influence from drought options.

Consideration for mitigation and monitoring of water quality pressures outside of the identified reaches yet influencing impacted reaches will be given during the walkover surveys.

### 3.3.2. CSO spill event monitoring

CSOs are designed to only spill untreated wastewater when the local sewerage network is over-capacity, as can occur during storm events. It is unlikely that CSOs will spill during drought conditions, but that it is still a possibility during intense storm events – which may occur during a drought. As such storm intensity forecasting will be utilised in order to predict the likelihood of CSO spill events:

- IDMON\_3 - Storm intensity forecasting to predict likely CSO spill events and the need for pre-emptive mitigation

Forewarning as to when key CSOs may spill to identified reaches during drought conditions will allow Yorkshire Water to increase compensation flows from upstream assets to mitigate the impact of any spill to watercourse.

In addition, Yorkshire Water consider that the most likely reason for a CSO spill in a drought would be owing to abnormal operation of the CSO, typically resulting from a blockage. Both Yorkshire Water and the EA are aware that mitigating the impacts of CSOs is very difficult and that Yorkshire Water own a very large number of CSOs in the study areas. In order to prevent impacts most of these CSOs are telemetered and flow trends are monitored by Yorkshire Water and their Repair and Maintenance Partners on a daily basis. Where flow trends are found to be abnormal (i.e. indicating a blockage), Yorkshire Water has a clear operational response procedure for resolving this by e.g. jetting the CSO. This procedure aims to prevent impacts before they occur.

### 3.4. In Drought Mitigation Options

The IDMON\_1 and IDMON\_2 surveillance walkovers incorporate visual and water quality monitoring. Detailed specification for the walkovers is provided in Appendix C. This includes a number of suggested signs of environmental distress which may be observed during the visual observations and the water quality sampling. If the monitoring identifies signs of environmental distress Yorkshire Water would notify the EA by telephone on 0800 80 70 60 and undertake a remedial course of action to address the signs of environmental distress. The recommended mitigation options associated with each specific reach are detailed in Appendix A but these actions could include any of the following suite of mitigation options:

The following measures are recommended to mitigate against flow impacts from third party abstractions on sensitive features, where appropriate:





- 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.

The following measures are recommended to mitigate against water quality impacts on sensitive features where appropriate:

- 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. Detailed in YWSL WwTW optimisation plan<sup>5</sup>.
- IDMIT\_4 – Artificial freshet release to dilute/displace water quality reduction
- IDMIT\_5 – Aeration of discharge from third party facility identified as a ‘significant’ water quality pressure

Further measures are recommended to mitigate against impacts on sensitive features where appropriate:

- 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 Wildlife and Countryside Act. Implementation would follow best practice guidance.

<sup>5</sup> YWSL (2022) Wastewater Treatment Works Optimisation and Maintenance for Drought Plan.





- 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.

The identification of appropriate mitigation to be implemented during a drought needs to take into account all of the species present in the reach, as the implementation of some mitigation measures for the benefit of one species could be at the detriment of another. For example, narrowing of the watercourse to provide habitat only in the middle of the channel for fish would have significant impacts upon marginal habitats for white-clawed crayfish, water vole, juvenile lamprey ammocoetes and fine-lined pea mussel.

The mitigation recommendations have been made in a hierarchy of approach which follows the general principle of 1) reducing the pressure at source; 2) pressure management in the river; and 3) ecological action. The implementation of mitigations during the in-drought and post-drought periods should follow this principle, with



movement to mitigation measures in the next hierarchy dependent upon the success or failure of mitigation in the lower hierarchy.

Further guidance for implementation of mitigation measures which involve ecological actions is provided in Appendix D.

### 3.5. Post Drought Mitigation Options

Some mitigation options are considered to be most effective when applied following removal of drought option measures (i.e. post drought).

The recommended post-drought mitigation options associated with each specific reach are detailed in Appendix A but could include any of the following suite of mitigation options:

- PDMIT\_1 – Enhancement of habitat beyond the impacted reach (macroinvertebrates, fish, fine-lined pea mussel, water vole, white-clawed crayfish).
- 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 obstacle (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. Methods to include stem injection with a glyphosate based herbicide for tall plants and cutting tap roots during first stage of growing season.

### 3.6. Post Drought Monitoring

In order to assess whether the implementation of the drought options has any long-term effects on any environmental features, monitoring after implementation of drought options will be necessary for certain features, as described below. This is in addition to the general baseline hydrometric, water quality, fisheries and macroinvertebrate monitoring specified in Section 2 which is assumed to continue and will provide a quantitative dataset to assess whether the implementation of



drought options has had any long-term effects on any sensitive environmental features with the extent of hydrological influence associated with each of the drought options and to demonstrate recovery where appropriate.

Monitoring post-drought will continue at those locations that are included in the baseline monitoring programme and at a frequency and duration as agreed with the Environment Agency.

Additional monitoring at further locations may also be required if identified during in-drought walkovers. This could also include monitoring of sensitive features such as fine-lined pea mussel, white-clawed crayfish and/or juvenile lamprey. Such monitoring will continue until such time that the data shows that the relevant features/aquatic communities are fully recovered and in agreement with the Environment Agency.

The recovery of sensitive features is considered likely to be rapid, based on recovery of waterbodies following previous drought years, such as 1995, where invertebrate communities (key indicator species) illustrated a rapid recovery after being subjected to serious hydrological stress. On reflection of this, the post drought monitoring programme is anticipated to comprise lower survey effort than during the on-set and in-drought periods. However, survey will allow sufficient data for comparison with on-set and in-drought data in order to determine recovery.

Surveys associated with each drought option are detailed in Appendix A and could include any combination of the following suite of 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.

### 3.7.Data Analysis

In order to assess whether the implementation of the drought options has any long-term effects, monitoring after implementation of drought options will be necessary for certain features. Comparison of the post-drought monitoring results to monitoring data from (a) baseline monitoring locations, (b) monitoring of control sites and (c) in-drought monitoring locations (where available), will provide a quantitative dataset to determine whether the implementation of drought options has had any long-term effects on any sensitive environmental features within the extent of hydrological influence associated with each of the drought options, demonstrate recovery where appropriate, and identify the need for further monitoring and mitigation.

Identifying any long-term effects on ecological features and an assessment of the efficacy of any in-drought and post drought mitigation measures should be initially informed by a direct comparison of the relevant biological metrics/indices.

For macroinvertebrate communities this includes a direct comparison of the EQRs calculated using RICT for  $WHPT_{NTAXA}$  and  $WHPT_{ASPT}$  indices and a direct comparison of the total WHPT score, LIFE scores and PSI scores as obtained for a specific monitoring site (i.e. where monitoring has been completed pre-drought and post drought from the monitoring site.). A drought option is considered to have resulted in



an impact on the macroinvertebrate community where EQRs have reduced by one biological band<sup>6</sup> when comparing the results of a minimum of five-year baseline monitoring data. Comparison against a long-term data set is required to allow for natural variation in community structure.

For fish communities the assessment should consider a direct comparison of the species assemblage, density, biomass and standing crop density and biomass for a specific monitoring site (i.e. where monitoring has been completed pre-drought and post drought from the monitoring site.). The data analyses should also include a comparison of length-frequency distribution plots to identify any impacts on recruitment. Where lamprey surveys have been completed, the assessment should consider ammocete density. A drought option is considered to have resulted in an impact on the fish community where EQRs have reduced by one biological band when comparing the results of a minimum of five-year baseline monitoring data. Comparison against a long-term data set is required to allow for natural variation in community structure. It is noted the this will require calculations of EQRs using the EA's FCS2 tool. Should this not be possible, the assessment should rely on expert judgment of the relevant metrics and data.

It is noted that monitoring results could vary naturally as a result of changes in habitat availability following a severe natural event (e.g. drought or flood). As such, the assessment of any impacts on the ecological features, and the subsequent need for further post drought mitigation, should also consider the result of the baseline, in-drought and post drought monitoring results at control sites. For example, the overall biomass of the fish community with a river reach associated with a drought option may have reduced by 10%, however, a similar observation could be made at a control site. As such, the 10% reduction could be considered to be as a result of natural variations/drought impacts and not necessarily as a result of the implementation of a drought option.

Biological indices and metrics are mostly informative and basic representations of a biological community's condition and represents a summary of complex ecological data. To reduce any uncertainty in the assessments it is, therefore, recommended that the assessment is further supported by a statistical analysis of the macroinvertebrate and fish community data using an appropriate software package (e.g. Primer or R) to complete a similarity analysis. The statistical analyses should be used to identify which species typified survey sites pre- and post-drought option implementation and whether there has been a statistically significant difference in either the diversity and/or abundance of the ecological communities. The statistical analyses should include the comparison between sites and with control sites and should consider minimum of five-year baseline monitoring data (where available) to allow for natural variation.

### 3.8.Mitigation measures: Permits and approvals

Many of the mitigation measures will require permits or approvals prior to implementation as summarised in Table 3.1. Irrespective of the need for a permit or permission, all planned mitigation measures would be discussed with the

<sup>6</sup> See Part 4, Section 1 of the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015)



Environment Agency in advance of implementation, as well as with Natural England, other authorities, stakeholders and landowners as appropriate.

**Table 3.1 Mitigation measures: permits and approvals**

Mitigation Measure	Permit or Permission Required?
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.	None, but agreement between the licence holder and Yorkshire Water would be required
IDMIT_2 - At identified SSSIs, mitigation would comprise the temporary cessation of impacting drought options by Yorkshire Water.	None – within Yorkshire Water's control
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.	None. No additional infrastructure or environmental permissions required.
IDMIT_4 - Artificial freshet release to dilute/displace water quality reduction	Depending on how the freshet is achieved, environmental permit and/or discharge permit <i>may</i> be required if it involves reservoir compensation flow releases higher than the statutory requirement. If it is achieved by reduction or cessation of abstraction, then no consent is needed.
IDMIT_5 - Aeration of discharge from third party facility identified as a 'significant' water quality pressure	None, but agreement between the licence holder and Yorkshire Water would be required
IDMIT_6 – Gradual phase-in of reduction in water volume/flows to avoid stranding of individuals (fish, white-clawed crayfish, fine-lined pea mussel)	None – within Yorkshire Water's control
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)	None – within Yorkshire Water's control
IDMIT_8 – Temporary reduction in volume of abstraction or increase in compensation release (fish)	None – within Yorkshire Water's control
IDMIT_9 – Artificial freshet releases to provide temporary variation in the flow regime (fish, fine-lined pea mussel, otter, water vole, white-clawed crayfish)	Depending on how the freshet is achieved, environmental permit and/or discharge permit <i>may</i> be required if it involves reservoir compensation flow releases higher than the statutory requirement. If it is achieved by reduction or cessation of abstraction, then no consent is needed.
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)	May require environmental permit from EA depending on nature of the work and NE consent if works are in a SSSI or European site
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 (macro-invertebrates, fish, white-clawed crayfish, water vole, otter)	Environmental permit from EA and NE consent if works are in a SSSI or European site
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)	Environmental permit from EA and NE consent if works are in a SSSI or European site
IDMIT_13 – Provision of piscivorous “visual” bird scaring measures (e.g. using streamers in riparian trees) to control predation upon species using refuges (fish).	None – but consultation with EA, NE, bird specialists would be important to ensure compliance with other nature protection legislation.





Mitigation Measure	Permit or Permission Required?
IDMIT_14– Gravel washing of spawning habitats where walkover surveys and routine monitoring identifies likely habitat degradation as a result of sedimentation (fish)	Environmental permit from EA and NE consent if works are in a SSSI or European site. Discharge permit and temporary abstraction licence may also be required depending on where water obtained from for washing and how the washwater is to be disposed of.
IDMIT_15 – Aeration of watercourse where significant mortality or change in species abundances are likely to be attributed to water quality deterioration	Discussion with the EA on aeration methods to determine whether any permits or formal permissions are required.
IDMIT_16 – Modification of flow structure across barriers to retain favourable conditions to facilitate the movement/migration of species (fish)	Environmental permit from EA and NE consent if works are in a SSSI or European site, plus permission from the owner of the barrier.
IDMIT_17 – Provision of freshet releases to enable migration of fish across significant obstacles (fish)	Depending on how the freshet is achieved, flood defence consent and/or discharge permit <i>may</i> be required if it involves reservoir compensation flow releases higher than the statutory requirement. If it is achieved by reduction or cessation of abstraction, then no consent is needed.
IDMIT_18 – Regular inspection and clearing of screens to ensure they retain their correct working function (fish, white-clawed crayfish)	None – within Yorkshire Water's control
IDMIT_19 – Capture and relocate individuals across significant barriers, taking into account migratory periods (immigration and emigration) (fish).	EA consent required (with consultation with NE for designated conservation sites or species).
IDME15 – 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).	EA consent required for fish movement and crayfish licence required (with consultation with NE)
IDMIT_20 – 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).	EA consent required for fish movement and crayfish licence required (with consultation with NE).
IDMIT_22 – Implementation of navigation controls in the channel to reduce disturbance/damage upon vulnerable species and/or populations.	Controls to be implemented by the appropriate navigation authority (EA, Canal and River Trust, Associated British Ports) for the river, canal, navigable water and estuary involved
IDMIT_24– Cessation of water transfer should it be identified that fish disease has been spread between catchments and notify the EA.	None – within Yorkshire Water's control
PDMIT_1 – Enhancement of habitat beyond the impacted reach (macroinvertebrates, fish, fine-lined pea mussel, water vole, white-clawed crayfish).	May require environmental permit from EA depending on nature of the work and NE consent if works are in a SSSI or European site
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).	Depending on how the freshet is achieved, environmental permit and/or discharge permit <i>may</i> be required if it involves reservoir compensation flow releases higher than the statutory requirement. If it is achieved by reduction or cessation of abstraction, then no consent is needed.
PDMIT_3 – Modification to barriers and/or flows to improve passage where walkover survey identifies insufficient water depth or volume at obstacles (fish).	Likely to require environmental permit from EA and the permission of the owner of the barrier or river reach.
PDMIT_4 – Capture and relocate across barrier (taking migratory period into account) where significant numbers of migratory fish congregate at obstacle (fish).	EA consent required (with consultation with NE for designated conservation sites or species).
PDMIT_5 – Relocation of juveniles where walkover surveys identify the likely desiccation of marginal	EA consent required (with consultation with NE for designated conservation sites or species).



Mitigation Measure	Permit or Permission Required?
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).	EA consent required (with consultation with NE for designated conservation sites or species).
PDMIT_7 – Restocking using offspring from broodstock from the catchment where monitoring indicates loss of fish abundance or recruitment (fish).	EA consent required (with consultation with NE for designated conservation sites or species).
PDMIT_8 – Restocking of coarse fish from the catchment where monitoring indicates loss of fish abundance or recruitment (fish).	EA consent required (with consultation with NE for designated conservation sites or species).
PDMIT_9 - Removal/treatment of giant hogweed where monitoring indicates an increase in abundance or distribution	EA consent may be required (with consultation with NE for designated conservation sites or species) depending on the nature of the treatment (e.g. a herbicide agreement may be required) and/or removal and subsequent method of disposal.

### 3.9. Monitoring and mitigation measures: ensuring environmental protection

The monitoring and mitigation measures set out in this EMP have been based on previous experience and evidence from droughts in Yorkshire or other parts of the UK and/or from water management experiences more broadly from water companies and the Environment Agency (for example, aeration of waterbodies by United Utilities on the Manchester Ship Canal or by the Environment Agency and Thames Water on the lower River Thames). The monitoring techniques required are well-known and have been applied both in drought conditions and normal conditions by Yorkshire Water and its contractors. The monitoring and mitigation measures have been discussed with the Environment Agency in developing this EMP to ensure they are appropriate and will afford environmental protection. Some of the mitigation measures do carry a level of risk (for example the capture and relocation of crayfish), and for this reason full consultation with the Environment Agency and Natural England will take place to agree whether a particular mitigation action is the best option in the prevailing drought situation and that it will have the greatest chance of success. Whilst no mitigation measure can claim to provide a 100% success rate, there is good evidence from across the UK that the measures set out in this EMP will likely have a positive, beneficial effect for the environment.

### 3.10. On-set, In and Post Drought Monitoring Location, Timing and Responsibility

Yorkshire Water is responsible for ensuring that the necessary data is collected to allow environmental assessment to inform the Drought Plan. Location, timing and frequency information for recommended further baseline monitoring surveys is summarised in Table 3.2. All surveys listed are the responsibility of Yorkshire Water.





**Table 3.2 Summary of location, timing, frequency and responsibility for recommended mitigation-led monitoring surveys**

Feature	Location	Timing	Frequency	Responsibility
<b>On-set of Environmental Drought</b>				
ODMON_1 Walkover Survey	Prior to drought option implementation	Duration of environmental drought	Once	Yorkshire Water
<b>In-drought Monitoring</b>				
IDMON_1 Targetted Surveillance Walkover Survey	Impacted reaches	Duration of drought permit/order	On the day of the flow change, the day after and then weekly thereafter until no further changes are noted.	Yorkshire Water
IDMON_2 Targetted Surveillance Walkover Survey - Water Quality Pressure	Impacted reaches with identified 'significant' water quality pressure(s)	Duration of drought permit/order	On the day of the flow change, the day after and then weekly thereafter until no further changes are noted.	Yorkshire Water
IDMON_3 - Storm intensity forecasting to predict likely CSO spill events and the need for pre-emptive mitigation	Impacted reaches with identified 'significant' CSO water quality pressure	Duration of drought permit/order	Continuous	Yorkshire Water
<b>Post-drought Monitoring</b>				
PDMON_1 - White-clawed crayfish	Sites to be defined by baseline surveys and walkover surveys (susceptible sites)	Following drought permit/order cessation between July and September	Bi-monthly until return to baseline habitat usage	Yorkshire Water
PDMON_2 - Fine-lined pea mussel	Sites to be defined by baseline surveys and walkover surveys (susceptible sites)	Following drought permit/order cessation between April and September	Bi-monthly until return to baseline habitat usage	Yorkshire Water



## 4. Monitoring Plan for Each Impacted Reach

A synchronised approach is proposed in this EMP to monitoring baseline, in-drought and post-drought changes. Monitoring reaches have been selected to allow co-ordination of hydrology, water quality and aquatic ecology sampling under similar hydrological conditions. Monitoring recommendations have been made for sensitive features that have been identified as having a serious risk from the drought options i.e. a moderate or major risk (or minor in the case of designated sites). These risks are based on cumulative impacts where reaches are subject to influence from two or more drought options and thus are a worst-case scenario.

The monitoring specification is set out for each impacted reach in Appendix A in a series of 'reach sheets' which are presented according to the EAR to which they relate:

- Appendix A.1 – North Area Reaches
- Appendix A.2 – North West Area Reaches
- Appendix A.3 – South West Area Reaches
- Appendix A.4 – South Area Reaches
- Appendix A.5 – River Option Reaches

The information for each reach includes the following information:

- Relevant WFD waterbodies
- Relevant drought options
- Summary of sensitive features and impact assessment
- Significant water quality pressures
- Water quality thresholds appropriate to WFD river type
- Baseline monitoring specification
- On-set of environmental drought monitoring (including grid references for walkover reach)
- In drought monitoring (including grid references for walkover reach(es))
- In drought mitigation
- Post drought monitoring
- Post drought mitigation.

As set out above, further work is required on the long-term water resource drought options. A detailed assessment of long term options would be completed in advance of use of these options and this would include specification of monitoring required to fill data gaps.

The mitigation recommendations have been made in a hierarchy of approach which follows the general principle of 1) reducing the pressure at source; 2) pressure management in the river; and 3) ecological action. The implementation of mitigations during the in-drought and post-drought periods should follow this principle, with



movement to mitigation measures in the next hierarchy dependent upon the success or failure of mitigation in the lower hierarchy.

The flow and water quality pressures identified relate to existing discharges and abstractions in the reaches that could present a 'serious' impact to sensitive features within the reach and therefore require consideration of mitigation. A range of other flow and water quality pressures have been reviewed in the EARs and have been assessed as presenting minor or negligible risks to sensitive features.

The sensitive features list identifies all of the features that have been considered for assessment in the EARs and not just those that require consideration of monitoring or mitigating. The mitigation and monitoring at the on-set of drought, in-drought and post-drought stages relate only to those sensitive features identified as being at risk of moderate and major impacts from the drought options, or where the risk is uncertain.

Detailed descriptions for ecological survey methodologies can be found in Appendix B.2.

The mitigation included within Appendix A identifies the suite of mitigation options that are available for management or reduction of impacts upon the sensitive features. As each mitigation option can be employed for a range of sensitive features, it is not feasible to identify the range of options for each sensitive feature. Consequently, it is the responsibility of Yorkshire Water to identify the appropriate options to deploy based upon the sensitive features present. The hierarchical approach, as identified above, is represented by the order in which the measures are presented. The movement from the first suite of mitigation to the second, and so on, is dependent upon the applicability and/or the success of the options available in the first approach.



# Appendices



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# Appendix A

## MONITORING PLAN FOR IMPACTED REACHES

### Appendix A Contents

Appendix A.1 – North Area Reaches

Appendix A.2 – North West Area Reaches

Appendix A.3-1 – South West Area Upper Calder Reaches

Appendix A.3-2 – South West Area Middle Calder Reaches

Appendix A.4 – South Area Reaches

Appendix A.5 – River Option Reaches





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[see separate documents]



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# Appendix B.1

## BASELINE MONITORING SITES



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## Existing Baseline Survey Sites

A comprehensive review has been undertaken in collaboration with the EA with respect to existing baseline survey monitoring sites. The review accounts for sites covered in the EARs for the North Area Reservoirs, the South Area Reservoir, the North-West Reservoir, South West Area and River Abstractions.

For the purposes of this EMP, information has been collated in a spreadsheet on the following attributes:

- Scheme
- ReachRiver Name
- Feature
- Site Name
- Grid Reference
- Site Ref
- Responsibility
- Last Survey Date used in EAR
- Method
- Comments

The spreadsheet is a live document which is updated to reflect ongoing monitoring by Yorkshire Water and the EA and consolidates past monitoring details and plans for future seasons. The spreadsheet has been shared with the EA and Yorkshire Water will continue to liaise with the EA and provide future versions.

### Data Exchange

In order to ensure that both Yorkshire Water and the Environment Agency has up-to-date baseline information available in the event of a drought, a data exchange agreement is in place between both organisations for those monitoring sites set out in this spreadsheet. Data for those sites on the spreadsheet will normally be exchanged on a 6-monthly basis, increasing to a monthly basis during a drought (and more frequently if agreed necessary during drought). The 6-monthly updates will also include the notification of the cessation of any monitoring parameters or points and the creation of any new monitoring parameters or points.

As part of the annual review of the Drought Plan (and this EMP), discussion should take place with the Environment Agency as to any changes in WFD classification for impacted reaches and whether this requires a change to the baseline monitoring programme. The baseline monitoring programme should be reviewed and refreshed as part of the annual review.



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## Appendix B.2

### ECOLOGY SURVEY METHODOLOGIES

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## WHITE-CLAWED CRAYFISH

A review undertaken by Yorkshire Water identified reaches within which a survey for white clawed crayfish would be required. Where conditions are suitable (water is not too deep), monitoring of white-clawed crayfish will follow the manual hand search procedures set out in the *Life in UK Rivers Monitoring Protocol*<sup>7</sup>. Surveys will be undertaken using one 500 m stretch of river in the monitoring reach. Within this stretch, a sampling site of 100 m/200 m will be surveyed using five patches to search for 10 potential refuges within each patch. Information gathered will include relative abundance, population structure, size distribution and the sex ratio of all crayfish found, in addition to the habitat details and the environmental conditions at the time of the survey.

Survey work will be undertaken by a licensed surveyor or their accredited agents.

Where it is identified that the river is too deep to survey through the methodology described above, the sites will be surveyed using crayfish traps. The traps will be set to sample one 100-200m stretch (from one bank) within a reach. The traps will be left overnight during appropriate conditions. Two surveys of each reach will be undertaken.

Any records of signal or other non-native crayfish found during surveys will also be reported

### Location and Timing

To focus surveys in suitable habitat, existing records collected by the Local Records Centre and the Environment Agency have been obtained and a review of the habitat along each reach identified in the EMP has been undertaken by manually inspecting aerial photos and ordnance survey information.

The surveys will be undertaken once between July and September in one year and then repeated once in every six years.

## FISH INCLUDING LAMPREY

All fish survey work will be carried out by hand-held electric fishing. The electric fishing sampling protocol will follow standard electric fishing practice for operators and equipment, as developed by the European Standards Committee (CEN, 2001) and detailed in the Environment Agency Code of Practice and Electric Fishing Equipment Annex A and B, Issue II regulations (Britton 2003<sup>8</sup>).

In all cases, the equipment used will be a bank-side control box with 50 or 100Hz pulsed-DC output at 220 volts and variable current. For all electric fishing equipment and modes of operation to comply with the EA Health and Safety Regulations, a

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<sup>7</sup> Peay, S. (2003) Monitoring the White-clawed crayfish *Austropotamobius pallipes*. Conserving Natura 2000 Rivers Monitoring Series No. 1 English Nature, Peterborough.

<sup>8</sup> Britton J.R. (2003) Fisheries Monitoring Programme Work Instruction 3.3: Sampling fish scales for age and growth determination. Environment Agency Management System.





minimum of a 3-person survey team will be required for the surveys, and in wider rivers this would preferably be a 4-person team.

The general survey approach will be to undertake one quantitative and two semi-quantitative surveys within each reach <15 m in width identified as requiring survey by YW, with results from the former being used to calibrate results from the latter.

Quantitative sampling will be carried out at all study sites to obtain absolute estimates of population density using the Carle and Strub (1978<sup>9</sup>) method and the efficiency of the sampling effort (probability of capture (P)) will be derived and validated using the Chi-squared test.

Each quantitative survey site will be fished by at least a three-person team, in an upstream direction three consecutive times taken from a known surface area between stop nets (Cowx and Fraser 2003<sup>10</sup>). A period of 20 minutes will be left between each run to allow water clarity to return and fish to become naturally distributed after each disturbance.

Semi-quantitative sampling will differ from quantitative sampling only in that one run will be carried out rather than three.

At new sites, 10x the river width (or minimum of 50m above 5m width) of river length should be sampled. At sites sampled previously, the same length of river must be sampled year on year. At each site, the number of fish of each species in each catch will be recorded and the length (fork length, nearest mm) will be measured.

Samples of scales will be taken from a small number of individual salmonid fish for determination of age and growth of the fish populations. Where large numbers of individuals are caught, scales will be taken from a representative sample of fish covering all size ranges (maximum of five fish from each 10 mm length band), and the age structure determined from comparison with length frequency data. Following processing, fish will be placed in oxygenated recovery bins to recover, before being released at the site where they were captured following completion of data collection.

### *Electric fishing for lamprey*

In habitat suitable for lamprey ammocoetes in or adjacent to a sampling area these will be surveyed. This will involve targeted electric fishing using a single anode, but if large numbers of ammocoetes are caught sites will be surveyed following a standardised fixed framework protocol (Harvey and Cowx 2003<sup>11</sup>), by selecting three small (<3m<sup>2</sup>) patches of suitable habitat (e.g. tree roots, silt substrate). Lamprey will be speciated where possible (using field based techniques) and their abundance and life-stage recorded.

### *Physico-chemical data*

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<sup>9</sup> Carle F.L. & Strub M.R. (1978) A new method for estimating population size from removal data Biometrics 34, 621-630.

<sup>10</sup> Cowx I.G. & Fraser D.F. (2003) Monitoring the Atlantic Salmon. Conserving Natura 2000 Rivers Monitoring Series No. 7, English Nature, Peterborough.

<sup>11</sup> Harvey J.P & Cowx I.G. (2003) Monitoring the river, brook and sea lamprey, *Lampetra fluviatilis*, *L. planeri* and *Petromyzon marinus*. Conserving Natura 2000 Rivers Monitoring Series No. 5, English Nature, Peterborough.



During the fish surveys the following information will also be collected: site length; average width; flow characteristics; substrate type; bankside vegetation; temperature; and conductivity.

In addition, a habitat survey will be carried out after each fish survey (on an annual basis) to meet the requirements of the HABSCORE assessment (Wyatt and Lacey 1994<sup>12</sup>; Wyatt *et al.* 1995<sup>13</sup>). These data will be analysed through the HABSCORE programme to evaluate the suitability of the site in terms of juvenile salmon and trout abundance, and provide a measure for future assessment of the impact of any drought permit/order changes in compensation flow on the habitat suitability and availability for salmonids.

### Location and Timing

Three sites will be sampled in each drought permit/order impact reach <15 m wide as identified as requiring monitoring by YW (i.e. where the EA are not surveying or where a sufficient baseline does not already exist).

One site in each reach will be sampled using a three-catch quantitative survey and the other two sites will be sampled using single-catch semi-quantitative surveys. The efficiency of sampling effort or probability of capture (P) at quantitative sites will be used to derive relative density (N/100m<sup>2</sup>) at semi-quantitative sites:  $N = ((C / P) / A) * 100$ , where C is the total number of fish caught in the single run and A is the sampling area (Cowx 1996<sup>14</sup>).

This approach will establish sufficient baseline fish data to inform statistically robust impact assessments of drought option implementation, over and above the effects of environmental drought.

In order to differentiate the effects of an environmental drought and those resulting from the application of a drought permit/order, the monitoring will include control sites outside of the extent of influence, i.e. unregulated reaches, both before and after the drought.

It is anticipated that the electro-fishing surveys will be undertaken annually for a period of four years. However, after two and three years it will be reviewed as to whether the third and fourth years are required as the data collected may be statistically robust.

The survey would then be repeated one year in every six, in accordance with 'Common Standards Monitoring Guidance for Rivers (JNNCC, 2005<sup>15</sup>)

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<sup>12</sup> Wyatt R.J. & Lacey R.F. (1994) Guidance notes on the design and analysis of river fishery surveys. NRA R&D Note 292, 118 pp.

<sup>13</sup> Wyatt R.J., Barnard S. & Lacey R.F. (1995) Use of HABSCORE V software and application to impact assessment. Report to NRA, No. 400; WRc.

The scope of this work is to cover 43 sites to be surveyed during the Spring and Autumn.

<sup>14</sup> Cowx I.G. (1996) The integration of fish stock assessment into fisheries management. In: Cowx, I.G. (ed.) Stock Assessment in Inland Fisheries. Fishing News Books, Blackwell Science, Oxford. pp 495-506.

<sup>15</sup> Joint Nature Conservation Committee (2005) Common Standards Monitoring Guidance for Freshwater Habitats and Species. Available at <https://hub.jncc.gov.uk/assets/1b15dd18-48e3-4479-a168-79789216bc3d>.



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## INVERTEBRATES INCLUDING FINE-LINED PEA MUSSEL

A semi-quantitative methodology will be employed for the collection of benthic macro-invertebrates from shallow in-stream habitats. These data will provide continuity with previously gathered data and enable the use of routine biological assessment tools for rivers based on invertebrates, i.e. River Invertebrate Prediction and Classification System (RIVPACS) and Lotic-invertebrate Index for Flow Evaluation (LIFE) scores.

A three-minute kick/sweep sample will be taken, covering all in-stream habitats, followed by a one-minute hand search. This is consistent with the method set out in the Environment Agency (EA) procedure for RIVPACS/LIFE analysis (EA, 1999).

Samples collected will be preserved using a 90% industrial methylated spirits on site, allowing long term storage of samples if required. Every six months samples need to be checked and it may be necessary to top up the preservatives to replace losses from evaporation.

As a number of factors determine the composition and dynamics of macro-invertebrates populations, other environmental parameters will be collected at each sampling location including: pH, conductivity, dissolved oxygen concentration at the surface and near the bed, wetted width of the river, river depth, substratum composition, macrophyte cover, riparian vegetation, shading, riparian land use, altitude, slope of bank and underlying geology.

### *Fine lined pea mussels*

There is the potential for fine lined pea mussel to be present in a small number of reaches. The sampling methodology for these reaches, in addition to the standard macro-invertebrate kick-sampling, will comprise the following: Suitable habitat comprising fine sediments accumulating at both the margins of the watercourse and further into the channel will be kicked into the sampling net. Approximately three minutes of sampling will be undertaken. Samples will then be sieved first on site to remove excess sediment over 2.36mm, with anything smaller than this being placed in a bucket and preserved with ethanol. Samples will be sorted in the lab and any pea mussels picked out and sent for identification to Ian Killen. Other environmental parameters will be collected at each sampling location as per the methodology outlined above for standard macro-invertebrate kick-sampling.

### **Location and Timing**

To encompass natural seasonal variations in populations of benthic macro-invertebrates, sampling will be required in Spring (March to May) and Autumn (September to November) in accordance with the sampling procedure agreed with Yorkshire Area Environment Agency. Additional surveys to be carried out at representative sites during summer.

One site per reach identified as requiring monitoring will be sampled for macro-invertebrates (sampling for fine lined pea mussel will only occur in those reaches identified to have potential). The site chosen will be selected on the basis that it is likely to provide a representative sample of macro-invertebrates for the reach.

It is anticipated that baseline data will be collected annually for four years. However, after two and three years it will be reviewed as to whether the third and fourth years



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are required as the data collected may be statistically robust. It will then be repeated one year within every six for both macro-invertebrates and fine-lined pea mussel, in accordance with 'Common Standards Monitoring Guidance for Terrestrial and Freshwater Invertebrates'<sup>16</sup>

### General Methodological Notes

In addition to the methodologies outlined above, it should also be noted that sites will only be surveyed providing:

1. Access and permission is granted by the relevant landowner/ tenant
2. Access is safe
3. Weather and river flow conditions are suitable.

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<sup>16</sup> Joint Nature Conservation Committee (2008) Common Standards Monitoring Guidance for Terrestrial and Freshwater Invertebrates. Available at <http://data.jncc.gov.uk/data/80873e1e-63eb-44a0-925c-b5edec5fa3fd/CSM-TerrestrialFreshwaterInvertebrates-2008.pdf>.



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## Appendix C

### ON-SET / IN DROUGHT WALKOVER SURVEY SPECIFICATION AND MITIGATION TRIGGERS





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## Surveillance Walkover Assessment Specification – ODMON\_1, IDMON\_1 and IDMON\_2

Visual monitoring “walkover surveys” of the riverine environment and spot sample measurements of water quality will be undertaken to identify environmental problems on impacted reaches that may be affected or caused by Yorkshire Water lowering compensation flows. Surveillance surveys will be undertaken in each impacted reach during the on-set and in drought periods (OMON\_1, IDMON\_1), and at additional locations where ‘significant’ water quality pressures are identified (IDMON\_2).

### Duration and Frequency

Initial walkover assessments will be undertaken during the onset of drought period (OMON\_1). The in drought surveillance walkovers (IDMON\_1 and IDMON\_2) will take place from the day prior to the drought option flow change until the drought permit / order expires or is revoked, unless otherwise agreed by the EA. For all surveillance walkover surveys the frequency will be as follows:

- The day prior to the flow change
- The day of the flow change (to the Tier 1 condition as specified in the Drought Plan and reported in the relevant EAR).
- One week after the flow change (and not within three calendar days of the previous survey). Where significant changes are recorded from the previous walkover survey, weekly thereafter until no further change identified, unless otherwise agreed by the EA.
- The day of any consequent flow change (to the Tier 2 condition as specified in the Drought Plan and reported in the relevant EAR).
- One week after the flow change (and not within three calendar days of the previous survey). Where significant changes are recorded from the previous walkover survey, weekly thereafter until no further change identified, unless otherwise agreed by the EA.

### Method

The visual monitoring of the potentially affected reaches to detect any potential change in habitat will be recorded onto the ‘Low Flows River Conditions Observation Form’, a copy of which is included at the end of this appendix. Photographs should be taken at recorded locations to be repeated during subsequent surveys.

Changes in fish habitat can be discreet and subtle as discharge reduces. Baseline maps (and images) should be available in each survey reach such that changes can be detected and reported by the field team.

### Location

Subject to any clarification provided by initial walkover assessments undertaken during the onset of drought period (OMON\_1), surveillance walkover surveys of habitat quality and ecological stress should be undertaken at the locations specified for each impacted reach in Appendix A (IDMON\_1). Surveillance walkover surveys of water quality and ecological stress should also be undertaken at those sites identified in Appendix A for reaches in which ‘significant’ water quality pressures have



been identified (IDMON\_2), and will extend 10m upstream and at least 100m downstream of the discharge.

## Environmental Problems

Environmental problems observed may include:

- Fish in distress, for example gasping at the surface or leaping out of the water
- Dead or dying fish
- Concentration of fish in restricted areas/pools which could increase susceptibility to predation
- Exposure of key functional habitat, particularly where there are reduced flows over or siltation of brown trout redds
- Stranding of fish in marginal areas
- Signs of pollution

From general water quality spot surveys; low levels of dissolved oxygen below the boundary of WFD moderate and poor status or high values of ammonium (surrogate for total ammonia) in excess of boundary of WFD moderate and poor status; or high values of unionised ammonia in excess of 40µg/l. For onset of drought walkovers the good-moderate boundary will be used to provide an early warning of potential areas at risk.

The included indicators of environmental stress for dissolved oxygen saturation and total ammonia for standard environmental problems are the boundary of WFD moderate and poor status, appropriate by WFD river type. These values, as proposed by the Environment Agency are:

### Dissolved oxygen

- Upland and Low Alkalinity WFD River Typology: less than 64%
- Lowland and High Alkalinity WFD River Typology: less than 54%
- Salmonid rivers: less than 64%

### Ammonia

- Upland and Low Alkalinity WFD River Typology: 0.75mg/l total ammonia
- Lowland and High Alkalinity WFD River Typology: 1.1mg/l total ammonia.

If the monitoring identifies signs of environmental distress Yorkshire Water would notify the EA by telephone on 0800 80 70 60 and undertake a remedial course of action to address the signs of environmental distress – see 'Mitigation Measures' below.

## Data Recording

Yorkshire Water shall measure and record the following information for all environmental problems identified:

- The location of the site of environmental problems observed



- Time
- Water quality parameters
- Any hydromorphological distress such as bank slippage or changes in erosional zones against the baseline condition
- Photographs should be taken of any signs of environmental distress
- Weather conditions at the time of the observations
- Any discolouration or odours
- Time series of event as conditions prevail
- Where relevant to the environmental problem observed the following would be recorded:
  - Approximate number of dead fish
  - Any signs of physical damage or fish distress
  - Approximate number of fish in distress, gasping at the surface or leaping out of the water
  - Whether the fish are being stranded in shallow pools
  - Description of stretches of any watercourses that have no flow or significantly reduced flow
  - Approximate size of the fish affected
  - The species of fish affected
  - Signs of pollution
  - Any new erosion or bank slippage.

Photographic imagery will be captured before, during and after each flow reduction event. The imagery will provide a clear visual representation of the changing flow conditions during the compensation reduction process and demonstrate how this is impacting the high priority areas with NGR's and direction recorded at each photography station.

### **Water Quality Monitoring**

In-stream water quality monitoring should be undertaken in the form of spot sample measurements using hand held meters to identify environmental problems on the affected waterbodies that may be caused by the reduction in flow. These spot sample measurements should be targeted in priority areas, such as holding pools as these areas offer key refuge for adult fish as the water recedes, but also below any significant water quality pressures (identified for each reach sheet in Appendix A).

Water quality monitoring should be undertaken during each walkover survey from the day prior to the compensation flow being reduced, until the drought permit/order expires or is revoked.



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In situ probe readings and spot water quality samples should be taken in the centre of the channel at mid-depth where appropriate. The following parameters will be recorded:

- Dissolved oxygen concentration (mg/l) and saturation (%)
- Conductivity
- Water temperature
- pH
- Turbidity
- Ammonium concentration
- Unionised ammonia
- Suspended solids
- Other determinands as specified in Appendix A for specific reaches (e.g. iron)

If low levels of dissolved oxygen (less than 54 or 64% saturation depending on river typology) are recorded during monitoring Yorkshire Water will initiate appropriate mitigation measures.

### Reporting

Yorkshire Water will provide the EA a report within one week of surveys being undertaken, detailing:

- Inventory of walkover surveys undertaken: dates, locations and findings
- Summary of water quality measurements, where taken
- Completed *River Conditions Observation Form - Low Flows* from surveillance walkover surveys of habitat quality and ecological stress

The report shall be sent to:

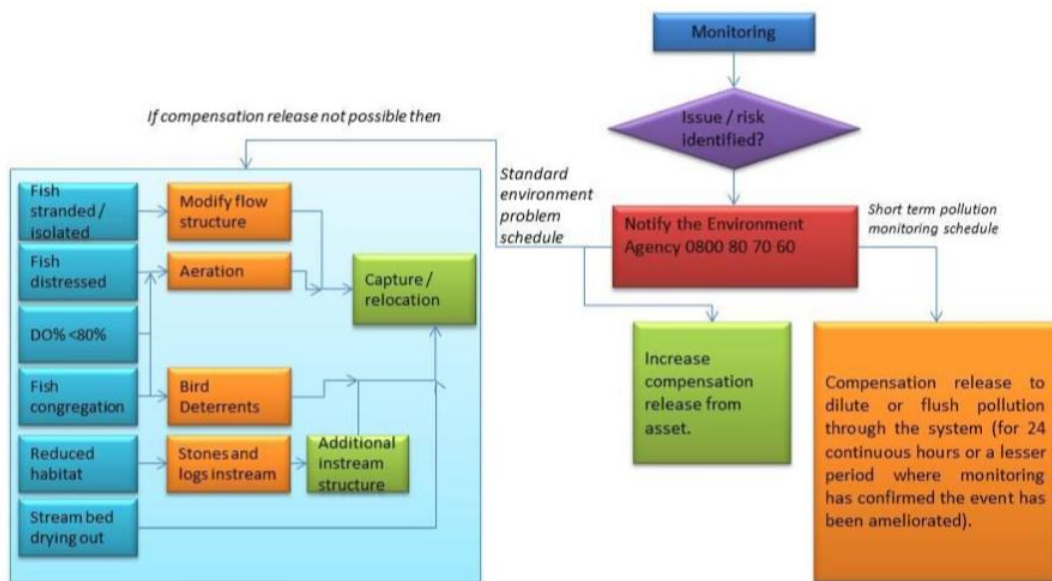
Drought.Yorkshire@environment-agency.gov.uk

### Mitigation Measures

If during the visual and water quality monitoring there are significant environmental problems observed (e.g. fish in distress/ low dissolved oxygen / reduced habitat availability etc.), then a mitigation response may be required. Mitigation recommendations for each impacted reach are included in Appendix A. The mitigation recommendations have been made in a hierarchy of approach which follows the general principle of 1) reducing the pressure at source; 2) pressure management in the river; and 3) ecological action. The implementation of mitigations during the in-drought and post-drought periods should follow this principle, with movement to mitigation measures in the next hierarchy dependent upon the success or failure of mitigation in the lower hierarchy. Figure C.1 illustrates the mitigation response decision making process.



Figure C.1 Mitigation Response





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## Low Flows River Conditions Observation Form

[See separate file]

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## Appendix D

### MITIGATION MEASURES – GUIDANCE FOR ECOLOGICAL ACTIONS

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## Placing stones or logs in a main river to enhance habitats

**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)

Placing stones or logs in a main river to enhance habitats is permitted under flood risk activity (FRA) exemption FRA18<sup>17</sup> where installation of habitat structure made of natural materials (but not including weirs and berms) is permitted on a main river. Placing these items may assist in creating alternate refuges in the event that identified refuges are insufficient or not retained during compensation reduction procedures. These structures should be permitted assuming:

- stones must be less than 400mm in any dimension and of a type that occurs naturally in the main river
- logs must be of less than 2m in length, less than 400mm in diameter and oriented to within 45° of the flow of water
- logs must be from a tree species that occurs naturally in the vicinity of the main river; and it must be securely pinned to the bed or bank of the main river to prevent wash out and congregation downstream
- the stones or logs are placed in the channel over no more than 20m of the length, and 20% of the width, of the main river
- no stones or logs are placed within 100m of a non-agricultural building in the floodplain, a natural channel habitat structure, an existing emplacement of stones or logs placed in the main river for habitat enhancement or a man-made structure on or in the main river
- all material should be removed within 1 month of the expiry of the drought permit/order.

## Provision of in-stream structures

**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)

It may be necessary to introduce in-stream structures at sites to create functional refuges to support displaced fish stocks. Installing habitat structures made of natural materials (excluding weirs and berms) is permitted under exemption FRA15<sup>18</sup> which allows installation of structures made of natural materials (but not including weirs and berms).

These structures should be ready to be installed at suitable sites and would be permitted as long as:

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<sup>17</sup> <https://www.gov.uk/government/publications/environmental-permitting-regulations-exempt-flood-risk-activities/exempt-flood-risk-activities-environmental-permits>

<sup>18</sup> <https://www.gov.uk/government/publications/environmental-permitting-regulations-exempt-flood-risk-activities/exempt-flood-risk-activities-environmental-permits>



- the structure occupies no more than half the width of the cross-sectional area of the channel in the main river and no more than 20m of the length of the main river
- no part of the structure is higher than 0.3m above the level of the river bed or 25% of the height of the bank (excluding any wall or embankment), whichever is greater
- the structure is made from naturally occurring woody material and is securely fastened to the bed of the main river, the bank or both
- no works take place within 100m of a non-agricultural building in the floodplain, another natural channel habitat structure, stones or logs placed in the main river for habitat enhancement or a man-made structure on or in the main river
- all structures should be removed within 1 month of the expiry of the drought permit/order.

### Artificial channel narrowing

**IDMIT\_12** - Provision of Artificial channel narrowing to maintain lateral connection within the reach and support habitat requirement for species. Constrained channels tend to lack shallower marginal areas and are more uniform so that, under low flows, habitat variation may be lacking. Improving connectivity can The restoration and reconnection of marginal habitats will allow the growth of vegetation and marginal silt deposits. Channel narrowing can increase flow energy, encouraging fine sediment to be transported rather than deposited on the channel bed.

Where these take place, channel narrowing may occur and establish a more varied channel profile and hydraulic habitats. Creates faster flowing water refugia under low flow conditions and enabling a quick natural recolonisation of the reach post-drought (fish, macroinvertebrates, white-clawed crayfish, fine-lined pea mussel, otter, water vole).

### Bird deterrents

**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 Wildlife and Countryside Act. Implementation would follow best practice guidance.

If the water level and therefore fish cover becomes limited as a result of the reduced compensation flow, piscivorous bird deterrents should be installed in refuge areas, where fish are likely to congregate to limit the interaction between piscivorous birds and fish which may become temporarily vulnerable to predation.

Visual deterrents will be used due to their ease of installation and efficacy. To maximise the effectiveness of the visual deterrents, their use should be reinforced by a human presence during the ongoing monitoring. Deterrent units should be placed where flow reduction reduces the availability of fish cover, and these should be rotated frequently and unpredictably to further prevent piscivorous birds from habituating to these deterrents.



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Whilst there is no guarantee of preventing all interactions, a variety of deterrents should be used to maximise their effectiveness. These should include rotating mirrored units, wind driven rotation vanes, flags and replica predators. Their use should also be subject to the site reach, riparian vegetation and weather conditions on the day.

Predator model raptors may influence a large variety of species; however, some piscivorous birds are likely to quickly learn that they do not respond to behavioural cues. Therefore, whilst a cost-effective; short-term method, these will be positioned with other traditional human shaped visual deterrents. These should be fitted with loose/bright clothing which may create noise and movement caused by the wind. Again, regularly changing the position of such units may improve their effectiveness.

If deployment extends into March, then consideration of effects on breeding birds is required, in particular kingfishers which are specially protected under Wildlife and Countryside Act 1981 Schedule 1. Therefore, if bird deterrents are located near to a suspected kingfisher nesting bank, they should be removed at the beginning of March.

### Aeration of watercourse

**IDMIT\_15** - Aeration of watercourse where significant mortality or change in species abundances are likely to be attributed to water quality deterioration

If dissolved oxygen saturation falls to unsatisfactory levels (below the boundary of WFD moderate and poor status, appropriate by WFD river type), then oxygen infusion should proceed at these locations, where fish are likely to congregate in impounded refuge areas. Aeration units will be on site prior to the drought option being initiated, ready to be deployed by the monitoring teams if required and would be powered by a series of leisure batteries which are capable of powering diffusers (suitable to uplift dissolved oxygen in small rivers).

However, if after deployment of the aeration units, dissolved oxygen saturation is recorded at or below the trigger level for a period of 2hrs, the monitoring team will report immediately to Yorkshire Water, so that an increased continuous release of compensation water from the reservoir can be initiated.

Aeration should only be considered a temporary measure and would be focussed at locations where fish are likely to congregate (deeper pooled water or glides). It should also be considered in reaches that experience chronic pollution issues or where a risk of potential contamination has been identified from the preliminary walkover survey. Should the oxygen diffusion and increased compensation flow not be sufficient to raise dissolved oxygen levels within 24hrs, a fish relocation procedure should be initiated. Should fish show signs of distress or mortality during this time they would be relocated to the defined 'safety' point.

### Fish capture and relocation

**IDMIT\_19** - Capture and relocate individuals across significant barriers, considering 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.

A combined approach should be used to capture any fish, either isolated from the main flow of the river or showing signs of distress from the DP implementation process. Standard methods should be used including electric fishing to capture fish from cover features and also manual searches (under cobbles etc.) using hand nets to manually capture fish. Any fish captured should be relocated to a suitable area of habitat less affected by the reduction in flow. All electric fishing should be undertaken by fully trained APEM fisheries scientists following standard electric fishing practice for operators and equipment, as developed by the European Standards Committee and detailed in the Environment Agency Code of Practice and Electric Fishing Equipment Annex A and B, Issue II regulations

If fish continue to show signs of distress or distressed fish are occupying areas not suitable for aeration, they should be captured and held for a short period, allowing recovery of both the fish and the levels of instream dissolved oxygen. In the case that these levels fail to recover, the fish should be moved to a suitable release site downstream where appropriate conditions exist on the day. It may also be necessary to relocate fish across barriers where the reduced compensation flow restricts movement between two areas as a result of an instream barrier.

Any eel captured should be kept in a separate tank to all other fish species as they secrete mucus which can infest the gills of other fish. Dissolved oxygen concentration should be monitored and optimum concentrations maintained by continuous infusion, using an oxygenation unit.

A description of juvenile lamprey habitat recorded during the initial baseline walkover should be summarised. In the event that juvenile lamprey habitat is encountered and considered to be at risk during the compensation reduction, these areas should be carefully monitored. As long as the compensation flow is lowered gradually, any juvenile lamprey will migrate towards the wetted fraction of the watercourse. This commonly occurs via subterranean substrate. However, where a risk of lamprey larval bed isolation is identified, the standard approach to capturing the larval life stage of lamprey would be applied with multiple electric fishing runs applied in optimal habitat until a depletion suggests that the population has been adequately removed (it may not be possible to capture all lamprey during this process). Any juvenile lamprey captured should be relocated to optimal habitat downstream where flows are sufficient enough to cover these areas.

The location of a suitable relocation site for fish should be described including the NGR, suitable parking and safe access to the site. The exact site of relocation should mimic conditions present at the site where the fish were captured, established by flow types and substrate present. This must be the case for fish species with specific functional habitat preferences such as juvenile lamprey.

The likelihood of the presence of white clawed crayfish in the impacted reaches is identified on each reach sheet. For these reaches it is recommended that the drought option implementation process is undertaken gradually in order to allow for individuals to seek refuge in the wetted areas of the watercourse. Should this not be the case, individuals identified as stranded by quickly receding stream width should be moved to appropriate, wetted habitat as close as possible and within the same reach.







