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United Utilities

Water for the North West

United Utilities

North West Transfer Strategic Resource Option

Gate 2: Assessment of Options Involving River Abstractions

Wood Group UK Limited – July 2022

Report for

[✂]
Strategy Manager (Water Trading)
United Utilities
Lingley Mere Business Park
Great Sankey
Warrington
Cheshire
WA5 3LP

Main contributors

[✂]

Issued by

……
[✂]

Approved by

……
[✂]

Wood Group UK Limited

Shinfield Park
Shinfield
Reading RG2 9FW
United Kingdom
Tel +44 (0)118 913 1234

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Contents

1. Introduction

1.1 Overview

1.1.1 The United Utilities (UU) North West Transfer (NWT) Strategic Resource Option (SRO) is one of 17 schemes promoted by Ofwat in the PR19 Final Determination to identify new strategic water resources to meet projected supply deficits as a consequence of population growth and climate change. The NWT SRO is a combination of the United Utilities Sources (UUS) and Vyrnwy Aqueduct (UUVA) SROs, as presented at Gate 1. Both the UUS and UUVA SROs have progressed through Gate 1 (July 2021) of the Regulators' Alliance for Progressing Infrastructure Development's (RAPID) gated process and UU is now preparing its Gate 2 submission for a combined NWT SRO.

1.1.2 At Gate 1, feasible options for the NWT SRO were identified by UU, and were subject to overarching environmental assessments. UU is now working towards its Gate 2 submission, the purpose of which is to enable detailed feasibility, concept design and multi-solution decision-making, building on the work undertaken during Gate 1.

1.1.3 In order to inform the Gate 2 submission, option-specific evidence-collection and assessments are being undertaken. These also take account of updated design information, and of regulator feedback (during Gate 1 including RAPID's Gate 1 decision and during the preparation of the Gate 2 submission). An Evidence and Assessment Scoping Report was produced (Wood, 2022), setting out the scope of evidence collection and assessment required for each option. This included:

- Informal scoping of the topics[1] that require specific evidence collection and assessment for the purposes of informing the overarching environmental assessments and UU's Gate 2 submission. All topics will receive appropriate consideration at future stages (for example, as part of any Environmental Impact Assessment (EIA)), but with the focus at Gate 2 on effects that cannot be readily avoided and/or mitigated, and those which have the potential to influence the selection of the options ultimately taken forward as part of the scheme and/or affect the overall feasibility of the scheme.
- The informal scoping identified the following key topics for specific evidence collection and assessment: aquatic ecology; Invasive Non-Native Species (INNS); water quantity; water quality. Specifically, these topics should be considered in relation to the operational activities associated with the scheme, i.e. the abstractions from rivers or groundwater.
- For each option, a scope of work for each of those key topics was identified. This covered:
  - Evidence collection that should commence in Gate 2, but may continue beyond the Gate 2 submission date;

[1] Taking into account the topics listed in the Environmental Assessment of Plans and Programmes Regulations 2004 and The Town and Country Planning (Environmental Impact Assessment) Regulations 2017 , as well as those topics adopted for the purposes of the SEA of UU's WRMP24

- Assessment that should be undertaken to inform the Gate 2 submission;
- Assessments that are likely to be required beyond the Gate 2 submission.

1.1.4 The purpose of this report is to present the evidence collection and assessment for the options involving river abstractions, to inform UU's Gate 2 submission. Based on the outcome of the assessments, it also includes recommendations for work required beyond Gate 2.

1.1.5 This report sits alongside report *Gate 2: Assessment of Options Involving Groundwater Abstractions* (Wood, 2022). The evidence and assessment from both reports is then used to inform the over-arching assessments including the Habitats Regulations Assessment (HRA), Water Framework Directive (WFD) assessment and the Integrated Environmental Assessment Report (IEAR).

1.2 Introduction to the North-West Transfer Scheme

1.2.1 The NWT SRO solution promotes best value sub-options, selected to facilitate the transfer of water from Lake Vyrnwy into the River Severn as part of the Severn Thames Transfer (STT) SRO. The new water resources generated by the NWT options will not be transferred out of UU's supply area, rather they will maintain resilience for customers in the North West while trading is in operation. The NWT SRO comprises two principal components:

- new sources to offset water transferred out of region from Lake Vyrnwy as part of the STT SRO; and
- enabling works on the Vyrnwy Aqueduct to allow treated water from regional UU sources to be transferred by pumping into the Vyrnwy Aqueduct to maintain customer supplies (for transfer volumes greater than 50 Ml/d).

1.2.2 A total of 14 options are included in the NWT SRO at Gate 2 (13 source options and one enabling works option). The source options are geographically spread across UU's supply area, and include river and groundwater abstractions, river abstractions. Of the 13 source options, nine are included in the NWT Full Solution (i.e. the options required to provide resilience under a 205 Ml/d trading scenario), with the remaining four held in reserve, to be implemented if the ongoing assessment of the Full Solution indicates one or options to be unfeasible.

1.2.3 This report presents option-specific evidence and assessment, in relation to the options of the NWT scheme that involve abstractions from rivers. The five relevant options are introduced in **Table 1.1** and shown spatially on **Figure 1.1**.

Table 1.1 NWT SRO Options assessed in this report

Option ID	Option name	Description	Capacity (Ml/d)	Part of NWT Full Solution?
WR015	[✂]	[✂]	40	Yes
WR049d	[✂]	[✂]	40	Yes
WR076	[✂]	[✂]	25	Yes
WR144	[✂]	[✂]	5	No
STT041b	[✂]	[✂]	58	No

1.3 Scope of assessment

1.3.1 This report sets out the evidence and assessment relating to the potential impacts on the environment of the options involving abstractions from rivers. These assessments are targeted towards understanding the feasibility of the options, as required for UU's Gate 2 submission to RAPID. Principally, this involves understanding the potential influence of the abstractions on river flow, and the resulting impact on other environmental factors. These are key considerations for informing the overarching assessments, in particular the WFD assessment and the HRA.

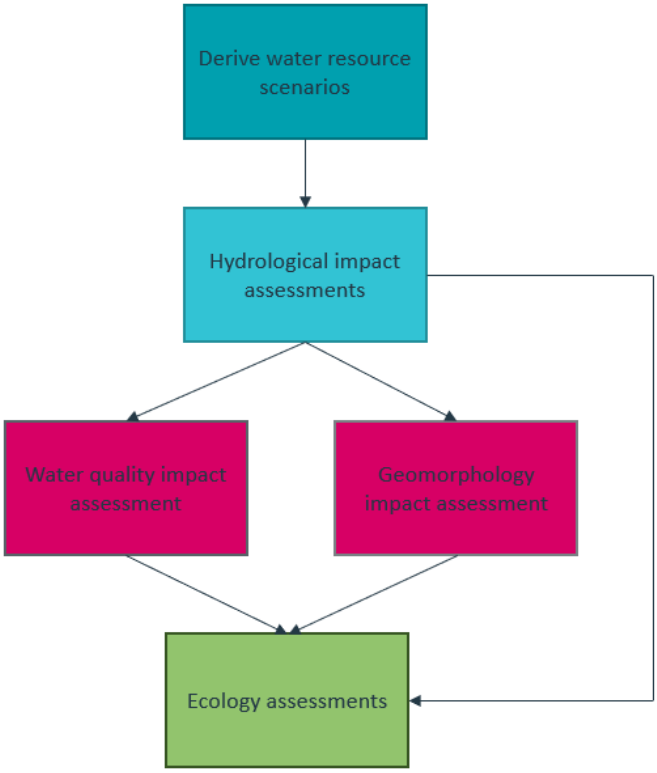
1.3.2 The assessments in this report have predominantly relied on existing environmental data, to undertake assessments of:

- The impact of the proposed abstractions on river flows. This is based on gauged flow records, and uses the predicted rates of utilisation of each source;
- The baseline physical and chemical environment in each river, i.e. an assessment of geomorphology and physical habitat availability, and of water quality. The potential for the baseline habitat to be altered by the predicted changes in river flows is then considered;
- The baseline ecological habitat in each river, including assessments of macroinvertebrates, macrophytes and fish. The potential for ecological receptors to be impacted by the predicted changes in river flows is then considered. A review is also undertaken of potentially relevant designated sites.

1.3.3 This sequential approach to assessment is illustrated in **Figure 1.2**. Further details of the scope of assessment are set out in **Section 2**.

1.3.4 The assessments have been designed to provide improved evidence and assessment to inform UU's Gate 2 submission, and to identify any likely key constraints to implementation. It is also designed to identify further evidence collection and assessment that will be required beyond the Gate 2 submission, to provide more targeted and detailed understanding.

Figure 1.2 Relationship between topic assessments



1.3.5 This report sets out the operational impacts that could occur as a result of each of the options individually, specifically focussing on the proposed new river abstractions.

1.4 Structure of this report

1.4.1 The report has been presented to enable review both by option and by topic:

- Section 2 provides an overview of the overall approach to evidence collection and assessment for each topic;
- Sections 3 to 7 then set out the findings of the evidence collection and assessment for each option, with a separate section for each option. These draw on the topic-specific assessments in the appendices;
- Section 8 provides a summary of the findings and recommendations for future evidence collection and assessment.

1.4.2 The appendices present the topic-specific assessments:

- Appendix A- water resource scenarios used in the assessments
- Appendix B- impacts of the proposed abstractions on river flows
- Appendix C- results of the geomorphology and habitat walkover surveys
- Appendix D- potential impacts of the proposed abstractions on water quality
- Appendix E- likely sensitivity of macroinvertebrate communities to abstraction

- Appendix F- likely sensitivity of macrophyte communities to abstraction
- Appendix G- likely sensitivity of fish communities to abstraction
- Appendix H- likely sensitivity of designated sites to abstraction
- Appendix I- current waterbody status summary.

2. Methods

2.1 Introduction

2.1.1 This section provides a summary of the approaches taken for the assessments in this report. These build on the outline methods set out in the Evidence and Assessment Scoping Report (Wood, 2022), focussing specifically on the assessments undertaken to inform UU's Gate 2 submission to RAPID. The purpose of the assessments is to improve confidence in the feasibility of the options proposed as part of the NWT scheme. The Evidence and Assessment Scoping Report also introduced further monitoring and assessment that should continue beyond the Gate 2 submission, in order to inform Gates 3 and 4. This report does not cover those longer-term activities.

2.1.2 The assessments are focussed on the potential impacts of new abstractions from rivers, which would occur as a result of a reduction in river flow. A sequential approach can therefore be taken to the assessment, which was introduced in **Figure 1.1** and is summarised below:

- Assess impacts of the proposed abstractions on river flows. This is based on utilisation predictions for each abstraction, provided by UU from its water resource modelling;
- Consider potential implications for water quality and geomorphology resulting from the reduced flows;
- Consider likely sensitivity of the ecology downstream of the proposed abstractions to reduced river flow (including the ability of migratory species to pass upstream), and any identified impacts on water quality and geomorphology.

2.1.3 The approach to each step is discussed in more detail below.

2.2 Hydrological impact assessment

2.2.1 The assessment of impact on flows is based on used of historic gauged flow records, allowing a quantified assessment of the reduction in flows that would result from the proposed abstractions. As it does not provide a comparison to natural flows (which is the standard benchmark for flow compliance), the following sources of information are used to supplement the assessment:

- The natural flows from QUBE[2] are used to give an indication as to whether gauged flows are generally above or below natural;
- The Environment Agency's 2013 Abstraction Licensing Strategies (ALS) for the relevant catchments[3], which include an assessment of water availability, and any Hands-Off Flows applicable;

[2] QUBE (developed from Low Flows Enterprise) provides estimates of flows in ungauged catchment. QUBE derives flow statistics at any location by drawing on data from other gauged catchments with similar catchment characteristics. https://www.hydrosolutions.co.uk/software/qube/

[3] Abstraction licensing strategies (CAMS process) - GOV.UK (www.gov.uk)

- The Environment Agency provided updated water availability assessments in March 2022, and a draft 2021 ALS for the Upper Mersey. The more recent information has been used in preference to the 2013 ALSs where available;
- Review of the current hydromorphology classification in the River Basin Management Plan (RBMP).

2.2.2 These assessments are designed to provide sufficient indication to inform the feasibility of each option. Subsequent assessments, beyond UU's Gate 2 submission to RAPID, are recommended using rainfall-runoff modelling, to allow a more comprehensive assessment compared to natural flows, and to allow future climate scenarios to be considered.

2.2.3 The assessment calculates the potential impact of each proposed abstraction on river flows, by using:

- Gauged flows from the closest representative flow gauge, using flows from the National River Flow Archive (NRFA) website[4] (downloaded June 2022). In some cases, a longer or more complete record was available from the Environment Agency[5], in which case that was used in preference. Relevant gauges are shown in **Figure 2.1**.
- Catchment areas and estimated natural flow statistics at each abstraction location, from QUBE (data provided by United Utilities).
- Predicted abstraction utilisation profiles, as provided by United Utilities. These are presented for each source in **Appendix A**. Two utilisation profiles are assessed: the "all years" profile, and the "1 in 500 drought year" profile (with the former representing average conditions, and the latter representing a worst case).

2.2.4 Impacts of the proposed abstractions have been calculated at the abstraction location itself, and at any downstream gauges. The impacts are calculated by subtracting the abstraction from the gauged flow record, and the resulting impacts interrogated:

- As a percentage impact on a long-term flow duration curve (FDC);
- By reviewing the year of minimum flows and/or maximum percentage impact on flows, which are then plotted as a time series.

2.2.5 The hydrology assessment is described in more detail in **Appendix B**.

2.3 Geomorphology and habitat assessment

2.3.1 The assessments undertaken have been designed to provide an initial overview of the general hydromorphological quality of the watercourses associated with each of the options. This has focussed on collection of evidence through walkover visits, which has been used to inform the likely sensitivity of the reaches to the reduced flows that could result from abstraction.

2.3.2 The field surveys used publicly-available access to watercourses, and used the MoRPH methodology[6] in order to present a standardised approach. MoRPh is a river habitat

[4] https://nrfa.ceh.ac.uk/data/search
[5] https://environment.data.gov.uk/hydrology/explore
[6] https://modularriversurvey.org/morph-rivers/

survey tool which records both the physical habitat and hydromorphological functions within rivers and streams. These surveys have been supplemented by photographs and notes of key features along the broader survey reach to provide an understanding of the variability of the river form.

2.3.3 The surveys were undertaken in May 2022. This was an opportune time of year to survey, as sufficient vegetation growth had occurred to identify species/habitats, but there was still reasonable visibility of key river form/features before the vegetation is fully grown.

2.3.4 The evidence collection and assessment is described in detail in **Appendix C**, which covers both the surface water and groundwater options. The locations of the walkover surveys associated with the surface water options (i.e. the focus of this report) are shown in **Figure 2.2**.

2.4 Water quality assessment

2.4.1 The intention of the water quality assessment is to determine whether the proposed abstractions could cause a reduction in water quality as a result of reduced dilution, and any resulting risk to WFD status. For these Gate 2 assessments, the focus has been on identifying the risk of deterioration from current status, to provide an initial assessment of risk. More detailed modelling is planned for Gate 3, which will allow assessment of whether reduced dilution could cause an impediment to improving status from other planned improvements in the catchment.

2.4.2 The following steps have been taken for this Gate 2 assessment:

- For each abstraction, upstream and downstream water quality monitoring locations from the Environment Agency's online water quality database and the water company reported CIPS data have been extracted for the period 2010 to 2022.
- The location of waste-water treatment works (WwTWs) both upstream and downstream of the abstraction points (up to 20 km in either direction) have been identified, and where available effluent data has been identified for the same period.
- Where there are sufficient spatially-distributed river water quality monitoring locations, timeseries data for orthophosphate, ammoniacal nitrogen and BOD (as the key WFD physio-chemical parameters) have been compared to flow data to understand how the concentrations of these species change over time and downstream. Additionally, concentrations of nitrate have been included as it can have a significant influence on the ecological health of a river and estuarine habitats.
- Predicted impacts on concentrations from the abstractions have been calculated through the following steps:
  - Where water quality data is available, the mean concentration of nitrate, orthophosphate, ammoniacal nitrogen and BOD based on samples taken in April to September (inclusive) over the 10 year dataset have been used to represent the low flows period.
  - Mean "actual" and "predicted" flow values for the same low flow period have also been calculated in Ml/d for the abstraction points.

- The actual flow value (Ml/d) is used with the mean concentrations to calculate solute load, and this value is used with the predicted mean flow to calculate a mean concentration during periods of abstraction.
- The actual and predicted mean concentrations are compared to understand the likely impacts.
- Current WFD status of the impacted waterbody is checked and commentary is made on the likely impact of the change in concentrations.

2.4.3 Where priority substances or specific pollutants have been detected, a comparison of their levels is made against Environmental Quality Standards (EQS), with commentary made on whether the level of pollution could increase to above these standards due to the abstraction impact on dilution.

The assessment locations are illustrated in **Figure 2.3** and the assessment is described in **Appendix D**.

2.5 Ecology assessments

2.5.1 The ecology assessments have drawn on the Environment Agency's existing monitoring, downloaded from the Fish and Ecology Data Explorer[7]. A review was undertaken of data availability compared to the proposed abstraction locations, to identify locations that are both downstream of the abstractions, and have a long period of record with relatively recent samples. The locations selected for assessment are shown in **Figure 2.4** (macroinvertebrates), **Figure 2.5** (macrophytes) and **Figure 2.6** (fish).

Macroinvertebrates

2.5.2 Relationships between hydrological conditions and relevant macroinvertebrate indices were assessed, using both observed metrics, and Environmental Quality Ratios (EQRs), which demonstrate how scores compare to those 'expected' based on river characteristics. Indices that have been used for the assessment include:

- LIFE (F) (Lotic Invertebrate Index for Flow Evaluation), as developed by Extence, Balbi and Chadd (1999);
- WHPT-ASPT (Average Score Per Taxon), calculated using the Whalley-Hawkes-Paisley-Trigg approach from UKTAG (2014);
- WHPT-NTAXA (Number of Scoring Taxa), calculated using the approach from UKTAG (2014); and
- PSI (Proportion of Sediment-sensitive Invertebrates), developed by Extence *et al* (2011).

[7] https://environment.data.gov.uk/ecology/explorer/

2.5.3 Expected scores were calculated using RICT[8] (where relevant habitat data are available) and used to calculate the EQRs. Observed/expected scores were compared to WFD standards for WHPT-ASPT and WHPT-NTAXA. Indicative thresholds were used to indicate potential pressures from flow and sediment respectively: these are 0.94 for LIFE and 0.7 for PSI (Environment Agency, 2012).

2.5.4 EQRs were plotted with flow to look for relationships between the two during the period for which data were available, which provided an indication of how macroinvertebrate communities may be affected over a range of flows, levels and/or water quality as a result of each option.

2.5.5 Invertebrate data was also reviewed for the presence of legally protected invertebrate species, species listed on Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 or Red Data Book invertebrate species. Where present, the likely influence of changes in flow, level and/or water quality as a result of each option were considered for each species.

2.5.6 The assessment locations are illustrated in **Figure 2.4** and the assessment is described in **Appendix E**.

Macrophytes

2.5.7 Relationships between hydrological conditions and relevant macrophyte indices were assessed, taking account of the WFD status of the macrophyte communities. This was based on the LEAFPACS method: all metrics were considered, but with the most relevant being:

- River Macrophyte Nutrient Index (RMNI), which indicates nutrient levels; and
- River Macrophyte Hydraulic Index (RMHI), which indicates association with flows.

2.5.8 Macrophyte data was reviewed for the presence of legally protected species and species listed on Section 41 of the NERC Act. Where present, the likely influence of changes in flow, level and/or water quality as a result of each option was considered for each species.

2.5.9 The assessment locations are illustrated in **Figure 2.5** and the full assessment is presented in **Appendix F**.

Fish

2.5.10 The purpose of the assessment at Gate 2 was to establish the baseline environment; identify the potential sensitivity of fish stocks to flow changes in river flows downstream of the proposed abstractions, and hence understand the likely impact of the abstractions on fish populations.

2.5.11 Data relating to fish fauna have been drawn from the Environment Agency Ecology & Fish Data Explorer, which has been interrogated for survey data within the relevant catchments for the period 2000 to present. Where data was not available for key reaches then the

[8] River Invertebrate Classification Tool (RICT) https://fba.org.uk/FBA/Discover-and-Learn/Projects/RIVPACS-RICT/Public/Discover-and-Learn/Projects/RIVPACS-RICT-Landing-Page.aspx?hkey=72b27a8b-d566-4bab-b863-ca39545226ae

entire online archive was searched (back to 1965). Where there is a paucity of Environment Agency data, additional information has been sought from third parties such as the Ribble Rivers Trust that undertake an annual programme of monitoring.

2.5.12 Data on the current WFD status of waters bodies was drawn from the Environment Agency Catchment Data Explorer (Environment Agency 2022b). A search of river obstructions that may be affected by each of the resource options was undertaken by interrogating aerial imagery in Google Earth.

2.5.13 This information has been used to undertake a qualitative assessment of potential impacts on fisheries, drawing on relevant supporting literature.

2.5.14 The assessment locations are illustrated in **Figure 2.6,** and the full assessment is presented in **Appendix G**.

2.6 Review of designated sites

2.6.1 Designated sites could potentially be affected by the proposed river abstractions as a result of reduced river flows downstream, including riverine designations or wetland habitats on the floodplain. All nationally or internationally designated sites downstream[9] of each of the abstractions have been reviewed individually. This has included:

- Sites of Special Scientific Interest (SSSIs)
- Special Areas of Conservation (SACs)
- Special Protection Areas (SPAs)
- Ramsar sites
- National Nature Reserves (NNRs)

2.6.2 The approach involved:

- Identification of any designated habitats downstream of the abstraction using Geographic Information Systems (GIS) and the MAGIC website[10];
- For each identified site, a review of the designated features and location was carried out, in the context of potential connectivity to the river.

2.6.3 Sites identified as being potentially affected by any of the abstractions will be subject to further investigation in future stages of assessment (beyond Gate 2 submission). Local designations and priority habitats will also be given consideration, where relevant, at that later stage.

The assessment is described in **Appendix H**, with all sites shown in **Figure 2.7**.

[9] There is some potential for ecological features of sites upstream of abstractions to be impacted indirectly, by affecting the ability of migratory species to move upstream. Potential effects of this type are considered via the assessments on fish and other aquatic species.
[10] https://magic.defra.gov.uk

2.7 WFD river water body classification

2.7.1 The current (2019) WFD ecological status for relevant water bodies is displayed in **Figure 2.8** and the classification of the hydrological regime (river flows and morphological condition) in each WFD Water Body Catchment is shown in **Figure 2.9**[11]. The classification data, and reasons for not achieving good, are discussed in relation to individual options in the following sections.

2.7.2 **Appendix I** identifies the WFD water bodies that are relevant to each option (as discussed in the individual option chapters), and presents the WFD classification data for those water bodies.

[11] Those water bodies shown in grey on Figure 2.9 are not assessed for hydromorphology. This applies to water bodies that are designated as Heavily Modified Water Bodies (HMWBs) as a result of hydrological or morphological alterations.

3. Assessment of impact of WR015 (River Irwell)

3.1 Option description

3.1.1 [✂]

3.1.2 The assessment in this report focusses on the potential impacts of the proposed new abstraction. Impacts on other components of the option, including both construction and operation, will be considered in the separate overarching assessment reports.

3.2 Waterbody Status

3.2.1 The surface water abstraction associated with option WR015 would be located in the Irwell (Croal to Irk) WFD surface water body, which flows into the downstream Irwell / Manchester Ship Canal (Irk to confluence with Upper Mersey) WFD surface water body. Both are classed as **heavily modified**. The current WFD status of both water bodies is summarised in **Table 3.1** (with more detail available in **Appendix I**). Both water bodies are at Moderate Ecological Potential, and failing chemical status. For biological elements, invertebrates are classified as Moderate in the Irwell. For physico-chemical parameters, the Irwell (Croal to Irk) water body has ammonia and phosphate classified as Moderate and for the Irwell / Manchester Ship Canal (Irk to confluence with Upper Mersey) water body, failing parameters include ammonia (Moderate), BOD (Moderate), Dissolved Oxygen (DO) (Bad) and phosphate (Poor).

3.2.2 Reasons for failure include contaminated sediments, sewage and trade discharges and urbanisation. River flows are not listed as a reason for failure on either water body.

Table 3.1 WFD dependent surface water body screening*: Surface water Option WR015

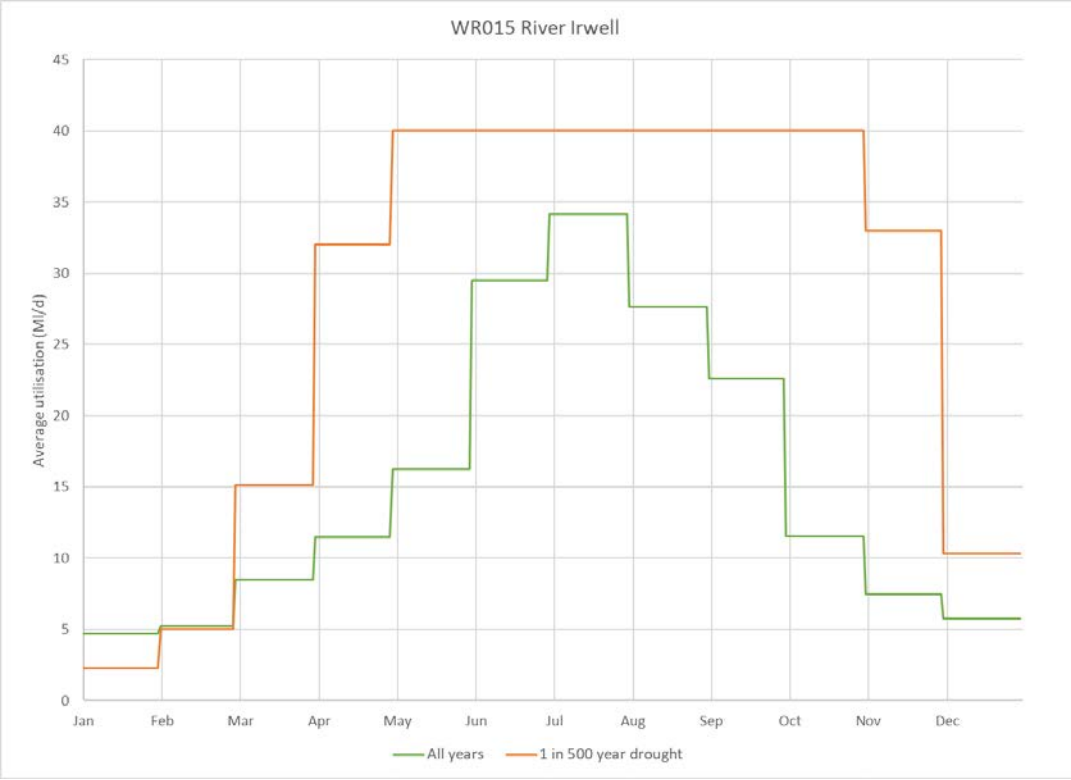
Water body	Ecological status	Biological quality	Physico-chemical quality	Hydro-morphological	Chemical
Irwell (Croal to Irk) GB112069061451	Moderate	Moderate	Moderate	Supports Good	Fail (Mercury, PFOS, PDBE)
Irwell / Manchester Ship Canal (Irk to confluence with Upper Mersey) GB112069061452	Moderate	-	Moderate	Supports good	Fail (Mercury, PFOS, PBDE, Tributyltin compounds)

* Based on Catchment Data Explorer data from https://environment.data.gov.uk/catchment-planning/ accessed 20/06/2022. 2019 classification. RNAG Reasons for Not Achieving Good; PBDE Polybrominated diphenyl ethers; PFOS Perfluorooctane sulphonate.

3.3 Anticipated utilisation

3.3.1 The anticipated utilisation of option WR015, as provided from UU's water resource modelling, is presented in **Figure 3.1**. The option has a maximum capacity of 40 Ml/d. **Figure 3.1** shows that with the 'all years' abstraction scenario, the rate of abstraction would peak in summer at 34 Ml/d, with a minimum of approximately 5 Ml/d in winter. With the '1 in 500 year drought' abstraction scenario, the option may be utilised at its maximum capacity for a number of months through the spring, summer and early autumn.

Figure 3.1 Modelled utilisation of option WR015



3.4 Assessment of impacts on river flow

3.4.1 The proposed abstraction would have an impact on river flows on the River Irwell, downstream of the abstraction near Kearsley. Flow impact assessments are based on gauged flow records at:

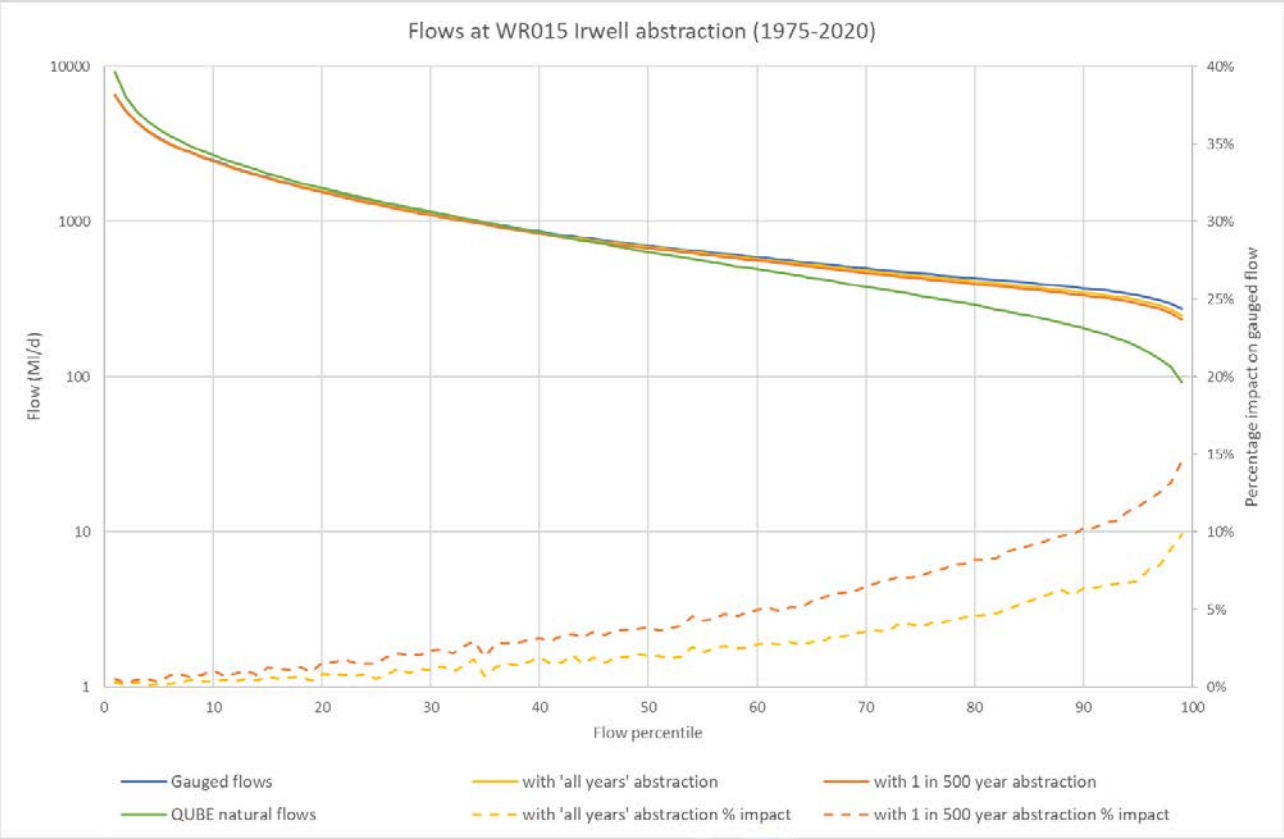
- 69026 (Irwell at Kearsley, recorded as 690503 in Environment Agency records);
- 69002 (Irwell at Adelphi Weir);
- Combined flows from 69002 (Irwell at Adelphi Weir), 69020 (Medlock at London Road) and 69043 (Irk at Collyhurst Weir). This provides an indication of flows entering the Manchester Ship Canal.

3.4.2 The assessment in **Appendix B** shows that impact of the proposed abstraction would be a 7% reduction from gauged flows at Q95 for the 'all years' utilisation scenario, and 11% reduction for the 1 in 500 year utilisation scenario. This is shown in **Figure 3.2.** The catchment is discharge-rich, with discharges supporting flows above natural at low flows.

The Environment Agency's water availability assessment, provided to UU in March 2022, states that there is unconstrained water available for an abstraction of this size.

3.4.3 The current assessment therefore indicates that on the basis of flows alone, the abstraction is likely to be feasible. The need for a Minimum Residual Flow (MRF) requirement is likely, but would likely affect only a small number of days.

Figure 3.2 Impacts of WR015 on flows in the River Irwell at the abstraction location



3.5 Geomorphology and habitat

3.5.1 **Appendix C** (Section 2.13) presents the results of the walkover survey in May 2022, when a reach downstream of WR015 was visited.

3.5.2 At the location visited, the channel width was 20-30m wide. The right bank was steep and with extensive berms, while the left bank was gentler. The channel bed was relatively uniform with exposed bedrock on the right bank, with an unvegetated side bar on the left bank. The water surface profile was a mixture of smooth glides, with areas of 'rippled' flow and unbroken standing waves. Overall, the reach visited was considered to be relatively insensitive to flow changes, with significant changes in flow likely to be needed to alter the degree of wetted/exposed channel bed. However, more extensive surveys would allow more confidence in the assessment.

3.6 Water quality

3.6.1 Water quality assessments have been undertaken at relevant locations downstream of the proposed abstraction on the Irwell, including Environment Agency monitoring locations which also coincide with WwTWs at Bolton and Salford. The assessment in **Appendix D** considers the baseline relationships between water quality and flow in the Irwell. Concentrations of pollutants tend to increase downstream through the catchment, with higher concentrations in the Salford / Manchester area compared to the area around the abstraction location itself. It is noted that UU propose to make improvements at Bolton WwTW, which is a short distance downstream of the proposed abstraction location, to reduce concentrations of ammonia, phosphate and additional storm storage. This is part of a wider ongoing programme of work to improve water quality in the Irwell and, more broadly, the lower Mersey and Manchester Ship Canal.

3.6.2 Initial assessments calculating the impact of the predicted changes to dilution as a result of reduced flows suggest that there would be only a very small change in concentrations. The current WFD classifications for the Irwell (Croal to Irk) water body have ammonia at Moderate, BOD at Good and Phosphate at Moderate. Comparison of the baseline and predicted concentrations indicates that the abstraction would be unlikely to result in a change in status at any of the sample points. Similarly, there is a low risk of EQS exceedance of Priority Substances occurring as a result of reduced flows associated with the proposed abstraction.

3.6.3 Whilst the risk to water quality in the context of deterioration of WFD status is considered to be low, the assessment approach does not allow consideration of the risk of impeding future improvements (i.e. reducing the dilution available in relation to future water quality improvements in the catchment). It is also recognised that the lower Irwell and downstream water bodies form a relatively complex, urban catchment, the details of which are not captured by the simple calculations carried out to date. Therefore, a more comprehensive assessment is recommended, using the Environment Agency's SAGIS SIMCAT model for the North West River Basin District.

3.7 Macroinvertebrates

3.7.1 The assessment has used historic Environment Agency data, focussed on key locations at:

- 67275, [✂]
- 69675, [✂]

3.7.2 The sample locations can therefore provide some indication of potential impacts of abstraction, but with some limitations of the period of record and locations.

3.7.3 The assessment in **Appendix E** shows that water quality, flows and sediment all exert pressures on the invertebrate community in the Irwell, although the WHPT-ASPT scores indicate that water quality has improved over the past two decades. It is possible that a reduction in flow associated with the scheme could exacerbate the flow, sediment, and potentially habitat, pressures, although there is considerable uncertainty with the current level of data availability. The river and its invertebrate communities are likely to be relatively insensitive to changes in flow, in these large, slow-flowing reaches. However, as

noted in **Section 3.6**, further habitat surveys should be carried out to confirm this is the case along the reaches downstream of the abstraction. Alongside this, continuation of seasonal macroinvertebrate surveys at the existing sites is recommended.

3.8 Macrophytes

3.8.1 Only a single relevant sample site has been identified on the River Irwell, and it is 15 km downstream of the proposed abstraction. The reach between the sample site and abstraction includes confluences with tributaries and an increasingly urbanised catchment, and the sample site therefore may not necessarily be representative of conditions closer to the abstraction.

3.8.2 The assessment in **Appendix F** shows that the macrophyte community on the Irwell in the vicinity of the sample site is adapted to moderate-low flow velocities but as noted above, this may not necessarily be representative of conditions at the abstraction. Surveys closer to the abstraction are therefore recommended. In addition, the potential for impacts on physical habitat parameters, which could in turn influence macrophyte communities, should be given more detailed consideration.

3.9 Fish

3.9.1 An understanding of the fish fauna within the lower reaches of the River Irwell is informed by 23 surveys undertaken at six sampling stations between 2003 and 2014 (recognising that the most recent is eight years ago and cannot be confirmed to be representative of current conditions). The available data suggest that the composition of fish in the River Irwell downstream of the proposed abstraction comprises coarse fish, predominantly species such as chub (*Squalius cephalus*), gudgeon (*Gobio gobio*) and minnow (*Phoxinus phoxinus*), which frequent the middle and lower reaches of the main channel (central course). These species are considered to have a 'medium' tolerance to environmental disturbance. Brown/sea trout (*Salmo truta*), which have a low tolerance to environmental disturbance, are recorded in the upper catchment but rarely in the lower reach of the river. European eel (*Anguilla Anguilla*), which are highly tolerant of disturbance, were not recorded in any of the surveys, however, are likely to be present in low density within the catchment. The lower reach lacks critical habitat for these species, but would serve as a migration route to the upper catchment.

3.9.2 There are three significant weirs in the lower reach of the River Irwell downstream of the proposed abstraction, at Ringley, Lower Kersal and Adelphi Street. Ringley weir is subject to a UU AMP7 investigation and will have a fish passage project in AMP8: liaison between project teams will therefore be required for this location. Below the confluence with the Manchester Ship Canal, water level is regulated by a series of locks with associated sluices and weirs.

3.9.3 The abstraction from the River Irwell, and resulting changes in hydrology and water quality, could result in impacts as set out in **Table 3.2**. These are described in more detail in **Appendix G**.

Table 3.2 Summary of potential impacts on fish

Type of impact	Commentary
Reduction in instream habitat.	The results of the walkover survey indicate limited critical habitat for cyprinid spawning and low occurrence of suitable marginal habitat for juveniles. However, reductions in depth and flow may impact the carrying capacity of this reach for adult fish. This would particularly be the case where reduction in flows over weirs may reduce optimal habitat that may be associated with weir pools during the summer months for adult fish, and spawning habitat that may be associated with the tails of the weir pool. The potential for changes to sediment deposition should also be considered. More extensive habitat surveys will be required to understand the potential impacts.
Impact on the passage of migratory species including European eel, brown/sea trout as well as potamodromous species that complete their migration entirely within the freshwater environment	Reductions in water level may reduce the current porosity of weirs to migrating fish, reducing connectivity between adjacent reaches and potentially reducing the efficacy of the fish pass installed on the left bank of the weir at Ringley. It is recommended that further assessment and modelling of the risk of modified flows to the efficacy of the fish pass at Ringley is undertaken.
Mortality or reduced viability as a result of changes in water quality (temperature, dissolved oxygen).	Water quality modifications may result in increased phytoplankton and epiphytic algal growth, which may influence spawning success of species such as bullhead and stone loach, as well as macroinvertebrate assemblage that provide food for fish. However, **Section 3.6** has shown that impacts on water quality are likely to be small, and are unlikely to result in deterioration of WFD status.
Changes in the overall biodiversity of both macroinvertebrate and the plant community that provide both food and shelter for fish.	See comments above relating to physical habitat availability and water quality.
Entrainment of drifting fish egg and larvae.	Eggs and larvae are vulnerable to entrainment from bankside raw water abstractions. Intake design should consider potential entrainment of aquatic biota at an early design stage. Additional survey information may be required to understand their density and the extent of suitable habitat at the potential point of abstraction.

3.10 Designated sites

3.10.1 A table of designated sites downstream of the proposed abstraction on the Irwell can be found in **Appendix H**, with a map showing their locations at **Figure 2.7**. Of these, the following sites have been identified as potentially having connectivity to the river:

- Woolston Eyes SSSI. This site consists of four large lagoons used for depositing dredgings from the Manchester Ship Canal, and is a nationally important site for its breeding bird assemblage of lowland open waters and their margins. The site lies in between the Manchester Ship Canal and River Mersey (into which the Irwell flows). The relationship between flows in the bounding watercourses and the wetlands should be further considered, although it is considered highly unlikely that the proportional changes in flow in the Irwell described above would result in any notable change to

water levels at this location, particularly since the Manchester Ship Canal is controlled by locks.

- Mersey Estuary SSSI, SPA and Ramsar. The River Irwell is connected to the Mersey Estuary via the River Mersey and the Manchester Ship Canal. Therefore, a reduction in flow in the River Irwell will result in some reduction in freshwater flow contribution to the Mersey Estuary. This is assessed further, in combination with other options, in the WFD Compliance Assessment and the HRA.

3.11 Conclusions and recommendations

3.11.1 The assessments in this section have shown that the abstraction associated with option WR015 would reduce flows in the River Irwell, by up to 11% at Q95, at the highest anticipated rates of abstraction. However, flows are supported in the catchment by discharges, which reduces the impact compared to natural flows, and the Environment Agency has indicated that there is water available for the abstraction. The assessment therefore indicates that, on the basis of flows alone, the abstraction is likely to be feasible, subject to consideration of any other relevant environmental constraints.

3.11.2 The proportional flow reductions have been considered in relation to other environmental factors, and it has been found that:

- Habitat downstream of the abstraction is likely to overall be relatively insensitive to changes in flow. However, this is only based on a limited reach, and surveys over a longer reach length are required;
- Resulting changes to water quality are likely to be very small, and not result in a change of WFD status of any parameters. However, risks of impeding future improvements require further assessment;
- The invertebrate communities appear to be relatively insensitive to changes in flow, although this assessment would be better informed by further habitat survey;
- Potential impacts on fish cannot be discounted without further consideration of habitat availability and impacts on the passability of downstream weirs.

3.11.3 On this basis, the following recommendations are made for further primary data collection:

- Further habitat surveys downstream of the abstraction including:
  - At the invertebrate sampling locations, with specific focus on the characteristics of the sample locations with respect to flow sensitivity;
  - To map fisheries habitat.
- Macroinvertebrate sampling should be restarted at the current location (67275), in the immediate vicinity of the abstraction, to bring the records up to date. This assumes that the habitat surveys confirm its location is suitable with regards to flow sensitivity: if that is found not to be the case, then an alternative location should be sought;
- eDNA survey, to improve characterisation of fish populations.

3.11.4 The following recommendations are made for further evidence collection and assessment:

- Rainfall-runoff models should be established for the proposed abstraction location, and used to consider the potential impacts on flow under a range of climatic conditions;
- The Environment Agency's SAGIS SIMCAT model for the North West River Basin District should be used, to provide a more refined assessment of impacts on water quality and of a range of flow and water quality scenarios.
- Further assessment of potential impacts on fish, including:
  - Assess risks to fish pass efficacy, in the first instance using the SNIFFER (2010) and ZSL (2008) rapid barrier assessment methodologies[12]. Liaise with AMP7 project team regarding fish passage at Ringley weir;
  - Consider hydraulic modelling, to improve the understanding of impacts on velocity and depth.
- Review of previous investigations and/or conceptualisations of Woolston Eyes SSSI, to ascertain likely sensitivity to changes in flow in the adjacent water bodies. This should be a high-level review, recognising that the likelihood of any observable impact on water levels in the river and ship canal is extremely low.
- Further assessment of the impact on flows to the Mersey Estuary and its relevant designated features, in combination with other relevant options within the NWT scheme.

[12] *WFD111 Phase 2a Coarse resolution rapid assessment methodology to assess obstacles to fish migration*. Sniffer, 2010. https://www.sniffer.org.uk/wfd111-phase-2a-fish-obstacles-manual-pdf
ZSL (2018) *A Field Guide for Assessing the Passability of Man-Made River Structures by European Eels*. https://www.zsl.org/sites/default/files/media/2019-03/ZSL_EelBarrierAssessmentTool_Final_0.pdf

4. Assessment of impact of WR049d (River Ribble)

4.1 Option description

4.1.1 [✂]

4.1.2 The assessment in this report focusses on the potential impacts of the proposed new abstraction. Impacts on other components of the option, including both construction and operation, will be considered in the separate overarching assessment reports.

4.2 Waterbody Status

4.2.1 The WR049d surface water abstraction is located in the Ribble – conf Calder to tidal WFD surface water body; there are no WFD waterbodies downstream of this location. The water body is classed as heavily modified. The current WFD status of the water body is summarised in **Table 4.1** (with more detail available in **Appendix I**). The water body is at Moderate Ecological Potential and failing chemical status. For ecological elements, fish and macrophytes/phytobenthos are both classified at Moderate. For physico-chemical parameters, Phosphate is classified as Medium, while other elements are High.

4.2.2 Reasons for failure include diffuse source pollution (agriculture and rural land management), sewage discharges and misconnections (domestic general public, urban and transport and water industry). Physical modification is also listed but with details pending. River flows are not listed as a reason for failure.

Table 4.1 WFD dependent surface water body screening*: Surface water option WR049d

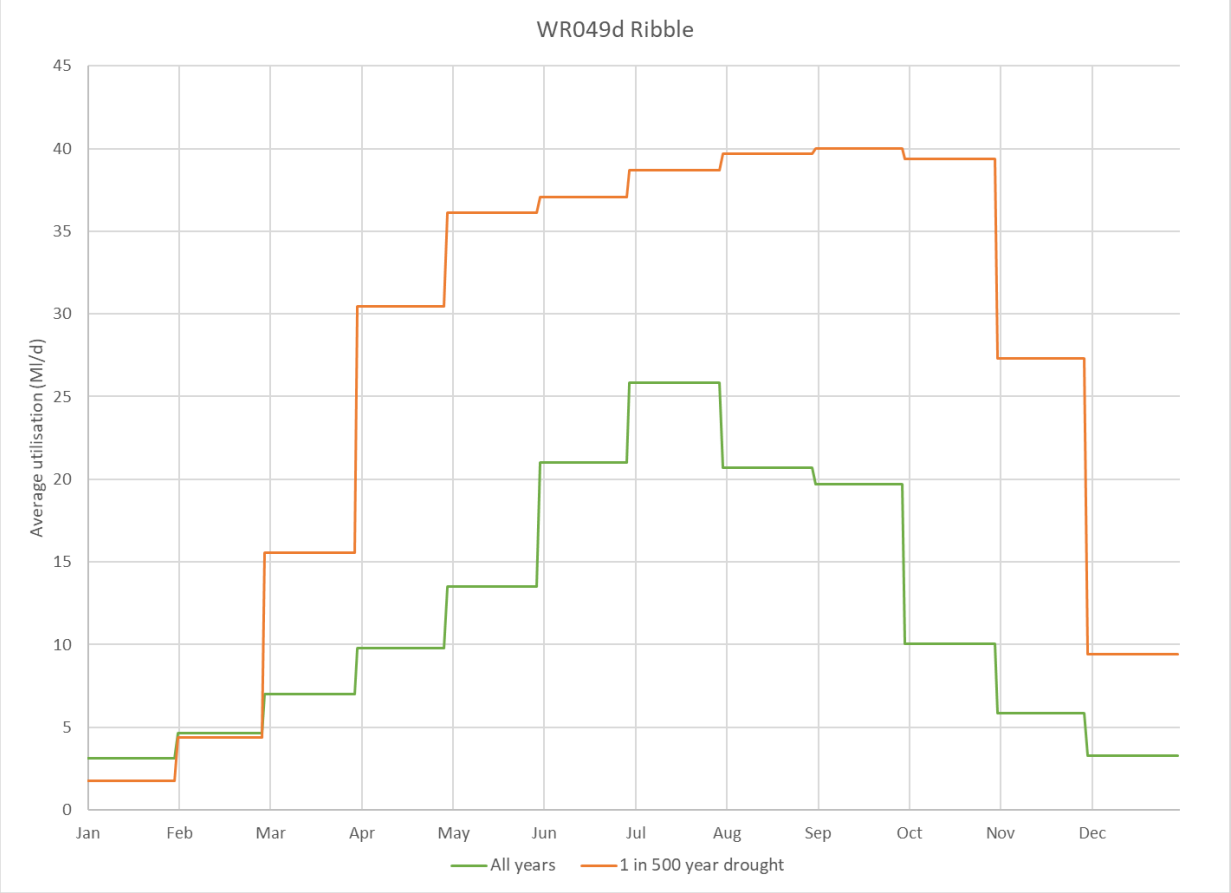
Water body	Ecological status	Biological quality	Physico-chemical quality	Hydromorphological	Chemical
Ribble – conf Calder to tidal GB112071065500	Moderate	Moderate	Moderate	Supports good	Fail (Mercury, PBDE)

* Based on Catchment Data Explorer data from https://environment.data.gov.uk/catchment-planning/ accessed 20/06/2022. 2019 classification. RNAG Reasons for Not Achieving Good; PBDE Polybrominated diphenyl ethers; PFOS Perfluorooctane sulphonate.

4.3 Anticipated utilisation

4.3.1 The anticipated utilisation of option WR049d, as provided from UU's water resource modelling, is presented in **Figure 4.1**. The option has a maximum capacity of 40 Ml/d. **Figure 4.1** shows that with the 'all years' abstraction scenario, the rate of abstraction would peak in summer at 26 Ml/d, with a minimum of 3 Ml/d in winter. For the '1 in 500 year drought' abstraction scenario, use of the option would be sustained at a higher rate through the summer and early autumn, reaching the maximum rate in August.

Figure 4.1 Modelled utilisation of option WR049d



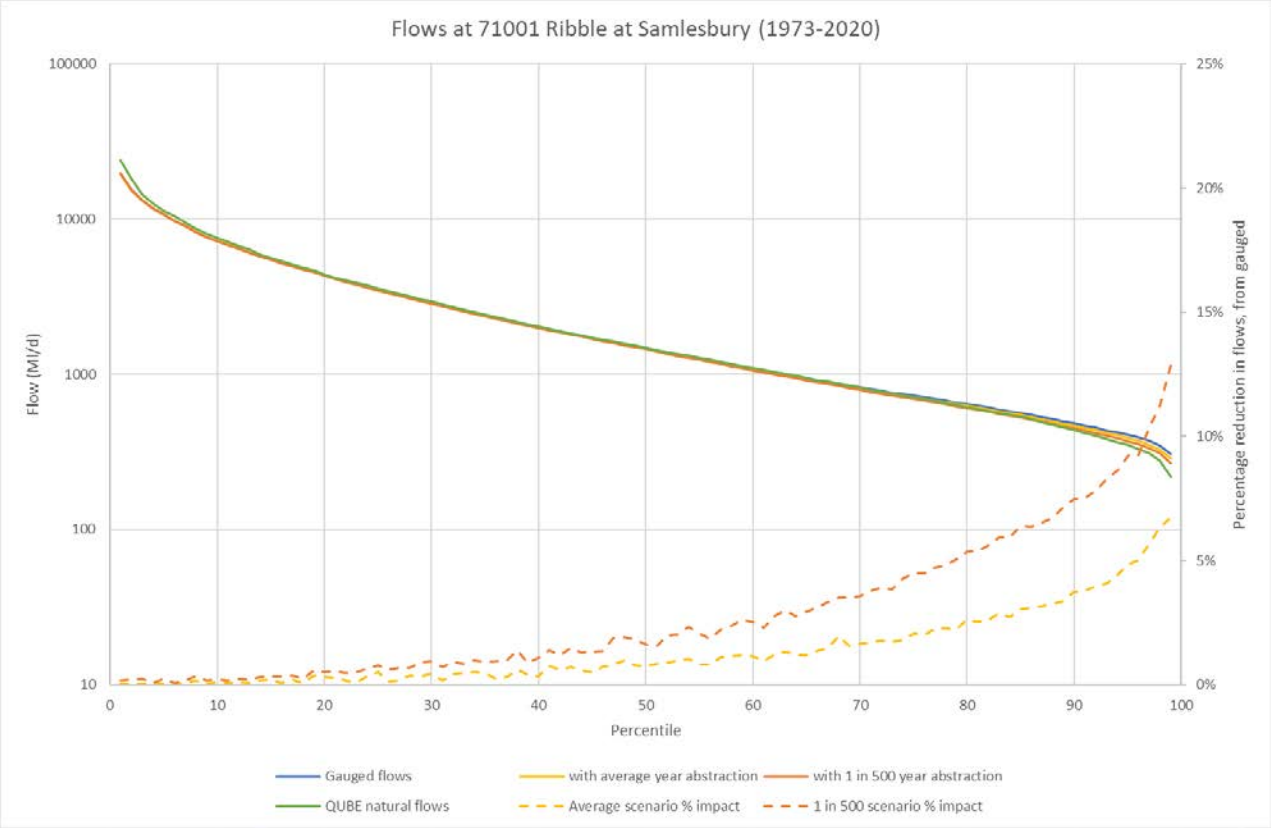
4.4 Assessment of impacts on river flows

4.4.1 [✂]

4.4.2 **Appendix B** shows that the impacts on flow at Q95 would be less than 5% for the 'all years' utilisation scenario, and 9.2% for the 1 in 500 utilisation scenario. This is illustrated in **Figure 4.2**.

4.4.3 Based on the HOF in the 2013 ALS (recognising this is being updated), abstraction would be allowed for the vast majority of the time, but may be constrained at the lowest flows. As the Environment Agency has confirmed that water is available in the Ribble at Q95, it is likely that any constraints will continue to only affect the lowest flows. The current assessment therefore indicates that, on the basis of flows alone, the abstraction is likely to be feasible.

Figure 4.2 Impact of WR049d on flows in the River Ribble at abstraction location



4.5 Geomorphology and habitat

4.5.1 **Appendix C** (Section 2.1) presents the results of the walkover survey in May 2022, when a reach downstream of WR049d was visited.

4.5.2 At the location visited, the channel width was around 35m wide, with steep bank faces. Overall, the reach appeared stable, with only minor natural bank adjustments via localised erosion/deposition underway. Assumed historical channel management and the effect of high-flows backing up due to the nearby tidal limit in addition to coarse mobile bed material, has led to minimal in-channel vegetation. Overall, the reach visited was considered to be relatively insensitive to flow changes. Significant changes in flow may be needed to alter the degree of wetted/exposed channel bed even at the riffle locations, which are judged to be the most sensitive to changes in flow. However, more extensive surveys would allow a more confident assessment.

4.6 Water quality

4.6.1 Water quality assessments have been undertaken at relevant locations downstream of the proposed abstraction on the Ribble, including Environment Agency monitoring locations which also coincide with the WwTW at Walton le Dale. This WwTW is in the tidal reach of the Ribble, and is therefore subject to tidal influences as well as freshwater flows.

4.6.2 The assessment in **Appendix D** considers the baseline relationships between water quality and flow in the Ribble. The assessment notes a tendency for orthophosphate

concentrations to be higher in summer than winter, whereas nitrates tend to be lower in summer.

4.6.3 Assessments calculating the impact of the predicted changes to flows on dilution suggest that there would be only a very small change in concentrations. The current WFD classifications for the Ribble (conf. Calder to tidal) have ammonia at High, BOD at High and Phosphate at Moderate. Comparison of the baseline and predicted concentrations demonstrates that the abstraction would be unlikely to result in a change in status at any of the sample points. Similarly, there is a low risk of EQS exceedance of Priority Substances occurring as a result of reduced flows associated with the proposed abstraction.

4.6.4 The risk to water quality in the context of deterioration of WFD status is considered to be very low. However, it is recognised that the assessment approach does not allow consideration of the risk of impeding future improvements (i.e. reducing the dilution available to support any future water quality improvements in the catchment). The Environment Agency has expressed concerns about option WR049d from a water quality perspective, relating to Combined Sewer Overflows. In order to address this, a more detailed assessment is proposed, using the Environment Agency's SAGIS SIMCAT model for the North West River Basin District.

4.7 Macroinvertebrates

4.7.1 The assessment has used historic Environment Agency data at site 64957, on the River Ribble [✂]. The survey site is well located to inform the assessment of potential impacts of abstraction.

4.7.2 Invertebrates in the Ribble (conf Calder to tidal water body) are classified as Good, and this is demonstrated in the historic data, which shows little evidence of pressures in the WHPT-ASPT, WHPT-NTAXA or PSI data. In contrast, the assessment in **Appendix E** shows highly variable LIFE scores, although they do not appear to be related to changes to flows. Further interrogation of site characteristics will be required to understand this, which could be achieved through further habitat surveys. Based on the current information, it appears unlikely that a reduction in flow associated with the abstraction would have an observable impact on the macroinvertebrate communities.

4.8 Macrophytes

4.8.1 There is an established macrophyte survey location [✂], although it has not been surveyed since 2013. The assessment in **Appendix F** indicates that the macrophyte community is adapted to moderate flow velocities, and as such, it could potentially be influenced by flow regime change. The modest predicted flow reductions are likely to have a relatively minor impact on physical habitat availability (i.e. flow velocities, wetted width and water depth). However, there would be a benefit to collecting up to date survey data, and giving more detailed consideration to physical habitat availability, to provide improved certainty.

4.9 Fish

4.9.1 There is a paucity of fish survey data within the main channel of the lower River Ribble. Historic Environment Agency records (1994) show fish populations in the lower reaches around Samlesbury comprising predominantly coarse fish with a 'moderate' to 'high' tolerance of environmental pressures such as barbel (*Barbus barbus*), chub, dace, gudgeon (*Leuciscus leuciscus*) and roach (*Rutilus rutilus*). Further up the catchment, salmonids with a low tolerance to environmental disturbance dominate including Atlantic salmon (*Salmo salar*), sea and brown trout, grayling (*Thymallus thymallus*), along with rheophilic fish such as chub and gudgeon, stone loach (*Barbatula barbatula*) and bullhead (*Cottus gobio*). European eel is also common. In the estuary, smelt (*Osmeridae*) are found.

4.9.2 There are few areas of critical habitat for salmonids in the lower reaches of the Ribble, instead this river reach serves as a migratory pathway, with adults migrating upstream to spawn from March – October and juveniles (smolts) migrating downstream to the sea between April and June.

4.9.3 There are no weirs downstream of the proposed abstraction location. The Ribble Rivers Trust recently removed a redundant weir from the river at Samlesbury, which was approximately 1km upstream from the proposed abstraction location.

4.9.4 The abstraction from the River Ribble, and resulting changes in hydrology and water quality, could result in impacts as set out in **Table 4.2**. These are described in more detail in **Appendix G**.

Table 4.2 Summary of potential impacts on fish

Type of impact	Commentary
Decreased flow and velocity that may impact upon the upstream/downstream migration of salmonids and European eel.	Further analysis is recommended the impact of the predicted flow reductions on flow velocity and depth, and therefore indirectly to fisheries habitat and the extent of saline ingress. A further study is required to predict the likely impact that a reduction in freshwater flow to the estuary may have on returning migrants, with fluvial flow to the estuary considered a primary factor controlling entry of salmonids into freshwater.
Reduction in water quality that could directly influence fish migration into the River Ribble.	The assessment in **Section 4.6** has indicated that only very small changes in water quality are likely to result from reduced dilution, which are unlikely to result in deterioration of WFD status. Water temperature may require further consideration, in terms of the impact of lower flows and/or shallower water depths, since water temperature may modify the return migration of salmon.

4.10 Designated sites

4.10.1 A table of designated sites downstream of the proposed abstraction on the Ribble can be found in **Appendix H**, with a map showing their locations at **Figure 2.7**. Of these, the following sites have been identified as potentially having connectivity to the river:

- Ribble Estuary SSSI, and the Ribble and Alt Estuaries SPA and Ramsar. A reduction in flow in the River Ribble will result in some reduction in freshwater flow contribution to the Ribble Estuary. This is assessed further, in combination with other options, in the WFD Compliance Assessment and the HRA.

4.10.2 The Ribble Estuary is also designated as a Marine Conservation Zone (MCZ) (**not shown on Figure 2.7**), due to the habitat it provides for smelt (*Osmerus eperlanus*). This will be included in further assessment of impacts on fisheries beyond Gate 2, as discussed in more detail in **Appendix G**.

4.10.3 The abstraction location is in close proximity to Brockholes Local Nature Reserve, managed by Lancashire Wildlife Trust. Any potential impacts on this site will be considered in future stages of assessment.

4.11 Conclusions and recommendations

4.11.1 The assessments in this section have shown that the abstraction associated with option WR049d would reduce flows in the River Ribble by less than 10% at Q95, even at the highest anticipated rates of abstraction. The Environment Agency has indicated, following a recent review of the Ribble CAMS ledger, there is water available for the abstraction. The assessment therefore indicates that, on the basis of flows alone, the abstraction is likely to be feasible, subject to consideration of any other relevant environmental constraints.

4.11.2 The proportional flow reductions have been considered in relation to other environmental factors, and it has been found that:

- Habitat downstream of the abstraction is likely to overall be relatively insensitive to changes in flow. However, this is only based on a limited reach, and surveys over a longer reach length are required;
- Resulting changes to water quality are likely to be very small, and not result in a change of WFD status of any parameters. However, potential risks of impeding future improvements require further assessment;
- The invertebrate communities show fluctuations in LIFE scores (which are generally used to indicate flow stress), but those fluctuations do not appear to be related to flow. While it appears unlikely that a reduction in flow associated with the abstraction would have an observable impact on the macroinvertebrate communities, this would be better informed by review of the sampling site characteristics, and wider habitat survey;
- Potential impacts on fish cannot be discounted without further consideration of impacts of reduced flow and any resulting impacts on temperature on salmonid migration from the estuary into freshwater.

4.11.3 On this basis, the following recommendations are made for further primary data collection:

- Further habitat surveys downstream of the abstraction including:
  - At the invertebrate sampling locations, with specific focus on the characteristics of the sample locations with respect to flow sensitivity;

    - To map fisheries habitat.
- Macroinvertebrate sampling should be continued at the current location (64957), to bring the records up to date (assuming that the habitat surveys confirm its location is suitable with regards to flow sensitivity).
- eDNA survey, to improve characterisation of fish populations.

4.11.4 The following recommendations are made for further evidence collection and assessment:

- Rainfall-runoff models should be established for the proposed abstraction location, and used to consider the potential impacts on flow under a range of climatic conditions.
- The Environment Agency's SAGIS SIMCAT model for the North West River Basin District should be used, to provide a more refined assessment of impacts on water quality, with a range of flow and water quality scenarios.
- Further assessment of potential impacts on fish, including:
    - Consider hydraulic modelling, to improve the understanding of impacts on velocity and depth;
    - Desk study of potential impacts of reduced flow or increased temperature on salmonid or smelt migration (including liaison with other research projects in to smelt spawning habitats in the Ribble, as appropriate).
- Further assessment of the impact on flows to the Ribble Estuary and its relevant designated features, in combination with the other relevant options within the NWT scheme.

5. Assessment of impact of WR076 (River Bollin)

5.1 Option description

5.1.1 [✂]

5.1.2 The assessment in this report focusses on the potential impacts of the proposed new abstraction. Impacts on other components of the option, including both construction and operation, will be considered in the separate overarching assessment reports.

5.2 Waterbody Status

5.2.1 The WR076 surface water abstraction is located in the Bollin (Ashley Mill to Manchester Ship Canal) WFD surface water body which flows into the downstream Manchester Ship Canal and Mersey (Bollin confluence to Howley Weir) WFD surface water bodies. Upstream of the Bollin confluence, the Mersey and Manchester Ship Canal are combined, but they separate again at the same location as the Bollin confluence (the Bollin enters on the left bank of the canal, while the Mersey flows out from the right bank). Therefore, flow from the Bollin may contribute to both downstream water bodies.

5.2.2 The Bollin and Mersey are both classed as heavily modified (although it is understood that the heavily modified designation will be removed from the Bollin for the 3rd cycle River Basin Management Plans (Environment Agency, pers. comm.)). The Manchester Ship Canal is classified as artificial in its hydromorphological designation. The current WFD status of all water bodies is summarised in **Table 3.1** (with more detail available in **Appendix I**). All water bodies are at Moderate Ecological Potential, and failing chemical status.

- For the Bolin (Ashley Mill to Manchester Ship Canal), fish and invertebrates are both classified, with the former Poor and the latter Good. For physico-chemical parameters, Phosphate is Poor, while other parameters are Good or High.
- For the Mersey (Bollin confluence to Howley Weir), fish and macrophytes/ phytobenthos are both classified, with the former Bad and the latter Good. For physico-chemical elements, failing parameters include ammonia (Moderate), DO (Moderate) and phosphate (Poor).
- For the Manchester Ship Canal, the overall potential is Medium based on mitigation measures assessment, but there are no individually classified biological or physico-chemical elements.

5.2.3 For all waterbodies, reasons in common for failure include diffuse source pollution and point sewage discharge. Landfill leaching is listed as an additional reason in the Manchester Ship Canal water body. Physical modification is also listed but with details pending except for the Mersey water body which is due to changes relating to flood protection and urban development. River flows are not listed as a reason for failure on any water body.

Table 5.1 WFD dependent surface water body screening*: Surface water option WR076

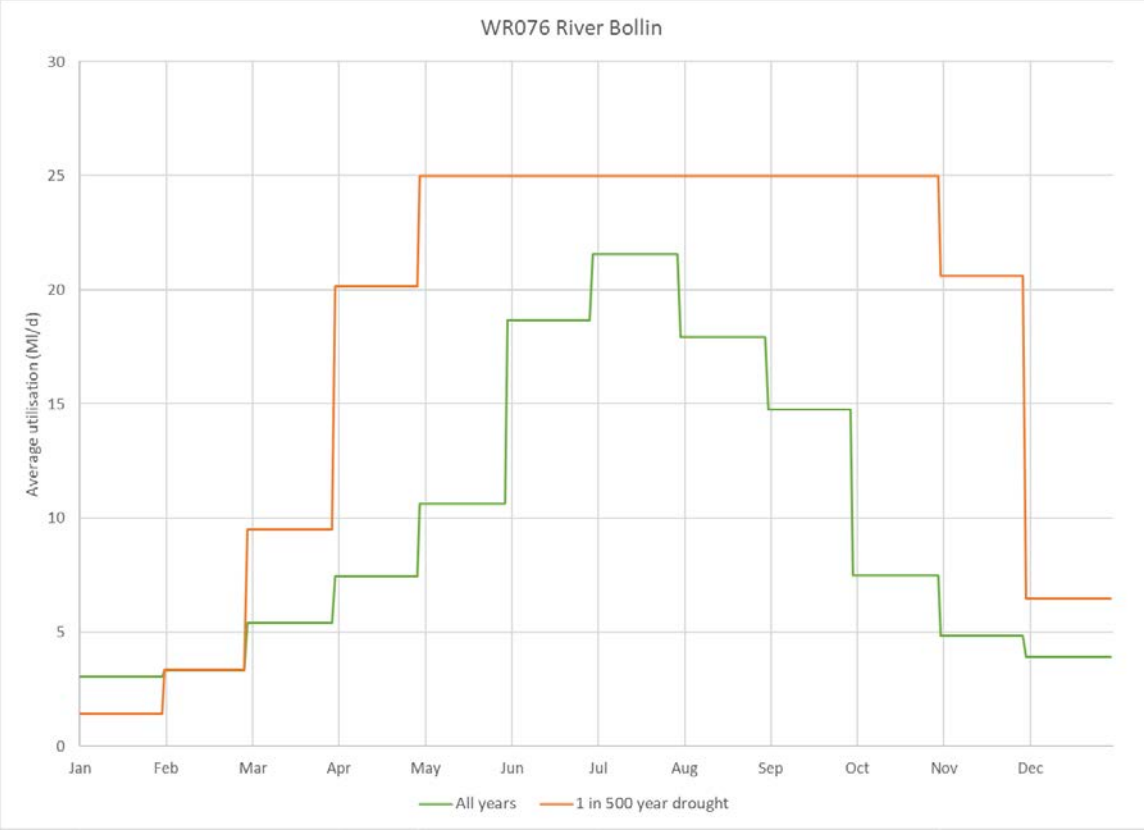
Water body	Ecological status	Biological quality	Physico- chemical quality	Hydro-morphological	Chemical
Bollin (Ashley Mill to Manchester Ship Canal) GB112069061382	Moderate	Poor (due to Fish)	Moderate	Supports good	Fail (Mercury, PBDE)
Mersey (Bollin confluence to Howley Weir) GB112069061012	Moderate	Bad (due to invertebrates)	Moderate	Supports good	Fail (Benzo(g-h-i)perylene, Mercury, PFOS, PBDE, Tributyltin compounds)
Manchester Ship Canal GB71210004	Moderate	-	-	-	Fail (Mercury, PBDE, Tributyltin compounds)

* Based on Catchment Data Explorer data from https://environment.data.gov.uk/catchment-planning/ accessed 20/06/2022. 2019 classification. RNAG Reasons for Not Achieving Good; PBDE Polybrominated diphenyl ethers; PFOS Perfluorooctane sulphonate.

5.3 Anticipated utilisation

5.3.1 The anticipated utilisation of option WR076, as provided from UU's water resource modelling, is presented in **Figure 5.1**. The option has a maximum capacity of 25 Ml/d. **Figure 5.1** shows that with the 'all years' abstraction scenario, the rate of abstraction would peak in July at 22 Ml/d, with a minimum of 3 Ml/d in winter. With the '1 in 500 year drought' abstraction scenario, use of the option would be sustained at the maximum rate of 25 Ml/d for a sustained period through spring, summer and early autumn.

Figure 5.1 Modelled utilisation of option WR076



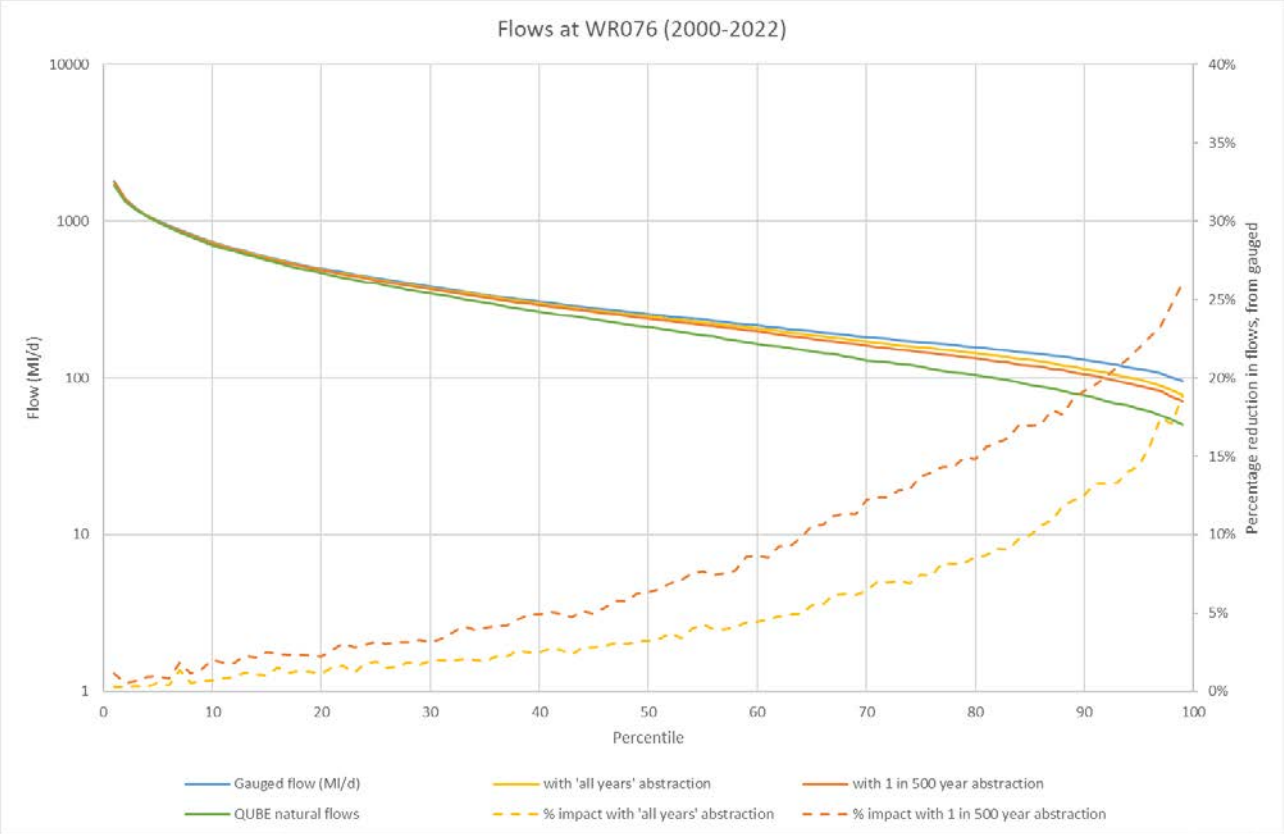
5.4 Assessment of impact on river flows

5.4.1 [✂]. Flow impact assessments are based on gauged flow records at NRFA gauge 69045 (Bollin at Bollington Mill).

5.4.2 The assessment in **Appendix B** shows that impacts on flow may exceed 10% downstream of the abstraction location, at low flows. The impacts at Q95 are predicted to be a 14% reduction from gauged in the 'all years' utilisation scenario, and a 22% reduction in the 1 in 500 year scenario. This is illustrated in **Figure 5.2**.

5.4.3 The catchment is discharge-rich, with low flows being above natural, and the draft Upper Mersey ALS (Environment Agency, 2021) indicates that there is water available for abstraction at the proposed rate. Therefore, on the basis of flows alone the assessment indicates that the abstraction is likely to be feasible. A Minimum Residual Flow (MRF) requirement is likely, probably affecting only a small number of days, but would need to take account of ecological and/or water quality considerations (as discussed in the remainder of this chapter).

Figure 5.2 Impacts of WR076 on flow in the River Bollin at abstraction location



5.5 Geomorphology and habitat

5.5.1 **Appendix C** Section 2.9) presents the results of the walkover survey in May 2022, when a reach downstream of WR076 was visited.

5.5.2 At the location visited, the channel width was approximately 8m wide, and bank faces were generally steep. Surrounding land use is heavily managed (arable). The river appeared stable with some areas of reinforcement, and few areas of exposed earth or depositional features. Both banks appeared fairly homogenous. The water surface profile was mainly smooth glides, with areas of minor upwelling. Overall, the reach visited was considered to be relatively insensitive to flow changes, with a deep channel and no deposition features observed. However, further surveys should be carried out along downstream reaches, to confirm if this is characteristic.

5.6 Water quality

5.6.1 The water quality assessment for the Bollin can be found in **Appendix D**. The main mechanism by which reduced flows may impact water quality is by providing reduced dilution of discharges entering the river downstream. There are no WwTWs downstream of the proposed abstraction location on the Bollin, and therefore there is limited potential to impact water quality. However, on a precautionary basis, a 'worst case' assessment has been carried out, assessing a reduction in flow against the same loading as in the baseline. This has used an Environment Agency water quality monitoring location in close proximity to the proposed abstraction location.

5.6.2 The assessment in **Appendix D** considers the baseline relationships between water quality and flow in the Bollin. The assessment notes a tendency for orthophosphate concentrations to be higher in summer than winter, whereas BOD tend to be lower in summer. Concentrations of pollutants are generally similar between the Bollin and the downstream Mersey, although the Environment Agency has commented that the Bollin provides water of relatively high DO into the Mersey.

5.6.3 Assessments calculating the impact of the predicted changes to flows on dilution suggest that there would be only a very small change in concentrations. The current WFD classifications for the Bollin (Ashley Mill to Manchester Ship Canal) have ammonia at Good, BOD at Good and Phosphate at Poor. The chemical status includes failures for benzo (g-h-j) perylene, mercury, PFOS, PDBE and tributyltin. Comparison of the baseline and predicted concentrations of physico-chemical parameters indicates that the abstraction would be unlikely to result in a change in status on either the Bollin or the downstream Mersey.

5.6.4 The risk to water quality in the context of deterioration of WFD status is considered to be very low, particularly as there are no WwTWs on the Bollin downstream of the proposed abstraction location. However, the assessment approach does not allow consideration of the risk of impeding future improvements. (i.e. reducing the dilution available in relation to future water quality improvements in the catchment). It is also recognised that the downstream catchment of the lower Mersey and Manchester Ship Canal is a complex system, the details of which are not captured by the simple calculations carried out to date. The Environment Agency has expressed concern about reducing inputs of flow from the Bollin, which has relatively high DO, into the Manchester Ship Canal. Therefore, a more comprehensive assessment is recommended, using the Environment Agency's PR24 SAGIS SIMCAT model for the North West River Basin District, and UU's in-house modelling of the Manchester Ship Canal.

5.7 Macroinvertebrates

5.7.1 The assessment has used historic Environment Agency data at site 69696, on the River Bollin at the proposed abstraction location. The survey site is well located to inform the assessment of potential impacts of abstraction, and has data available up to 2021.

5.7.2 Overall, the macroinvertebrate data presented in **Appendix E** suggest that there has been an improvement in water quality, and potentially habitat, over the last 10 years. The LIFE and PSI scores are reasonably consistent over the same period and do not indicate presence of flow or sediment stress. This apparent lack of flow stress, even during low flow years, suggests that there is limited potential for the proposed option WR076 to adversely affect the invertebrate community.

5.7.3 It is noted, however, that the macroinvertebrate data do not extend back to the mid-1990s drought period, where stress in macroinvertebrate communities is most often observed (at other sites across the country). Monitoring should be continued at the current site, to continue capturing a range of hydrological conditions, with current catchment pressures.

5.8 Macrophytes

5.8.1 There is a macrophyte sample location in close proximity to the proposed abstraction location, which has seven surveys in total, including recent (2021) data.

5.8.2 The assessment in **Appendix F** indicates that the macrophyte community is adapted to moderate flow velocities, and as such, it could potentially be influenced by flow regime changes. The river in the vicinity of the abstraction is canalised and likely to have low sensitivity to changes in flow, in terms of impacts on wetted width and depth. However, considering the relatively substantial impacts on flow, the potential for impacts on physical habitat parameters should be given more detailed consideration.

5.9 Fish

5.9.1 As described in **Appendix G**, the available data suggest that the composition of fish in the River Bollin downstream of the proposed abstraction comprises coarse fish, predominantly rheophilic species such as chub, dace and gudgeon which are common to the middle and lower reaches of the main channel. These species are considered to have a 'medium' tolerance to environmental disturbance. Roach were also common, which are considered to have a 'high' tolerance to environmental disturbance. Brown/sea trout are recorded in the upper catchment but rarely in the lower reaches of the river. Migratory species include both Atlantic salmon and European eel. Like brown/sea trout, Atlantic salmon have a low tolerance to environmental disturbance. Eel can accommodate a high level of disturbance.

5.9.2 A single weir, Heatley Weir, lies downstream between the proposed abstraction and the confluence with the Manchester Ship Canal/ River Mersey. Fish passes have been installed adjacent to each bank to facilitate upstream fish passage past the weir. In the Manchester Ship Canal and River Mersey, water level is regulated by a series of locks with associated sluices and weirs.

5.9.3 The abstraction from the River Bollin, and resulting changes in hydrology and water quality, could result in impacts as set out in **Table 5.2**. These are described in more detail in **Appendix G**.

Table 5.2 Summary of potential impacts on fish

Type of impact	Commentary
Reduction in instream habitat.	The channel downstream of the proposed abstraction is meandering with several mature meanders, but with steep banks. The latter suggests that any reduction in water level resulting from abstraction would not significantly reduce marginal habitat, whilst reduction in flow will likely increase flow habitat for juvenile coarse fish. However, reductions in flow velocity and depth may reduce cover/ refuge and optimal flow habitat for adult fish. The potential for changes to sediment deposition should also be considered. There is currently insufficient data available on potential changes to both velocity and depth in this reach to determine an effect on adult populations, and hydraulic modelling may be beneficial to provide more detail. This should be carried out in conjunction with more extensive habitat surveys.

Type of impact	Commentary
Impact on the passage of migratory species including Atlantic Salmon, European eel, brown/sea trout as well as potamodromous species that complete their migration entirely within the freshwater environment	Reductions in water level may reduce the current porosity of weirs to migrating fish, reducing connectivity between adjacent reaches and potentially reducing the efficacy of the fish pass installed on the weir at Heatley It is recommended that further assessment and modelling of the risk of modified flows to the efficacy of the fish pass at Heatley is undertaken.
Mortality or reduced viability as a result of changes in water quality (temperature, dissolved oxygen).	Water quality modifications may result in increased phytoplankton and epiphytic algal growth, which may influence spawning success of species such as bullhead and stone loach, as well as macroinvertebrate assemblage that provide food for fish. However, **Section 5.6** has shown that impacts on water quality are likely to be small, and are unlikely to result in deterioration of WFD status. Water temperature may require further consideration, in terms of the impact of lower flows and/or shallower water depths, since water temperature may modify the return migration of salmon.
Changes in the overall biodiversity of both macroinvertebrate and the plant community that provide both food and shelter for fish.	See comments above relating to physical habitat availability and water quality.
Entrainment of drifting fish egg and larvae.	The river is impounded upstream of Heatley Weir, which is likely to support species such as roach and perch, and provide optimal habitat for juvenile fish. These latter are vulnerable to entrainment from bankside raw water abstractions. Intake design should consider potential entrainment of aquatic biota at an early design stage. Additional survey information may be required to understand the density of juvenile fish and the extent of suitable habitat at the potential point of abstraction.

5.10 Designated sites

5.10.1 A table of designated sites downstream of the proposed abstraction on the Bollin can be found in **Appendix H**, with a map showing their locations at **Figure 2.7**. Of these, the following sites have been identified as potentially having connectivity to the river:

- Woolston Eyes SSSI. This site consists of four large lagoons used for depositing dredgings from the Manchester Ship Canal, and is a [✂] site for its breeding bird assemblage of lowland open waters and their margins. The site lies in between the Manchester Ship Canal and River Mersey, downstream of the Bollin confluence. The relationship between flows in the bounding watercourses and the wetlands should be further considered, although it is highly unlikely that the proportional changes in flow in the Bollin described above would result in any notable change to water levels at this location, particularly since the Manchester Ship Canal is controlled by locks.
- Mersey Estuary SSSI, SPA and Ramsar. The River Bollin is connected to the Mersey Estuary via the River Mersey and the Manchester Ship Canal. Therefore, a reduction in flow in the River Bollin will result in some reduction in freshwater flow contribution to the Mersey Estuary. This is assessed further, in combination with other options, in the WFD Compliance Assessment and the HRA.

5.11 Conclusions and recommendations

5.11.1 The assessments in this section have shown that the abstraction associated with option WR076 would reduce flows in the River Bollin, by more than 10% at low flows (up to 14% at Q95 for the 'all years' utilisation scenario, and 22% for the 1 in 500 year utilisation profile). Flows are supported in the catchment by discharges, which reduces the impact compared to natural flows, and the assessment therefore indicates that, on the basis of flows alone, the abstraction is likely to be feasible. However, further discussion with the Environment Agency is required to establish whether a HOF would be required, subject to consideration of any other relevant environmental constraints.

5.11.2 The proportional flow reductions have been considered in relation to other environmental factors, and it has been found that:

- Habitat downstream of the abstraction is likely to overall be relatively insensitive to changes in flow. However, this is only based on a limited reach, and surveys over a longer reach length are required;
- Resulting changes to water quality are likely to be very small, and not result in a change of WFD status of any parameters. However, risks of impeding future improvements require further assessment;
- The invertebrate communities in the available data do not appear to exhibit flow stress, suggesting limited potential for reduced flows to adversely affect the invertebrate community;
- Potential impacts on fish cannot be discounted without further consideration of habitat availability and impacts on the passability of downstream weirs.

5.11.3 On this basis, the following recommendations are made for further primary data collection:

- Further habitat surveys downstream of the abstraction including:
  - At the invertebrate sampling locations, with specific focus on the characteristics of the sample locations with respect to flow sensitivity;
  - To map fisheries habitat.
- Macroinvertebrate sampling should be continued at the current location (69696), to continue to keep the record up to date.
- eDNA survey, to improve characterisation of fish populations.

5.11.4 And the following recommendations are made for further evidence collection and assessment:

- Rainfall-runoff models should be established for the proposed abstraction location, and used to consider the potential impacts on flow under a range of climatic conditions.
- The Environment Agency's PR24 SAGIS SIMCAT model for the North West River Basin District, and UU's in-house model of the Manchester Ship Canal, should be used to

provide a more refined assessment of impacts on water quality and of a range of flow and water quality scenarios.

- Further assessment of potential impacts on fish, including:
  - Assess risks to fish pass efficacy, in the first instance using the SNIFFER (2010) and ZSL (2008) rapid barrier assessment methodologies;
  - Consider hydraulic modelling, to improve the understanding of impacts on velocity and depth.
- Review of previous investigations and/or conceptualisations of Woolston Eyes SSSI, to ascertain likely sensitivity to changes in flow in the adjacent water bodies. This should be a high-level review, recognising that the likelihood of any observable impact on water levels in the river and ship canal is extremely low.
- Further assessment of the impact on flows to the Mersey Estuary and its relevant designated features, in combination with the other relevant options within the NWT scheme.

6. Assessment of impact of WR144 (River Tame)

6.1 Option description

6.1.1 [✂]

6.1.2 The assessment in this report focusses on the potential impacts of the proposed new abstraction. Impacts on other components of the option, including both construction and operation, will be considered in the separate overarching assessment reports.

6.2 Waterbody Status

6.2.1 The WR144 surface water abstraction is located on the River Tame, in the Tame (Chew Brook to Swineshaw Brook WFD surface water body. This flows in to the Tame (Swineshaw Brook to Mersey) water body. Both water bodies are classed as heavily modified. The current WFD status of the water body is summarised in **Table 3.1** (with more detail available in **Appendix I**). The water body is at Moderate Ecological Potential, with failing chemical status. For both water bodies, invertebrates are classified as Moderate, with Fish (Poor) and macrophytes/phytobenthos (Moderate) also failing for the Tame (Swinshaw Brook to Mersey) water body. For physico-chemical parameters, phosphate is Poor for both water bodies, with and ammonia Moderate for the Tame (Chew Brook to Swineshaw Brook) water body, with other parameters at Good or High.

6.2.2 Reasons for failure include point sewage discharges. River flows are not listed as a reason for failure. For the downstream water body, additional reasons for failure include physical modification (barriers) and diffuse source pollution.

Table 6.1 WFD dependent surface water body screening*: Surface water option WR144

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydro-morphological	Chemical
Tame (Chew Brook to Swineshaw Brook) GB112069061111	Moderate	Moderate	Moderate	-	Fail (Mercury, PFOS, PBDE)
Tame (Swineshaw Brook to Mersey) GB112069061112	Moderate	Poor	Moderate	Supports Good	Fail (Mercury, PFOS, PBDE, cypermethrin)

* Based on Catchment Data Explorer data from https://environment.data.gov.uk/catchment-planning/ accessed 20/06/2022. 2019 classification. RNAG Reasons for Not Achieving Good; PBDE Polybrominated diphenyl ethers; PFOS Perfluorooctane sulphonate.

6.3 Anticipated utilisation

6.3.1 The anticipated utilisation of option WR144 is presented in **Figure 6.1**. The option has a maximum capacity of 5 Ml/d. This option is not included in the NWT Full Solution, and hence there is no utilisation profile specifically for this option. UU has advised that utilisation would be most likely to be similar to WR111, Woodford borehole. The WR111 profile, scaled to a 5 Ml/d maximum abstraction, is presented for WR144 in **Figure 6.1**.

6.3.2 **Figure 6.1** shows that the maximum abstraction rate would be reached in both the 'all years' abstraction scenario and the '1 in 500 year' abstraction scenario. The period for which this would be sustained is much longer in the '1 in 500 year' scenario, with the potential to extend from May all the way to the end of the year.

Figure 6.1 Modelled utilisation of option WR144

6.4 Assessment of impacts on river flow

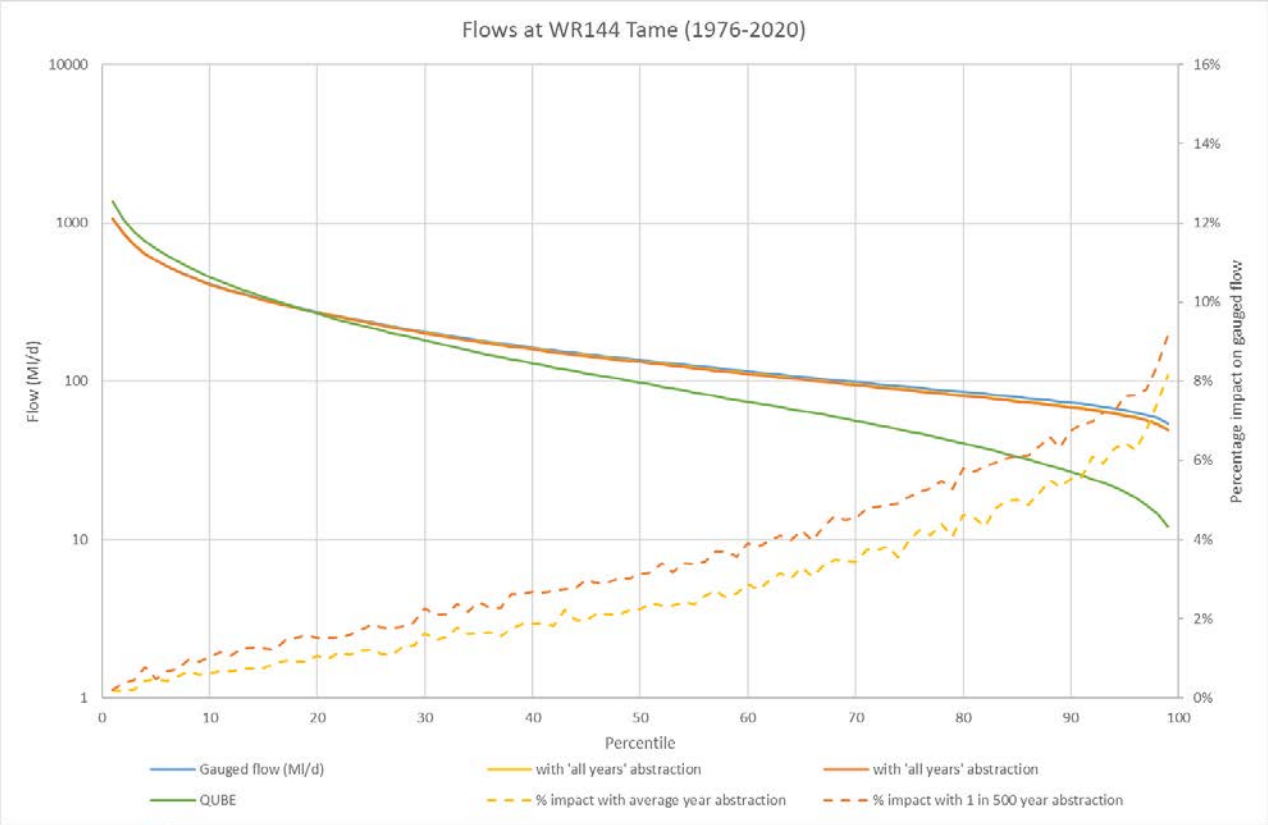
6.4.1 The proposed abstraction would have an impact on flows in the River Tame, [✂]. Flow impact assessments are based on gauged flow records at NRFA gauges:

- 69041 (Tame at Broomstairs). This has been used directly, and also scaled to the abstraction location;
- 69027 (Tame at Portwood).

6.4.2 The assessment in **Appendix B** shows impacts on flow would be consistently below 10% immediately downstream of the abstraction. This is illustrated in **Figure 6.2**. The impacts would be further reduced by the downstream CAMS Assessment Points, to less than 5% impact on flows at Broomstairs above Q98.

6.4.3 The draft 2021 Upper Mersey ALS shows restricted water is available in the Tame catchment, but with HOFs set at very low flows that have not been experienced in the current record. Therefore, it is expected that the HOF may serve as a minimum residual flow during periods of drought, but would apply only extremely infrequently. This suggests that, on the basis of flows alone, the abstraction is likely to be feasible.

Figure 6.2 Impact of WR144 on flows in the River Tame at abstraction location



6.5 Geomorphology and habitat

6.5.1 **Appendix C** (Section 2.15) presents the results of the walkover survey in May 2022, when two reaches downstream of WR144 were visited.

6.5.2 The upstream reach had a channel width of around 20m, with varying steepness of banks. The channel bed material comprised boulders, cobbles, and gravel-pebbles, and the bed was reinforced with brick/laid stone. The water surface profile was mainly rippled with some traces of smooth flow.

6.5.3 The downstream reach had a channel width of around 20m, with steep banks and a set-back embankment on the left side. There were some unvegetated side bar and berms on the left bank, and stable cliff, some active areas and bank toe accumulations on the right side. Overall, the reach appeared stable, with little evidence of active erosion and

depositional processes. The channel bed material comprised boulder, cobble, pebble-gravel with some areas of sand and silt. Further surveys and assessment may be required, to allow a confident assessment about the sensitivity of the morphology to changes in flow.

6.6 Water quality

6.6.1 Water quality assessments have been undertaken at relevant locations downstream of the proposed abstraction on the River Tame, including Environment Agency monitoring locations which also coincide with the waste water treatment works at Mossley. The assessment in **Appendix D** considers the baseline relationships between water quality and flow in the Tame, and found higher concentrations of both nitrate and orthophosphate in summer.

6.6.2 Assessments calculating the impact of the predicted changes to flows on dilution suggest that there would be only a very small change in concentrations. The current WFD classifications for the Tame (Chew Brook to Swineshaw Brook) water body have ammonia at Moderate, BOD at High and Phosphate at Poor. Comparison of the baseline and predicted concentrations demonstrates that the abstraction would be unlikely to result in a change in status at any of the sample points. Similarly, there is a low risk of EQS exceedance of Priority Substances occurring as a result of reduced flows associated with the proposed abstraction.

6.6.3 Whilst the risk to water quality in the context of deterioration of WFD status is considered to be very low, the assessment approach does not allow consideration of the risk of impeding future improvements (i.e. reducing the dilution available in relation to future water quality improvements in the catchment). It is also recognised that the Tame is subject to various influences (on both flow and water quality), including reservoirs upstream and significant levels of urbanisation. It is therefore recommended that a more comprehensive assessment could be undertaken using the Environment Agency's PR24 SAGIS SIMCAT model for the North West River Basin District.

6.7 Macroinvertebrates

6.7.1 The assessment has used historic Environment Agency data at sites:

- 66918, on the River Tame [✂] (last surveyed in 2016);
- 66794, on the River Tame [✂] (last surveyed in 2019).

6.7.2 The survey sites can be used to inform the assessment of potential impacts of abstraction, although both are some distance downstream. Establishment of a site closer to the abstraction may be of benefit.

6.7.3 Overall, the macroinvertebrate data presented in **Appendix E** demonstrate a marked improvement in water quality (indicated by WHPT-ASPT improvements), and potentially habitat (indicated by WHPT-NTAXA improvements) over the last 20-30 years. There is limited evidence of flow stress, particularly in more recent samples. The invertebrate community may nonetheless respond to periods of low flow, although their resilience to low flows may have improved in since the 1990s as a result of a reduction of other

pressures in the catchment. While the data suggests that there is in theory some potential for invertebrates to be affected by reduced flows, the small proportionate impacts calculated in **Section 6.4** and **Appendix B** are unlikely to result in any observable impact to invertebrate communities.

6.8 Macrophytes

6.8.1 There is limited data available for the Tame, with the most recent surveys in 2003. These may not necessarily be representative of current conditions. The assessment in **Appendix F** indicates that, at the time of the survey, the macrophyte community was adapted to moderate flow velocities, and as such, it could potentially be influenced by flow regime change. The modest predicted flow reductions are likely to have a relatively minor impact on physical habitat availability (i.e. flow velocities, wetted width and water depth). However, there would be benefit to collecting up to date survey data, and giving more detailed consideration to physical habitat availability, to provide improved certainty.

6.9 Fish

6.9.1 The composition of fish stocks in the vicinity of the abstraction, at Mossley, is informed by four surveys undertaken in the channel adjacent to the proposed abstraction location between 2002 and 2005. At that time, the population comprised primarily of rheophilic species including brown / sea trout, minnow and stone loach. Gudgeon, roach and three-spined stickleback (*Gasterosteus gasterosteus*) were also recorded rarely. Trout were the dominant species and abundant. This species is considered to have a low tolerance of environmental disturbance.

6.9.2 At least 11 weirs are apparent in satellite imagery downstream of Mossley, to its confluence with the River Goyt and Mersey. These are listed in full in **Appendix G**.

6.9.3 The abstraction from the River Tame, and resulting changes in hydrology and water quality, could result in impacts as set out in **Table 6.2**. These are described in more detail in **Appendix G**.

Table 6.2 Summary of potential impacts on fish

Type of impact	Commentary
Reduction in instream habitat.	More extensive habitat surveys are required to understand the potential sensitivity of the downstream reaches to reduced flows, and any associated changes to velocity, depth or sediment deposition. It is recognised that the proportional reductions in flow are relatively low for this abstraction, being less than 10% of gauged flows at all times.
Impact on the passage of migratory species including European eel, brown/sea trout as well as potamodromous species that complete their migration entirely within the freshwater environment	Reductions in water level may reduce the current porosity of weirs to migrating fish, reducing connectivity between adjacent reaches and potentially reducing the efficacy of any fish passed installed on the weirs It is recommended that further assessment and modelling of the risk of modified flows to the efficacy of fish passes is undertaken.

Type of impact	Commentary
Mortality or reduced viability as a result of changes in water quality (temperature, dissolved oxygen).	Water quality modifications may result in increased phytoplankton and epiphytic algal growth, which may influence spawning success of species such as bullhead and stone loach, as well as macroinvertebrate assemblage that provide food for fish. However, **Section 6.6** has indicated that only very small changes in water quality are likely to result from reduced dilution, which are unlikely to result in deterioration of WFD status.
Changes in the overall biodiversity of both macroinvertebrate and the plant community that provide both food and shelter for fish.	See comments above relating to physical habitat availability and water quality.

6.10 Designated sites

6.10.1 A table of designated sites downstream of the proposed abstraction on the River Tame can be found in **Appendix H**, with a map showing their locations at **Figure 2.7**. Of these, the only site with potential connectivity to the river is the Huddersfield Narrow Canal SSSI. However, this sits at a higher elevation than the River Tame, and therefore may flow into the river, but not vice versa. As a result, no impact on the canal would be anticipated as a result of the proposed abstraction.

6.10.2 The River Tame flows into the River Mersey, and ultimately to the Mersey Estuary (which is an SSSI, SPA and Ramsar). However, as the proportional impact on the Tame in its upper/mid reaches is small, the impact of this option on the Mersey would be minimal , and has not been considered in this assessment. However, this abstraction should be assessed in combination with other options, to consider the overall impacts of the NWT on the Mersey Estuary designations.

6.11 Conclusions and recommendations

6.11.1 The assessments in this section have shown that the abstraction associated with option WR144 would reduce flows in the River Tame by consistently less than 10% at the point of abstraction, further reducing downstream as a result of accretion. The current assessment therefore indicates that, on the basis of flows alone, the abstraction is likely to be feasible, subject to consideration of any other relevant environmental constraints.

6.11.2 The proportional flow reductions have been considered in relation to other environmental factors, and it has been found that:

- Habitat downstream of the abstraction is likely to overall be relatively insensitive to changes in flow. However, this is only based on a limited reach, and surveys over a longer reach length are required;
- Resulting changes to water quality are likely to be very small, and not result in a change of WFD status of any parameters. However, potential risks of impeding future improvements require further assessment;

- The invertebrate communities represented by the available data do not appear to exhibit flow stress, but do respond to periods of low flow. While the data suggests that there is in theory some potential for invertebrates to be affected, the small proportionate impacts on flow are unlikely to result in any observable impact to invertebrate communities.;
- Potential impacts on fish cannot be discounted without further consideration of habitat availability and impacts on the passability of downstream weirs.

6.11.3 On this basis, the following recommendations are made for further primary data collection:

- Further habitat surveys downstream of the abstraction including:
  - At the invertebrate sampling locations, with specific focus on the characteristics of the sample locations with respect to flow sensitivity;
  - To map fisheries habitat.
- Continuation of macroinvertebrate sampling at the current locations (66918 and 66794), to bring both records up to date. Consider adding an additional sample site closer to the abstraction location, dependent on a suitable reach being identified via the physical habitat surveys;
- eDNA survey, to improve characterisation of fish populations.

6.11.4 The following recommendations are made for further evidence collection and assessment:

- Rainfall-runoff models should be established for the proposed abstraction location, and used to consider the potential impacts on flow under a range of climatic conditions.
- Assess risks to fish pass efficacy, in the first instance using the SNIFFER (2010) and ZSL (2008) rapid barrier assessment methodologies. Depending on the outcome, hydraulic modelling of weirs may be recommended.
- Use of the Environment Agency's PR24 SAGIS SIMCAT model for the North West River Basin District is recommended, to provide a more refined assessment of impacts on water quality, with a range of flow and water quality scenarios.

7. Assessment of impact of STT041b (Rivers Roch and Irwell)

7.1 Option description

7.1.1 [✂]

7.1.2 [✂]

7.1.3 [✂]

7.2 Waterbody Status

7.2.1 STT041b surface water abstractions are located in the Roch (Spodden to Irwell) water body, and the Irwell (Croal to Irk) WFD surface water body. The Roch is a tributary of the Irwell, which flows into the Irwell. The Irwell at its downstream limit ultimately becomes the Manchester Ship Canal.

7.2.2 The relevant WFD water bodies are summarised in **Table 7.1**, along with a summary of their status information (with more detail available in **Appendix I**). All of the water bodies are classed as heavily modified.

7.2.3 The Roch (Spodden to Irwell) and Irwell (Roch to Croal) waterbodies are at Moderate Ecological Potential, and a failing chemical status. In the Roch (Spodden to Irwell) water body the biological failures relate to invertebrates being classified as Moderate, while in the Irwell (Roch to Croal) water body, invertebrates are Bad and macrophytes/phytobenthos Moderate. In terms of physico-chemical parameters, ammonia is at Moderate and phosphate at Poor in both water bodies, with other parameters at High.

7.2.4 Reasons for failure for these two water bodies include diffuse source pollution and point sewage discharge. Physical modification is also listed for the Roch (Spodden to Irwell). River flows are not listed as a reason for failure on any water body.

7.2.5 The Irwell (Croal to Irk) and Irwell/Manchester Ship Canal water bodies are as described in **Section 3.2** for option WR015.

Table 7.1 WFD dependent surface water body screening*: Surface water option STT041b

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydro-morphological	Chemical
Roch (Spodden to Irwell) GB112069064600	Moderate	Moderate	Moderate	-	Fail (Mercury, PFOS, PBDE)
Irwell (Roch to Croal) GB112069060840	Moderate	Bad (due to invertebrates)	Moderate	Supports good	Fail (Mercury, PFOS, PBDE)

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydro-morphological	Chemical
Irwell (Croal to Irk) GB112069061451	Moderate	Moderate	Moderate	Supports Good	Fail (Mercury, PFOS, PDBE)
Irwell / Manchester Ship Canal (Irk to confluence with Upper Mersey) GB112069061452	Moderate	-	Moderate	Supports good	Fail (Mercury, PFOS, PBDE, Tributyltin compounds)

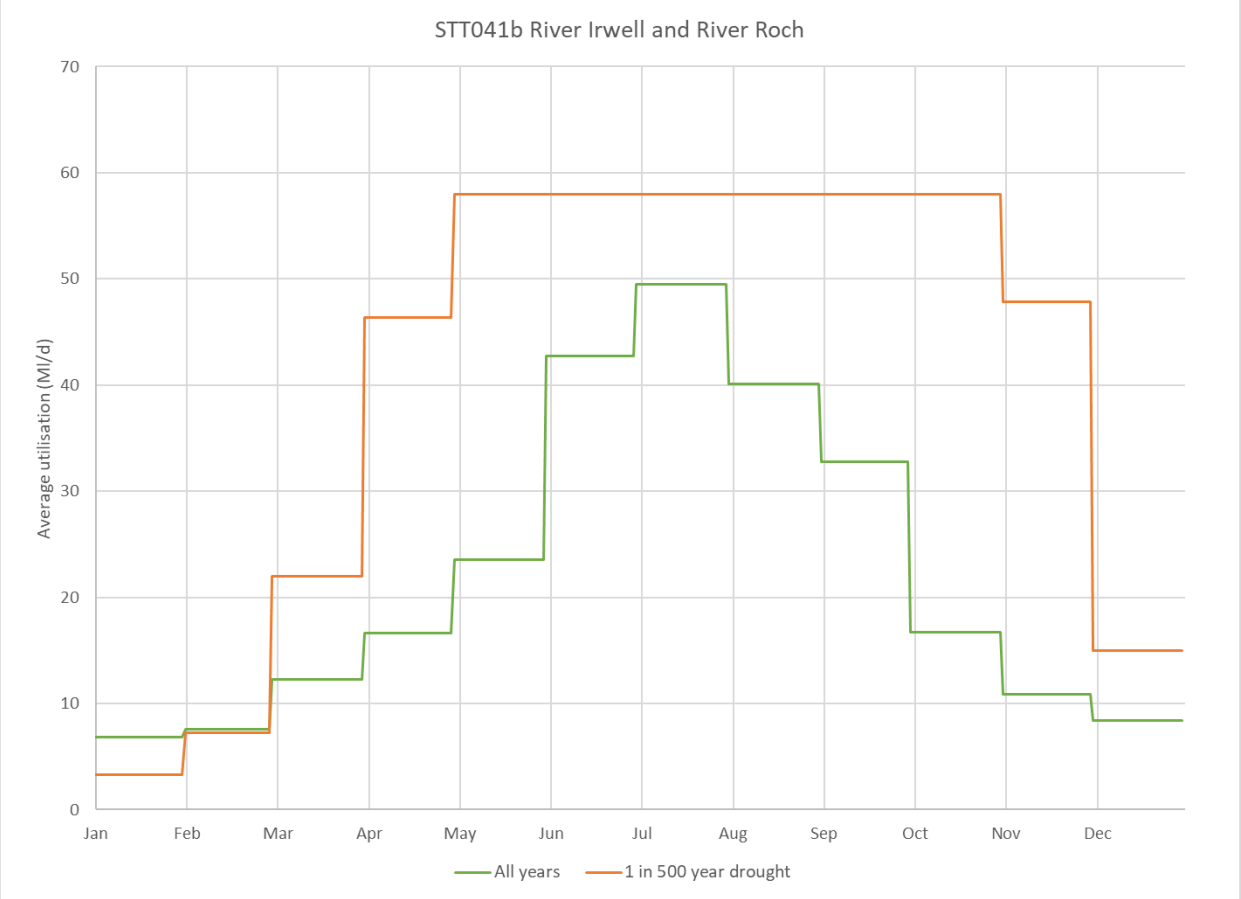
* Based on Catchment Data Explorer data from https://environment.data.gov.uk/catchment-planning/ accessed 20/06/2022. 2019 classification. RNAG Reasons for Not Achieving Good; PBDE Polybrominated diphenyl ethers; PFOS Perfluorooctane sulphonate.

7.3 Anticipated utilisation

7.3.1 The anticipated utilisation of option STT041b is presented in **Figure 7.1**. The option has a maximum capacity of 58 Ml/d in total (up to 40 Ml/d from the Irwell and 18 Ml/d from the Roch). This option is not included in the NWT Full Solution, and hence there is no utilisation profile specifically for this option. UU have recommended that utilisation would be most likely to be similar to WR015, which uses the Irwell abstraction on its own. The WR015 profile, scaled to a 58 Ml/d maximum abstraction, is therefore presented for STT041b in **Figure 6.1**.

7.3.2 **Figure 7.1** shows that in the 'all years' abstraction scenario, abstraction peaks just below 50 Ml/d, for the month of July. For the '1 in 500 year' abstraction scenario, abstraction may continue at the maximum rate from late spring to early autumn.

Figure 7.1 Modelled utilisation of option STT041b



7.4 Assessment of impacts on river flow

7.4.1 The abstractions associated with this option would have an impact on flow in the River Roch and River Irwell, downstream of the points of the abstractions, [✂]. Flow impact assessments are based on gauged flow records at:

- 69023 (Roch at Blackford Bridge). This has been scaled to the Roch abstraction location;
- 69026 (Irwell at Kearsley, recorded as 690503 in Environment Agency records);
- 69002 (Irwell at Adelphi Weir);
- Combined flows from 69002 (Irwell at Adelphi Weir), 69020 (Medlock at London Road) and 69043 (Irk at Collyhurst Weir). This provides an indication of flows entering the Manchester Ship Canal.

7.4.2 The assessment in **Appendix B** shows that on the Roch, the new abstraction is anticipated to reduce Q95 flows by up to 10.3% compared to gauged in the 'all years' utilisation scenario, and 15.3% in the 1 in 500 year utilisation. This is shown in **Figure 7.2**. The impact would be reduced below the confluence of the Roch and Irwell [✂].

7.4.3 Below the Irwell abstraction, the impact on flows is greater than for option WR015 due to the cumulative effect of the Irwell and Roch abstractions being used together. At the Irwell

abstraction location, the Q95 impact could reach up to 10% in the 'all years' scenario, and 17% in the 1 in 500 year scenario. This is shown in **Figure 7.3**. While the impacts would reduce further downstream as a result of accretion, they are likely to continue to exceed 10% at Adelphi Weir at Q95 and below in the 1 in 500 year utilisation scenario.

7.4.4 The catchment is discharge-rich, with discharges supporting flows above natural at low flows. The Environment Agency's water availability summary from March 2022 stated that water would be available for the Roch and Irwell abstractions individually. While this leaves some uncertainty about whether there is sufficient water available for the two if used together, the current assessment indicates that, on the basis of flows alone, the abstraction is likely to be feasible, potentially with a HOF affecting a small number of days (and which should account for ecological and water quality considerations, as discussed in the remainder of this chapter).

Figure 7.2 Impact of STT041b on flows in the River Roch

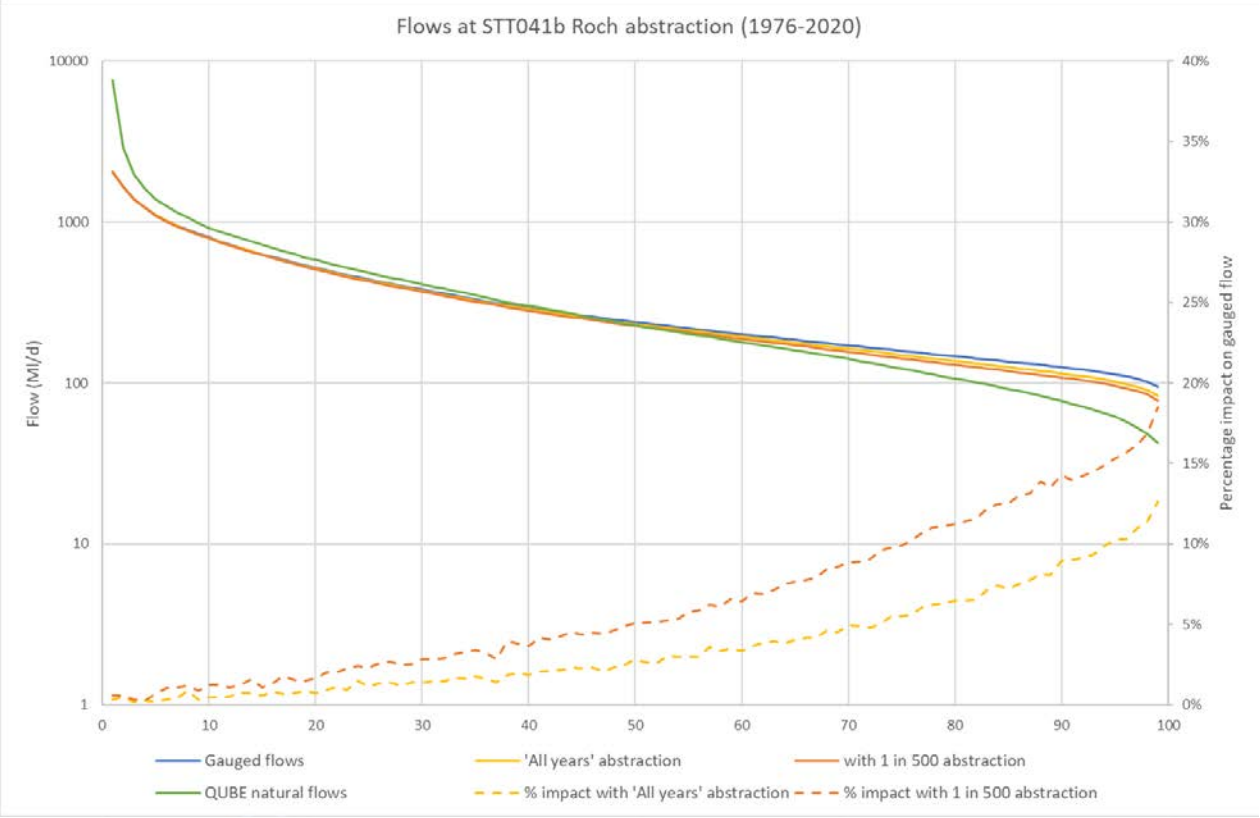
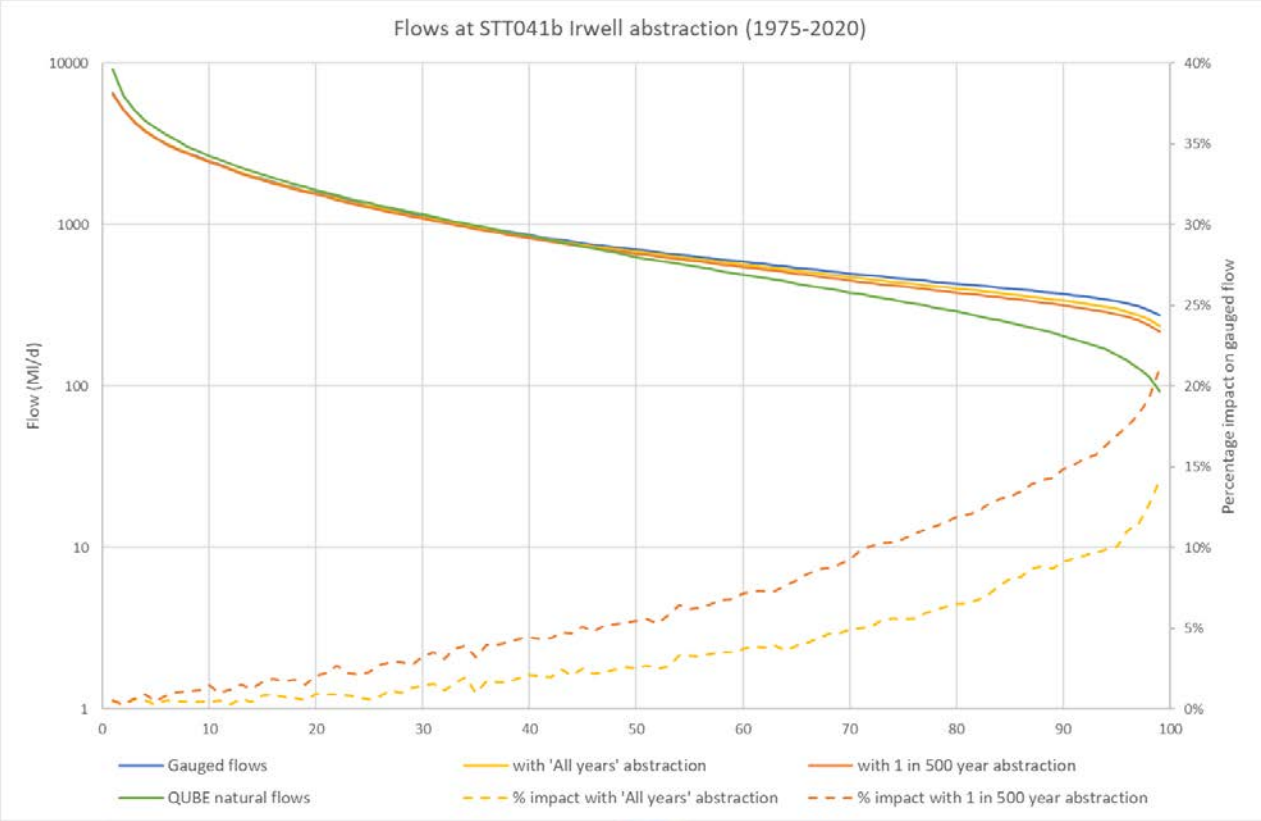


Figure 7.3 Impact of STT041b on flow in the River Irwell



7.5 Geomorphology and habitat

7.5.1 **Appendix C** (Sections 2.13 and 2.14) presents the results of the walkover survey in May 2022, when reaches downstream of the Roch and Irwell abstractions were visited.

7.5.2 At the location visited on the Roch, the channel width was approximately 10m, and the bank faces were generally steep. Active erosion was observed on the outside bank of a meander, with exposed bank material and a secondary channel visible around a large gravel bar that had been deposited. The channel bed material comprised a mixture of bedrock, boulders with traces of cobble, pebble-gravel, and sand, and no in-channel vegetation. The water surface profile was a mixture of smooth glides, with 'rippled' flow. Bankside vegetation had higher diversity on the lower left bank, compared to other options.

7.5.3 At the location visited on the Irwell, the channel width was 20-30m. The right bank was steep and with extensive berms, while the left bank was gentler. The channel bed was relatively uniform with exposed bedrock on the right bank, and an unvegetated side bar on the left bank. The water surface profile was a mixture of smooth glides, with areas of 'rippled' flow and unbroken standing waves.

7.5.4 Overall, the reaches visited were considered to be relatively insensitive to flow changes, with significant changes in flow likely to be needed to alter the degree of wetted/exposed channel bed. However, more extensive surveys would allow a more confident assessment.

7.6 Water quality

7.6.1 Water quality assessments have been undertaken at relevant locations downstream of the proposed abstractions on the Roch and Irwell, including Environment Agency monitoring locations which also coincide with WwTWs at Bury, Bolton and Salford. The assessment in **Appendix D** considers the baseline relationships between water quality and flow in the Roch and Irwell. Concentrations of pollutants tend to increase downstream through the catchment, with higher concentrations on the Irwell compared to the Roch. As noted in Section 3, UU propose to make improvements at Bolton WwTW, along with other improvements to water quality in the Irwell, lower Mersey and Manchester Ship Canal catchments.

7.6.2 Initial assessments calculating the impact of the predicted changes to dilution as a result of reduced flows suggest that there would be only a very small change in concentrations. The current WFD classifications for the Roch (Spodden to Irwell) water body have ammonia at Moderate, BOD at Good and Phosphate at Poor. The classifications for the Irwell (Croal to Irk) water body include ammonia at Moderate, BOD at Good and Phosphate at Moderate. Comparison of the baseline and predicted concentrations indicates that the abstractions would be unlikely to result in a change in status at any of the sample points, in either water body. Similarly, there is a low risk of EQS exceedance of Priority Substances occurring as a result of reduced flows associated with the proposed abstraction.

7.6.3 Whilst the risk to water quality in the context of deterioration of WFD status is considered to be low, the assessment approach does not allow consideration of the risk of impeding future improvements (i.e. reducing the dilution available in relation to future water quality improvements in the catchment). It is also recognised that the lower Irwell and downstream water bodies form a relatively complex, urban catchment, the details of which are not captured by the simple calculations carried out to date. Therefore, a more comprehensive assessment is recommended, using the Environment Agency's SAGIS SIMCAT model for the North West River Basin District.

7.7 Macroinvertebrates

7.7.1 The assessment has used historic Environment Agency data, focussed on key locations at:

- 69398, on the River Roch [✂] (most recent sample 2018);
- 68703, on the River Irwell [✂] (most recent sample 2009);
- 67275, on the River Irwell [✂] However, this has few recent samples (most recently in 2019, but samples are mainly from the 1990s), and also had insufficient site data to calculate Expected scores;
- 69675, on the River Irwell [✂] (most recently in 2018).

7.7.2 The sample sites are well-placed to assess the impacts of the Roch abstraction. For the Irwell abstraction, they can provide an indication, but with some limitations of the period of record and locations.

7.7.3 The assessment in **Appendix E** shows that invertebrate data on the River Roch demonstrate an improvement in water quality, and potentially habitat, over the past 20 years. The data indicates that invertebrate communities are not under flow stress in most years. However, they do appear to react to periods of low flow and so may be sensitive to reduced flows related to the proposed scheme, although their resilience may have improved in association with reductions in other catchment pressures over the last decades. There is also potential for reduced flows to increase sedimentation and habitat availability, depending on the scale of reduction.

7.7.4 In the Irwell, water quality, flows and sediment all exert pressures on the invertebrate community, although the data indicates that water quality has improved over the past two decades. It is possible that a reduction in flow associated with the scheme could exacerbate the flow, sediment, and potentially habitat, pressures, although there is considerable uncertainty with the current level of data availability. The river and its invertebrate communities are likely to be relatively insensitive to changes in flow, in these large, slow-flowing reaches. However, as noted in **Section 3.6**, further habitat surveys should be carried out to confirm this is the case along the reaches downstream of the abstraction.

7.8 Macrophytes

7.8.1 Sample sites for macrophytes include one site on the River Roch and one on the River Irwell. However the sample site on the Irwell is 15 km downstream of the proposed abstraction, with the reach between the sample site and abstraction including confluences with tributaries and an increasingly urbanised catchment. It therefore may not be representative of conditions closer to the abstraction.

7.8.2 The assessment in **Appendix F** shows that the macrophyte community on the Roch is adapted to moderate flow velocities, and as such, it could potentially be influenced by a reduced flow regime. The Irwell sample location indicates presence of a macrophyte community adapted to lower flow velocities than the Roch, but as noted above, this may not necessarily be representative of conditions at the abstraction. Considering the relatively substantial impacts on flow in both rivers, the potential for impacts on physical habitat parameters, which could in turn influence macrophyte communities, should be given more detailed consideration. This should ideally be focussed closer to the abstraction than the current survey site.

7.9 Fish

7.9.1 This section considers potential impacts associated with the abstraction from the River Roch. See **Section 3.9** for potential impacts associated with the Irwell abstraction: although the proportional impacts on flow in the Irwell will be greater for STT041b compared to WR015, the findings of the fisheries assessment are consistent between the two.

7.9.2 As discussed in **Appendix G**, there is a relative paucity of fish fauna data on the River Roch in the vicinity of the proposed abstraction, so the likely composition has been drawn from sites further up and downstream within the Roch (Spodden to Irwell) waterbody. The data that is available suggests composition of fish stocks mainly comprises rheophilic

coarse fish comprising species which are 'moderately' tolerant of environmental disturbance, including minnow, gudgeon, stone loach and chub. Brown/sea trout are also likely to frequent these waters as well as bullhead, both of which have a 'low' tolerance of disturbance.

7.9.3 A single weir at Blackford Old Bridge lies between the proposed abstraction point and the confluence with the River Irwell. A further six weirs lie downstream on the River Irwell, which are set out in full in **Appendix G**.

7.9.4 The abstraction from the River Roch, and resulting changes in hydrology and water quality, could result in impacts as set out in **Table 7.2**. These are described in more detail in **Appendix G**.

Table 7.2 Summary of potential impacts on fish (Roch abstraction)

Type of impact	Commentary
Reduction in instream habitat.	Further analysis is required to determine the impact of reduced flows on velocity and depth, and therefore indirectly to fisheries habitat. Marginal habitat is more heterogenous in the River Roch than further down the catchment on the River Irwell, and loss of marginal habitat may have a significant effect on juvenile flow and habitat refuge. The potential for changes to sediment deposition should also be considered. More extensive habitat surveys will be required to understand the potential impacts.
Impact on the passage of migratory species including European eel, brown/sea trout as well as potamodromous species that complete their migration entirely within the freshwater environment	Reductions in water level may reduce the current porosity of weirs to migrating fish, reducing connectivity between adjacent reaches and potentially reducing the efficacy of fish passes installed on weirs (on the Roch or downstream o the Irwell). It is recommended that further assessment and modelling of the risk of modified flows to the efficacy of fish passes is undertaken.
Mortality or reduced viability as a result of changes in water quality (temperature, dissolved oxygen).	Water quality modifications may result in increased phytoplankton and epiphytic algal growth, which may influence spawning success of species such as bullhead and stone loach, as well as macroinvertebrate assemblage that provide food for fish. However, **Section 7.6** has indicated that only very small changes in water quality are likely to result from reduced dilution, which are unlikely to result in deterioration of WFD status.
Changes in the overall biodiversity of both macroinvertebrate and the plant community that provide both food and shelter for fish.	See comments above relating to physical habitat availability and water quality.
Entrainment of drifting fish eggs and larvae.	Eggs and larvae are vulnerable to entrainment from bankside raw water abstractions. Intake design should consider potential entrainment of aquatic biota at an early design stage. Additional survey information may be required to understand their density and the extent of suitable habitat at the potential point of abstraction.

7.10 Designated sites

7.10.1 A table of designated sites downstream of the proposed abstraction on the Irwell can be found in **Appendix H**, with a map showing their locations at **Figure 2.7**. Of these, the following sites have been identified as potentially having connectivity to the river:

- Ashclough SSSI. This site is designated for geological interest, with the steep bank of the Irwell exposing the Ashclough Marine Band. This location should be included in future geomorphology surveys to confirm whether a change in flow could alter erosion or deposition of the river bank. However, any assessment should be relatively high-level, since this is the reach of the Irwell between the confluence with the Roch and confluence with the Croal, where impacts from the Roch abstraction will be relatively low.
- Woolston Eyes SSSI. This site consists of four large lagoons used for depositing dredgings from the Manchester Ship Canal, and is a nationally important site for its breeding bird assemblage of lowland open waters and their margins. The site lies in between the Manchester Ship Canal and River Mersey (into which the Irwell flows). The relationship between flows in the bounding watercourses and the wetlands should be further considered, although it is considered highly unlikely that the proportional changes in flow in the Irwell described above would result in any notable change to water levels at this location, particularly since the Manchester Ship Canal is controlled by locks.
- Mersey Estuary SSSI, SPA and Ramsar. The River Irwell is connected to the Mersey Estuary via the River Mersey and the Manchester Ship Canal. Therefore a reduction in flow in the River Irwell will result in some reduction in freshwater flow contribution to the Mersey Estuary. This is assessed further, in combination with other options, in the WFD Compliance Assessment and the HRA.

7.11 Conclusions and recommendations

The assessments in this section have shown that the abstraction associated with option STT041b would reduce flows in the River Roch by up to 15% at Q95, and in the Irwell by up to 17% at Q95, at the highest anticipated rates of abstraction. However, flows are supported in both catchments by discharges, which support low flows above natural. The Environment Agency's assessment of water availability stated that sufficient water was available for each option individually, but did not confirm about the combined impact.

7.11.1 The proportional flow reductions have been considered in relation to other environmental factors, and have found:

- Habitat downstream of the abstractions is likely to overall be relatively insensitive to changes in flow. However, this is only based on limited reaches, and surveys over a longer reach length are required;
- Resulting changes to water quality are likely to be very small, and not result in a change of WFD status of any parameters. However, risks of impeding future improvements require further assessment;
- For invertebrates:

- Invertebrate data on the Roch respond to periods of low flow. Although the data suggests that invertebrate communities are not generally under flow stress, they could be sensitive to reduced flows.
- The invertebrate communities on the Irwell appear to be relatively insensitive to changes in flow, although this assessment would be better informed by further habitat survey.

- Potential impacts on fish in the Roch and Irwell cannot be discounted without further consideration of habitat availability and impacts on the passability of downstream weirs.

7.11.2 On this basis, the following recommendations are made for further primary data collection:

- Further geomorphology and habitat surveys downstream of the abstraction including:
  - At the invertebrate sampling locations, with specific focus on the characteristics of the sample locations with respect to flow sensitivity (particularly downstream of the Irwell abstraction);
  - To map fisheries habitat;
  - The riverbanks at Ashclough SSSI should be included in the survey.
- Macroinvertebrate sampling should be continued at current locations (69398 on the Roch, 68703 and 67275 on the Irwell), downstream of both abstractions, to bring the records up to date. This assumes that the habitat surveys confirm that the location on the Irwell is suitable with regards to flow sensitivity: if that is found not to be the case, then an alternative location should be sought.
- eDNA survey, to improve characterisation of fish populations.

7.11.3 And the following recommendations are made for further evidence collection and assessment:

- Rainfall-runoff models should be established for the proposed abstraction location, and used to consider the potential impacts on flow under a range of climatic conditions.
- The Environment Agency's SAGIS SIMCAT model for the North West River Basin District should be used, to provide a more refined assessment of impacts on water quality and of a range of flow and water quality scenarios.
- Further assessment of potential impacts on fish, including:
  - Assess risks to fish pass efficacy, in the first instance using the SNIFFER (2010) and ZSL (2008) rapid barrier assessment methodologies;
  - Consider hydraulic modelling, to improve the understanding of impacts on velocity and depth.
- Review of previous investigations and/or conceptualisations of Woolston Eyes SSSI, to ascertain likely sensitivity to changes in flow in the adjacent water bodies. This should

be a high-level review, recognising that the likelihood of any observable impact on water levels in the river and ship canal is extremely low.

- Further assessment of the impact on flows to the Mersey Estuary and its relevant designated features, in combination with the other relevant options within the NWT scheme.

8. Summary and Recommendations

8.1 Summary

8.1.1 [✂]

8.1.2 A summary of the findings is presented in **Table 8.1**. This interprets the findings in the context of WFD compliance screening, and also includes a column for designated sites. It recognises that further evidence collection and assessment is required to draw firm conclusions. The table has been shaded to indicate potential risks to the water environment from the proposed abstractions.

8.2 Recommendations

8.2.1 A number of recommendations for further evidence collection and assessment have been made at the end of each section, for the individual options. These are summarised in **Table 8.2**, and will be continued beyond Gate 2, to inform future stages of assessment.

Table 8.1 Assessment of potential environmental risks associated with NWT Surface water Options

Option ID	River	Option capacity (Ml/d)	WFD classification elements						Designated sites
			Hydrology	Geomorphology	Water quality	Macroinvertebrates	Macrophytes	Fish	
WR015	Irwell	40	Limited impact on flow	Unlikely to be impacted	Minimal risk of deterioration. Uncertainty about impeding future improvements	Likely limited sensitivity to reduced flows, but further evidence required	Likely limited sensitivity to reduced flows, but further evidence required	Further evidence required	Upstream of Mersey Estuary
WR049d	Ribble	40	Limited impact on flow	Unlikely to be impacted	Minimal risk of deterioration. Uncertainty about impeding future improvements	Likely limited sensitivity to reduced flows, but further evidence required	Further evidence required	Further evidence required	Upstream of Ribble Estuary
WR076	Bollin	25	Some impact on flow, but ameliorated by discharges	Unlikely to be impacted	Minimal risk of deterioration. Uncertainty about impeding future improvements	Likely limited sensitivity to reduced flows, but further evidence required	Likely limited sensitivity to reduced flows, but further evidence required	Further evidence required	Upstream of Mersey Estuary
WR144	Tame	5	Limited impact on flow	Unlikely to be impacted	Minimal risk of deterioration.	Potential sensitivity to reduced flows	Further evidence required	Further evidence required	Upstream of Mersey Estuary, but minimal impact on flows at estuary
STT041b	Roch	18	Highest proportional impacts on flow, although ameliorated by discharges. Uncertainty about Environment Agency water availability assessment for combined option	Unlikely to be impacted	Minimal risk of deterioration. Uncertainty about impeding future improvements	Potential sensitivity to reduced flows	Further evidence required	Further evidence required	Upstream of Mersey Estuary
	Irwell	18+40				Likely limited sensitivity to reduced flows, but further evidence required	Likely limited sensitivity to reduced flows, but further evidence required		

Key to Table 4.1:

Lowest risk			Highest risk

Table 8.2 Summary recommendations for further evidence collection and assessment

Recommendation	WR015 Irwell	WR049d Ribble	WR076	WR144	STT041b
EVIDENCE COLLECTION					
Further physical habitat surveys. Recommend a drone survey for full coverage, and to target locations of MoRPH surveys.	Y	Y	Y	Y	Y
Macroinvertebrate sampling. Spring, summer and autumn at existing locations (although some locations to be reviewed following habitat surveys)	Y	Y	Y	Y	Y
eDNA survey (fish)	Y	Y	Y	Y	Y
Review of fish passage across weirs	Y	N	Y	Y	Y
ASSESSMENT					
Rainfall-runoff modelling. To allow assessment of flow impacts under a range of climatic conditions, and different abstraction scenarios.	Y	Y	Y	Y	Y
Water quality modelling, to allow a more refined assessment of potential water quality impacts, across a range of flow and water quality scenarios.	Y	Y	Y	Y	Y
Hydraulic modelling to inform fishery surveys. To be targeted at key sensitive locations identified by physical habitat surveys, and/or at weirs. Topographic survey may be required to inform modelling.	Possibly	Possibly	Possibly	Possibly	Possibly
Desk study- impacts on salmonid and smelt migration	N	Y	N	N	N

Appendix A Water resource scenarios

Appendix B
Hydrology assessment

Appendix C
Geomorphology and habitat walkovers

Appendix D
Water quality assessments

Appendix E
Macroinvertebrate assessments

Appendix F
Macrophyte assessments

Appendix G
Fish assessments

Appendix H
Designated sites assessments

Appendix I
Waterbody Status

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