# APPENDIX A – PHYSICAL ENVIRONMENT

# A1 INTRODUCTION

This appendix assesses the potential impacts on the physical environment of the catchment surrounding the River Ouse at Moor Monkton during the period of implementation of the associated drought option.

Details regarding the approaches/methodologies used for assessing susceptibility and sensitivity to drought options and the assessment of the impacts associated with drought options are presented in YWSL's Drought Plan 2027 Environmental Assessment Methodology[1].

This appendix is set out in the following sections:

Section A.2 Drought option

Section A.3 Study area

Section A.4 Physical environment effects – this includes:

1. Introduction
2. Setting
3. River flow regime
4. River habitat
5. River water quality
6. Summary of potential changes in the physical environment as a result of the drought option.

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

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

**Annex 3** maps the intermittent water quality pressures associated with the Ouse 1 reach (with the number of pressures in this reach making their presentation in Figure A4.1).

**Annex 4** documents the flow transposition in the absence of measured data (for illustrative time series) approach where flow transposition has been utilised.

# A2 DROUGHT OPTIONS

## A2.1 RIVER OUSE AT MOOR MONKTON DROUGHT ORDER

YWSL are authorised to abstract water from the River Ouse at Moor Monkton under licence serial number NE/027/0024/065 and 2/27/24/158. Under the terms of the licences the volume YWSL are permitted to take is dependent on the flow in the River Ouse as measured at Skelton gauging station (grid reference SE 568 554). The abstraction is limited to: 300 Ml/d when flow at Skelton gauging station is more than 1,000 Ml/d; 150 Ml/d when flow at Skelton gauging station is between 650 and 1,000 Ml/d; 72 Ml/d when flow at Skelton gauging station is between 400 and 650 Ml/d; and 10 Ml/d when flow at Skelton gauging station is less than 400 Ml/d.

In addition to the above the aggregate quantity of water authorised for abstraction from Moor Monkton under licence number NE/027/0024/065 and licence number 2/27/24/158 is limited to 12.5 Ml/hr ; 300 megalitres per day (Ml/d); and 73,000 megalitres per year (Ml/year). Abstraction must be taken at an instantaneous rate not exceeding 3,473 litres per second.

YWSL is currently operating within the terms and conditions of the licence agreements held with the Environment Agency to abstract from the River Ouse at Moor Monkton.

[1] Ricardo Energy & Environment (2025). Yorkshire Water Drought Plan 2027. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. March 2025.

The drought order application is to temporarily amend the licences to allow an additional 60 Ml/d to be abstracted at Moor Monkton in the flow bands below 1,000 Ml/d. If granted the order will be in place for up to six months, from the date which the order is granted.

If YWSL receive sufficient refill for the regional reservoirs stocks to recover to a level YWSL refer to as 'the normal control line' and no individual reservoir group is below a level YWSL refer to as the 'early warning trigger line', YWSL will revert back to the conditions defined in the licence agreement.

The abstraction rates (daily maxima and combined annual maxima) specified in the licences are unchanged. This means that the total annual maximum from the River Ouse is unchanged, but that more will be able to be taken when the river is low. These conditions are set out in **Table A2.1**.

Table A2.1 Ouse at Moor Monkton licence data

| Abstraction Water Source | NGR | Normal Abstraction Ml/d[2] | Proposed Drought Option Abstraction Ml/d | Benefit Ml/d |
|---|---|---|---|---|
| Ouse | SE525576 (Intakes 1 and 2)<br>SE527576 (Intake 3) | 300Ml/d when flows in Ouse (measured at Skelton downstream) are more than 1,000Ml/d<br>150Ml/d when flows in Ouse are between 650 and 1,000Ml/d<br>72Ml/d when flows in the Ouse are between 400 and 650Ml/d<br>10Ml/d when flows in the Ouse are less than 400Ml/d | 300Ml/d when flows in Ouse (measured at Skelton downstream) are more than 1,000Ml/d (No change)<br>210Ml/d when flows in Ouse are between 650 and 1,000Ml/d<br>132Ml/d when flows in the Ouse are between 400 and 650Ml/d<br>70Ml/d when flows in the Ouse are less than 400Ml/d | Up to 60 |

[2] 1Ml/d is 1 million litres per day

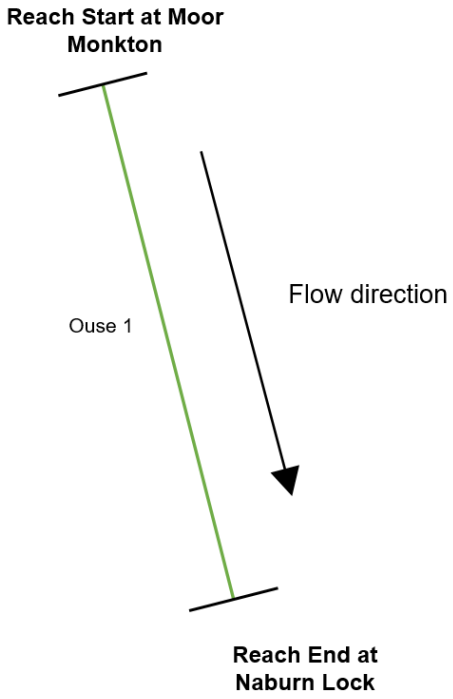
# A3 STUDY AREA

The zone of influence associated with the drought option is defined through hydrological effects. Within the overall zone of influence, the reach is defined on a hydrological basis. YWSL's Drought Plan 2027 Environmental Assessment Methodology[3] sets out this approach in detail in Section 3.4. The zone of influence for assessment of impacts is set out in **Section A3.1** below. Information on the likely timing of the drought option is set out in **Section A3.2** below.

## A3.1 ZONE OF INFLUENCE OF THE DROUGHT OPTIONS

The hydrological impact of the drought option was considered as part of the screening exercise. This determined what the timing, magnitude, zone of influence, nature of change and duration of the drought option would be. **Table A3.1** summarises this information, and the reach is illustrated in main EAR **Figure 4.1** and in a schematic below in **Figure A3.1**.

Figure A3.1 River Ouse schematic




[3] Ricardo Energy & Environment (2025). Yorkshire Water Drought Plan 2027. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. March 2025.

Table A3.1 River Ouse at Moor Monkton reach details

| Reach name | Watercourse name | Reach start | Reach end | Down-stream reach | Drought option |
|---|---|---|---|---|---|
| | | | | | Ouse at Moor Monkton |
| Ouse 1 | River Ouse | Moor Monkton | Naburn Lock | N/A<br>Study area end | ✓ |

The end of each study area has been defined previously to the point at which the River Ouse becomes tidal at Naburn Lock. The pass-forward flow to the Humber Estuary at the Naburn Lock at the tidal limit of the River Ouse with the drought order is a negligible reduction in freshwater contribution to the estuary and the zone of hydrological influence therefore ends at the tidal limit.

The tidal River Ouse ultimately joins the Humber Estuary which is designated as SAC/SPA. A 9.2% reduction in freshwater low flows (annual Q95) contribution from the Ouse catchment into the estuary (as would be likely considering the reductions identified in Section A4.2.3 as occurring higher up in the reach) is within the WFD standards[4] for main river freshwater inflows into transitional waterbodies such as that of the Humber Estuary. Assessment of the impacts of drought option implementation on the integrity of the Humber Estuary SAC/SPA concluded that there would be no significant effect of implementing one or all of the drought permits/orders on relevant features of the Humber Estuary SAC/SPA, i.e. there would be no adverse effect on the integrity of the interest features for which the Humber Estuary SAC/SPA is designated[5].

## A3.2 TIMING OF DROUGHT MEASURE EFFECTS

The assessment presented in this appendix is in support of a drought order application for a drought order to be implemented in summer 2025. In line with the YWSL's Drought Plan 2027 Environmental Assessment Methodology[6], the assessment here is appropriate for the assessment of hydrological impacts on low flow regimes in watercourses during the spring, summer and autumn. The assessment is also appropriate to determine the impacts of drought options on watercourses during the winter, when watercourses have relatively lower sensitivity to changes in low flow, and moderate sensitivity to changes in moderate flow. This covers the range of potential impacts associated with a six month drought order.

## A3.3 CUMULATIVE REACHES WITH OTHER EARS

There is one cumulative hydrological impact foreseen as a result of simultaneous deployment of the drought option at the River Ouse at Moor Monkton.

Ouse 1 is also impacted by the effects of the Leighton, Lumley Moor, Haverah Park and River Ure at Kilgram Bridge drought options, which together account for a combined maximum flow reduction of 12.19 Ml/d in the Ure and Nidd tributaries of the Ouse catchment upstream of the Moor Monkton intakes. If all five drought options were simultaneously deployed the overall combined flow reduction would be

[4] Entec (2007) Water Resource Standards for Freshwater Flows to Transitional Waterbodies *WFD 83* Table 7.5. The lower Ouse is poor ecological potential between Naburn and Stillingfleet, and moderate ecological potential from Stillingfleet until the Humber Estuary (note it is a heavily modified waterbody). All larger transitional water bodies for example the Thames, Severn and Humber fall into the low sensitivity category. Therefore, the appropriate proposed standard for main river inflows at low flow (<Q95) is a 50% change in flow.

[5] Scott Wilson (2011). Yorkshire Water Drought Plan: Assessment of Possible Impact on Humber Estuary SPA/SAC. Final Report Revision 2 February 2011. Report for Yorkshire Water.

[6] Ricardo (2025). Yorkshire Water Drought Plan 2027. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. February 2025.

72.19 Ml/d which represents a reduction of 12.4% and 17.1% in the summer Q95 and Q99 flow statistics, which is assessed as a **moderate** hydrological impact on this reach in summer months. The reduction in year round Q95 is 11.0%, which is assessed as a **minor** hydrological impact during winter months, noting no cumulative impact would be observed in year round Q50 flows with these being greater than 1000 Ml/d so not impacted by a River Ouse at Moor Monkton drought order.

# A4 PHYSICAL ENVIRONMENT EFFECTS

## A4.1 INTRODUCTION

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

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

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

YWSL's Drought Plan 2027 Environmental Assessment Methodology[7] provides details of the approach in Section 3.5. The approach has been developed to ensure compliance with the Environment Agency's March 2025 (DPG2025)[8] This also includes an updated draft of the supplementary guidance on the environmental assessment for water company drought planning.

## A4.2 OUSE 1

### A4.2.1 Reach introduction

A summary of physical environment information for Ouse 1 is provided in **Figure A4.1**. The reach includes part of the following WFD river waterbody:

- River Ouse from River Nidd to Stillingfleet Beck (GB104027069593)

### A4.2.2 Reach setting

The reach, located in main EAR **Figure 4.1,** comprises a 20.6km stretch of the River Ouse from Moor Monkton to Naburn Lock (**Table A2.1**). The reach has an additional catchment area of 302.5km$^2$ along its length.

### A4.2.3 River flow regime

Daily mean flows at the upper end of the reach, immediately downstream of the Moor Monkton abstraction, have been estimated using the Gustard flow transposition method. This is based on catchment parameter ratios and gauged flow data from an available downstream gauge at Skelton (see **Annex 4**). Prior to applying the flow transposition, adjustments to the gauged flow data were made to allow for the effects of the Moor Monkton abstraction. Daily mean abstraction was then added back on to the estimated (transposed) data series. This enabled the creation of an estimated daily flow record for the reach covering the period 1990-2023 with moderate to high confidence.

The maximum reduction in flow under the River Ouse drought option is 60Ml/d, when flow measured at the Skelton gauge is equal to or lower than 1,000 Ml/d. The flow reduction of 60Ml/d represents a reduction of 10.3% and 14.2% in the summer Q95 and Q99 flow statistics, which is assessed as a **moderate** hydrological impact on this reach in summer months. The reduction in year round Q95 is 9.2% and there would be no impact to year round Q50 flows (with Q50 being greater than 1000 Ml/d), which is assessed as a **negligible** hydrological impact during winter months.

There are two significant flow pressures influencing flow in Ouse 1, an abstraction for potable water, 'River Ouse – Acomb' a YWSL abstraction with a maximum peak rate of 130 Ml/d but currently restricted

[7] Ricardo (2025). Yorkshire Water Drought Plan 2027. Environmental Assessment Methodology. Report for Yorkshire Water Services Ltd. March 2025.

[8] Environment Agency (2024) Water company drought plan guideline. Final, March 2025..

to 27 Ml/d and a discharge licence leading to a significant flow addition from Naburn WwTW, with a dry weather flow of 45.1Ml/d. See Annex 1 and 2 for a full list of flow pressures considered in the assessment.

### A4.2.4 River habitats

River habitats have been characterised at a whole reach scale. The characterisation of the river habitats in this reach is supported by information from a walkover survey in this reach undertaken on 13/05/2021 (flow on this day, as measured at the Ouse at Skelton flow gauge, was 4995 Ml/d).

Ouse 1 is moderately sinuous lowland river surrounded by extensive floodplains. RHS data indicates the presence of 2 river terraces in the upper and lower sections of the reach. The reach itself falls ~1m over 21.6km, a slope of 0.003°. There is semi-continuous to isolated riparian tree cover throughout the reach with some few areas of continuous cover in the upper sections of the reach. Channel widths vary throughout the reach, measuring 50.7m at the start of the reach to 60.3m at the end of the reach. Where the reach passes through York the width decreases to around 35-40m, in response to channel modification from engineering. Extant aerial imagery shows no visible in-channel features. There are four RHS sites within the reach, site ID 21479 (3.8km downstream), 27207 (11.5km downstream), 23929 (14.2km downstream) and site ID 23910 (20.2km downstream). Data from the RHS site 23929, indicates the channel bed is composed of silt, with no channel features present or visible. The flow surface was predominately smooth and free of broken flow throughout the reach. RHS data indicate that smooth flow was solely observed at site 21479, while rippled flow was dominant at sites 23929 and 23910. Throughout the RHS sites, there were a total of no pools, and no riffles observed as well as no point bars. At site 27207, there was channel modification observed, including channel realignment and over deepening (>33% of the survey site), as well as >33% of the site being artificially ponded.

Bank erosion is visible throughout much of the reach, and erosion is very frequent in the first 9.3km prior to when the river flows through York. Poaching was observed in RHS survey 23929. Data from RHS sites identify a range of bank forms. At site 21479, banks were undercut. Towards the end of the reach bank slopes were steep (Survey sites 23929 and 23910). Bank vegetation types were noted as being predominantly simple to complex along the reach.

The surrounding land-use varies along the reach. In the upper reaches, prior to York, land use is a mixture of arable agricultural land and improved grassland with occasional urbanisation. Passing through York urbanisation and parkland is dominant, with a return to arable agricultural land and improved grassland south of York to the end of the reach. Urbanisation is greater in the lower sections of the reach after York compared to the upper sections of the reach. RHS data is in agreement but also identifies the presence of scrub and shrubs and tall herbs or rank vegetation along the reach.

Ouse 1 supports typical habitats of a lowland watercourse, with a moderately sinuous planform and extensive connectivity to the floodplain. As a result of the shallow slope, the flow structure present is relatively uniform along the reach and is dominated by low energy flows, however flow variation is expected, particularly in the more sinuous parts of the reach which will increase habitat diversity. The extensive presence of bank erosion throughout the reach suggests that the low energy environments have some force as a result of the volume of water, or high energy environments will become more apparent in spate. The uniformity of the watercourse is also highlighted by the absence of depositional features in the channel. The reach is likely to support adult fish, with cyprinid species likely to dominate and anadromous species will utilise the reach during the migratory period. Spawning habitat for fish species using unconsolidated gravels is unlikely to be present within the reach due to the absence of suitable substrate and habitat. The scattered presence of trees in the reach will provide some allochthonous energy to the watercourse and provide some, albeit limited, cover for fish. The weir present at the tidal limit may have an impact upon the movement of migratory species.

The drought options reduction in flow could lead to several potential impacts along Ouse 1:

- Minor risk of changes in the energy of the system associated with up to 14.2% reduction in flow for the duration of drought options.
- Potentially minor risk of reduction in wetted aquatic habitat (wetted width reduction) with increasing exposure of channel margins for duration of drought option.

- Potentially minor risk of change in available aquatic habitat (flow velocity reduction and depth reduction) for duration of drought option, with retention of smooth flow.
- Negligible risk to longitudinal connectivity.
- Minor risk of changes in sediment dynamics for duration of drought option. Reductions in discharge will lead to reductions in velocity and could lead to increased potential for the deposition of any fine sediment in transport noting that sources will be largely dormant during environmental drought. Coarse sediment dynamics are unlikely to be affected.

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

### A4.2.5 River water quality

The third downstream water quality monitoring location present in Ouse 1: River Ouse at Nether Poppleton (Skelton) (NE-49100488) has been used due to its data quality. There are 14 frequently spilling CSOs potential presenting an environmental risk in the reach. No continuous water quality pressures have been identified. A summary description of the potential risks to water quality in the River Ouse as a result of drought options is presented in **Table A4.1**.

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

| | Total ammonia | Oxygen | Phosphate |
|---|---|---|---|
| General quality | Ammonia concentrations were consistent with High WFD status (0.3 mg/l) throughout the monitoring period. | Dissolved oxygen saturation (%) values were consistent with High WFD status (70%) throughout the monitoring period with the exception of one value at Good status (60%) and one value at Bad status (45%). | Orthophosphate concentrations were predominately between Good (0.079 mg/l) and Moderate (0.193 mg/l) WFD status throughout the monitoring period. |
| Flow sensitivity (diffuse pollution) | None apparent | None apparent | Strong |
| WwTW presenting increased risk | None | None | None |
| Intermittent pressures presenting risk | Risk of short term acute, infrequent, temporary water quality pressures (acute toxicity of ammonia, suffocation from oxygen sags) locally downstream of 14 CSOs during rainfall events. | | None |
| Other point source pressures presenting risk | None | None | None |
| Summary | Moderate risk from drought options associated with CSO discharge | Moderate risk from drought options associated with CSO discharge | Moderate risk from drought options associated with change in dilution of diffuse pollution pressures |

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

An overall summary of potential changes in the physical environment of the River Ouse as a result of drought option is presented in **Table A4.2**.

Table A4.2 Summary of potential changes in the physical environment to Ouse 1 as a result of drought option

| Physical environment aspect reviewed | Assessment of risk from implementation of drought options |
|---|---|
| **River flows**<br>*Moderate impacts (summer)*<br>*Negligible impacts (winter)* | • Reductions of up to 14.2% in river flows in summer and dry autumn conditions throughout the reach. |
| **Flow depleted reaches**<br>*None* | • There are no flow depleted reaches within Ouse 1 |
| **River habitats**<br>*Minor risk* | • The moderate reduction in flow will change the energy of the system with the potential for minor risks to wetted aquatic habitats, habitat available for different species requirements longitudinal connectivity and sediment dynamics. |
| **Water quality**<br>*Moderate risk* | • Risk of short term acute, infrequent, temporary water quality pressures locally downstream of 14 listed CSO during rainfall events. There are no continuous water quality pressures identified as presenting increased risk with drought options implemented.<br>• SRP quality is predominantly within Good or Moderate WFD status with strong flow sensitivity, therefore a moderate risk to water quality has been assessed associated with change in dilution of diffuse pollution pressures to SRP.<br>• Measured ammonia and dissolved oxygen saturation water quality is predominantly consistent with High or Good WFD status and with no apparent flow sensitivity.<br>• No continuous water quality pressures are present in this reach. |

**Insert Figure A4.1**

# ANNEX 1 – REGULATED ABSTRACTIONS IN THE OUSE 1 REACH

| DP reach | Licence No. | Use Description | NGR 1 | Max Annual Quantity | Max Daily Quantity | Significant |
|---|---|---|---|---|---|---|
| Ouse 1 | 2/27/24/212 | Spray Irrigation - Direct | SE600694 6887 | 30450 | 436 | No |
| Ouse 1 | NE/027/0024/061 | Heat Pump | SE600615 1883 | 273500 | 848 | No |
| Ouse 1 | 2/27/24/078 | Potable Water Supply - Direct | SE576539 | 35000000 | 130000 | Yes |
| | | | SE580531 | | | |
| | | | SE581529 | | | |
| | | | SE582527 | | | |
| | | | SE583526 | | | |

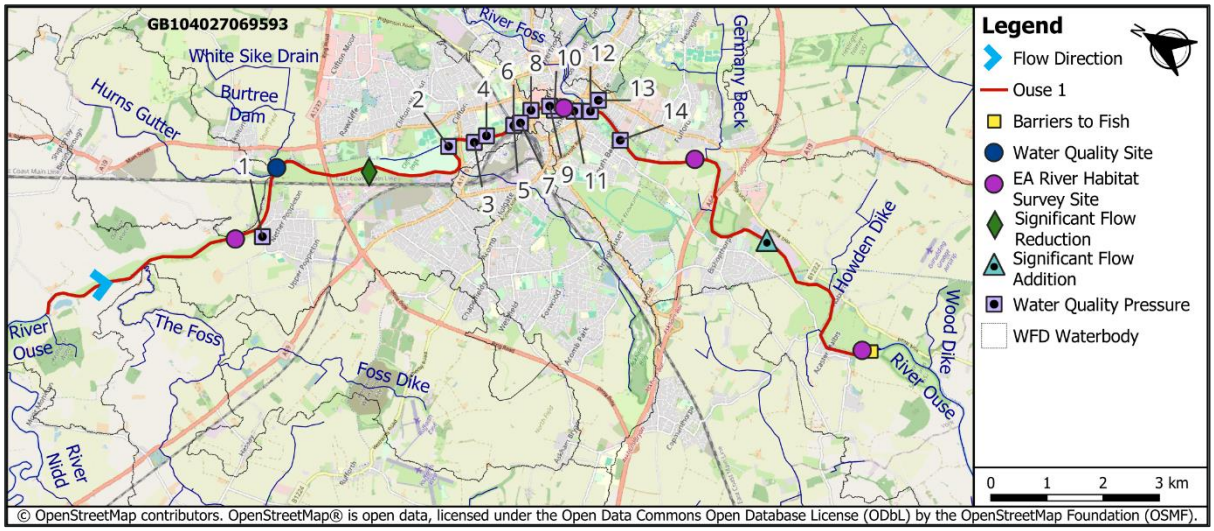
# ANNEX 2 – WATER QUALITY PRESSURES CONSIDERED IN THE ASSESSMENT

| Name | Permit Reference | Outfall NGR | Significant Water Quality Pressure | Intermittent/ Continuous |
|---|---|---|---|---|
| Naburn STW | 27/24/0124 | SE6009047150 | No | Continuous |
| Rawcliffe (York) STW | 27/24/0129 | SE5876052900 | No | Continuous |
| Rawcliffe York STW | YWS01989 | SE686234 | Yes | Intermittent |
| Rufforth WPC Works | 27/24/0337 | SE5360052200 | No | Continuous |
| Long Marston WPC Works Storm Tanks | E779 | SE5090051100 | No | Continuous |
| Nun Monkton STW | 27/21/0142 | SE5119057580 | No | Continuous |
| Riverside Gardens/CSO | 27/24/0465 | SE5569654982 | Yes | Intermittent |
| Jubilee Terrace CSO | C4958 | SE58995254 | Yes | Intermittent |
| Grosvenor Terrace CSO | 27/24/0452 | SE5997252840 | Yes | Intermittent |
| Skeldergate Bridge CSO | 27/24/0426 | SE6032851287 | Yes | Intermittent |
| Terry Avenue CSO | 27/24/0427 | SE6048351022 | Yes | Intermittent |
| Trafalgar Street/CSO | 1282 | SE6022750108 | Yes | Intermittent |
| Fishergate/ CSO | 27/24/0421 | SE60745451000 | Yes | Intermittent |
| The Esplanade York CSO | 27/24/0205 | SE59195240 | Yes | Intermittent |
| Lendal Hill CSO | 27/24/0417 | SE6001551986 | Yes | Intermittent |
| Common Hall Lane CSO | 27/24/0418 | SE6008051888 | No | Intermittent |
| Woolworths CSO | 27/24/0419 | SE6022051700 | No | Intermittent |
| Skeldergate Bridge CSO | 27/24/0420 | SE6041251320 | No | Intermittent |
| Hartoft Street CSO | 27/24/0422 | SE6061250656 | No | Intermittent |
| Farndale Street CSO | 27/24/0423 | SE6059050612 | No | Intermittent |
| New Walk CSO | 27/24/0424 | SE6045450368 | No | Intermittent |
| Butcher Terrace CSO | 27/24/0428 | SE6032350307 | No | Intermittent |
| Marygate Lane CSO | 27/24/0449 | SE5973352285 | Yes | Intermittent |
| Portland Street CSO | 27/24/0450 | SE6011752498 | No | Intermittent |
| Bootham Hospital CSO | 27/24/0451 | SE6000552809 | No | Intermittent |
| Grosvenor Terrace CSO | 27/24/0452 | SE5997252840 | No | Intermittent |
| Queen Street Bridge CSO | 27/24/0453 | SE5995451632 | No | Intermittent |
| Station Road CSO | 27/24/0454 | SE5966751664 | No | Intermittent |
| Royal York Hotel No.2 CSO | 27/24/0455 | SE5995051914 | No | Intermittent |
| Royal York Hotel No.1 CSO | 27/24/0457 | SE5995051914 | No | Intermittent |
| Landing Lane CSO | 27/24/0458 | SE5825352406 | No | Intermittent |
| Queens Staith CSO | 27/24/0459 | SE6019251592 | Yes | Intermittent |
| Marygate Landing CSO (No2) | C4957 | SE5974352059 | Yes | Intermittent |
| Castle Mills CSO | WA6109 | SE6049551299 | No | Intermittent |
| Longfield Terrace/CSO | 151 / 1 / 1 | SE5960652082 | No | Intermittent |
| Clifton Hospital/CSO | YWUCD1/78 | SE5821453350 | No | Intermittent |
| Marble Arch/CSO | 2908 | SE5970452016 | No | Intermittent |
| Millfield Lane York/CSO | 27/24/0466 | SE56615391 | No | Intermittent |
| Lower Poppleton/CSO | NPSWQD006095 | SE56905358 | No | Intermittent |
| Shipton Road/No 2 CSO | 2075 | SE5800254403 | No | Intermittent |
| Clifton Hospital/CSO | YWUCD1/78 | SE5821453350 | No | Intermittent |
| Plantation Drive/CSO | C4158 | SE5752052730 | No | Intermittent |

| Name | Permit Reference | Outfall NGR | Significant Water Quality Pressure | Intermittent/ Continuous |
|---|---|---|---|---|
| Knavesmire Road/CSO | 27/24/0437 | SE5926050438 | Yes | Intermittent |
| Tadcaster Road/CSO | 27/24/0245 | SE49134861 | No | Intermittent |
| Fulford Main Street/CSO | 952 | SE6109248703 | No | Intermittent |

# ANNEX 3 – OUSE 1 SIGNIFICANT INTERMITTENT WATER QUALITY PRESSURES

Map and table of the significant intermittent water quality pressures on the Ouse 1 reach.




| Map Number | CSO Name |
|---|---|
| 1 | Riverside Gardens CSO |
| 2 | Rawcliffe York STW |
| 3 | Jubilee Terrace CSO |
| 4 | The Esplanade York CSO |
| 5 | Grosvenor Terrace CSO |
| 6 | Marygate Lane CSO |
| 7 | Marygate Landing No.2 CSO |
| 8 | Lendal Hill CSO |
| 9 | Woolworths CSO |
| 10 | Queens Staith CSO |
| 11 | Skeldergate Bridge |
| 12 | Terry Avenue CSO |
| 13 | Fishergate CSO |
| 14 | Butcher Terrace |

# ANNEX 4 – FLOW TRANSPOSITION APPROACH

The Gustard[9] method for flow transposition has been used to scale flows from a suitable donor gauge to an ungauged assessment point. This is applied across the flow duration curve as follows:

1) For low flows (Q95 and lower flows):

$$\text{AP flow} = \frac{\text{Donor flow} \times \text{AP area} \times \text{AP BFI-HOST}}{\text{Donor area} \times \text{Donor BFI-HOST}}$$

2) For mean flows and higher:

$$\text{AP flow} = \frac{\text{Donor flow} \times \text{AP area} \times \text{AP SAAR} \times \text{AP SPR-HOST}}{\text{Donor area} \times \text{Donor SAAR} \times \text{Donor SPR-HOST}}$$

For this assessment this equation has been applied to flows of Q50 and higher, accepting that Q50 is not mean flow.

3) For intermediate flows between Q95 and Q50 a proportion of each of equation (1) and (2) has been used, based on Q statistic.

Scaling factors have been applied to the daily flow series of the donor catchment using the on-the-day Q statistic. Data covers the period from 1990-2024, unless otherwise stated.

As agreed with the Environment Agency, all abstractions and discharges of >5% of the summer Q95 of the donor gauge have been re-naturalised. Where those abstractions or discharges are YWSL then daily data have been used in the re-naturalisation. For all other identified abstractions or discharges the permitted value has been used in the re-naturalisation. Flow modifications in the catchment of the Assessment Point (AP) are treated similarly. This then provides the following equation:

4) Daily flow at AP = scaled re-naturalised donor gauge flow + flow modifications in recipient catchment

The section below identifies the specific datasets and values used in the derivation of the illustrative flow series at the AP in those reaches with appropriate measured data.

**Ouse 1**

| Aspect | Point | Data source |
|---|---|---|
| **Donor gauge** | River Ouse at Skelton | EA daily mean flow |
| **Summer Q95 at donor gauge for identifying abstractions/ discharges for re-naturalisation** | 599.62Ml/d | Derived from EA dataset for the 1990-2023 period |
| **Naturalisation of donor gauge** | YWSL Moor Monkton abstraction series added to flow series. | YWSL daily mean abstraction |
| **Post processing of recipient AP (flow)** | YWSL Moor Monkton abstraction series removed from flow series. | YWSL daily mean abstraction |

Catchment descriptors were collected, for each relevant site, from the FEH Webservice[10] as listed below:

| | Area km$^2$ | SAAR mm | SPR-HOST | BFI-HOST |
|---|---|---|---|---|
| **Donor gauge** | 3315 | 899 | 39.94 | 0.439 |
| **Recipient AP** | 3216.97 | 907 | 40 | 0.44 |

[9] Gustard, A., Bullock, A. and Dixon, J. M. (1992). Low flow estimation in the United Kingdom. Institute of Hydrology Report No. 108, Centre for Ecology and Hydrology, Wallingford.

[10] https://fehweb.ceh.ac.uk/GB/map

Scaling factors applied to the donor gauge daily flow series in deriving the daily flow series at the recipient AP are listed below:

| Q95 and lower flow scaling factor | Q50 and higher flow scaling factor |
|---|---|
| 0.980534783 | 0.972638899 |

T: +44 (0) 1235 75 3000
E: info@ricardo.com
W: www.ricardo.com