Old Walls RSA scheme Hydrological modelling

Executive summary

The impact of the Old Walls abstraction on flow in the West Webburn river has been assessed by comparing residual flows in the deprived reach downstream of the abstraction point to the Environmental Flow Indicator (EFI). Additionally, the impact of proposed new licence conditions, designed to provide flows required to protect the ecology of the West Webburn river, have also been assessed. The resulting difference in the volume of water available for abstraction has been calculated.

The Old Walls abstraction licence (14/46/004/0685) authorises abstraction by gravity from the West Webburn river at NGR SX 700 749 for the purpose of power generation. Authorised quantities are as follows:

Daily licence quantity: 69,120 cubic metres per day (m^3/d)
Annual licence quantity: 16,054,984 cubic metres per year (m^3/a)
Maximum instantaneous rate: 0.80 cubic metres per second (m^3/s)
Authorised months: All year

Additionally, the licence includes a prescribed flow of 0.025 m^3/s which applies to the 'flow over the notch of the Jordan Weir at NG4 SX 700 749". This hands off flow (HOF) is less than the natural Q99.9 flow (Qn99.9). Although this prevents abstraction of the entire river flow, the fully licenced abstraction causes the flow in the deprived reach to flatline at 0.025 m^3/s for long periods of time.

Based on the Environment Agency Guidance for run-of-river hydropower development, the EA have proposed licence conditions to ensure river flows are sufficient to support the ecology of the West Webburn river in the deprived reach. These conditions include:

Daily licence quantity: 69,120 m^3/d (unchanged)
Annual licence quantity: 10,502,497 m^3/a (reduced)
Instantaneous rate: 0.80 m^3/s (unchanged)
Authorised months: All year (unchanged)
HOF: 0.146 m^3/s (increased)
Percentage take: 35% (new)
Sweetening flow: 0.020 m^3/s (new). If flow in the river drops below 0.040 m3/s then abstraction into the leat for the purpose of sweetening flow must cease.

These concepts are described in the main report.

The main findings from the assessment are as follows:

- Maximum abstraction as permitted by the existing licence has the potential to cause flow in the deprived reach to flatline at 0.025 m^3/s for long periods of time.
- Maximum abstraction as permitted by the existing licence has the potential to leave the deprived reach below the Environmental Flow Indicator (EFI) target flow for 336 days a year (on average over 1991-2020), equivalent to 92% of the time. Under the proposed licence conditions, this reduces to 197 days a year on average, equivalent to 54% of the time. Additionally, under the proposed licence, when residual flows are below the EFI, they are only marginally below, where as residual flows are significantly below the EFI in the current fully licenced scenario.
- The Q95 flow (that is, the flow equalled or exceeded for 95% of the time) is used as a standard measure of low flow. Flows would be at or below the natural Q95 (approximately 0.146 m^3/s) for 70% of the time in the current 'fully licensed' scenario (between 1991-2020). This is equivalent to 255 days a year on average, compared to 18 days a year under natural conditions. Under the proposed licence conditions this reduces to 30 days on average a year (8% of the time).
- Inclusion of the higher Hands-Off Flow provides protection of low flows in the deprived reach.
- The 35% take provides variability of flow across the whole flow range.
- The inclusion of a sweetening flow provides some protection of the flow in the leat, although it does cause a small reduction in flow in the deprived reach below Qn95. However, below 0.040 m^3/s (less than Qn99.9) the river is protected as abstraction of the sweetening flow must cease.
- Based on the 1991-2020 record and under the proposed licence conditions, the licence holder would not have been able to abstract the current annual quantity of 16,054,984 m^3/a, as river flows would have restricted abstraction to 9,547,725 m^3/a. Therefore, the EA proposes a reduced annual quantity of 10,502,497 m^3/a. This is 9,547,725 m^3/a plus a 10% buffer to allow the licence holder to benefit from additional flows that may be available in the future due to changes in rainfall patterns. The proposed annual quantity is considered sustainable as the potential for environmental impact by the abstraction is mitigated by the HOF, percentage take and daily licence quantity.

Introduction of the proposed licence conditions will provide significant environmental benefits and will largely mitigate the risk to the ecology from the abstraction. Consequently, the water available for abstraction will be reduced, at low to medium flows.

Contents

Sign off

Version	Date	Status	Drafted by	Checked by
V1	18/06/25	Final report	Harriet Ames	Helen Rossall

1. Introduction

This report describes the hydrological modelling undertaken in support of the Old Walls RSA scheme. Modelling results are presented for the impact of the existing licence (14/46/004/0685) and the proposed alternative licence, which includes amended and additional conditions designed to improve the flow in the deprived reach.

The Old Walls abstraction point is located on the West Webburn river. The abstraction is non-consumptive, meaning that all of the water is returned to the river. However, it leaves a deprived reach between the abstraction point and where the water is returned to the river which is shown in figure 1.

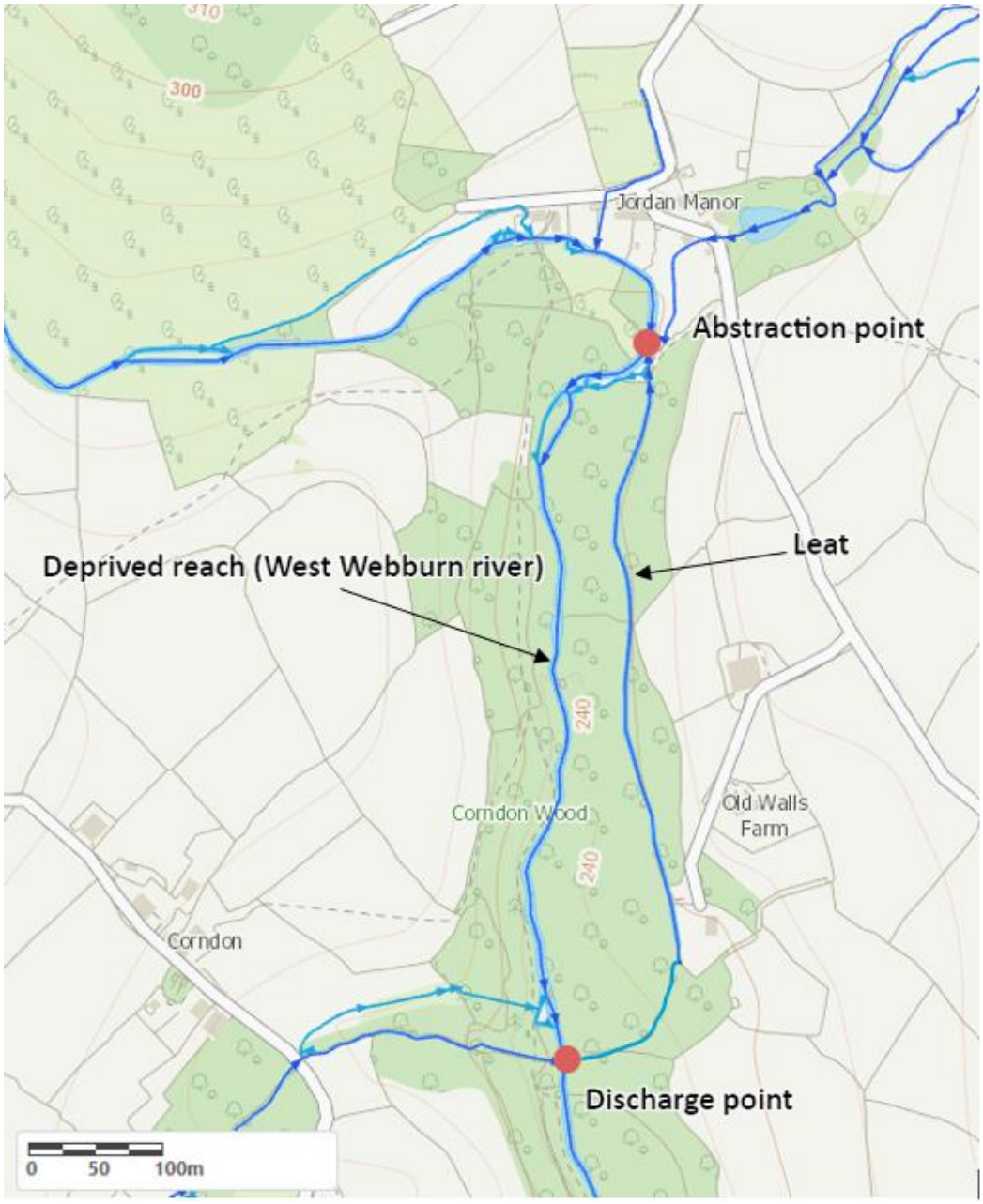

Figure 1 – Old Walls abstraction point and deprived reach

The modelled impact considered in this report applies to the approximately 600 m section of the deprived reach on the West Webburn river.

The modelling calculates the maximum possible volume of water that could be abstracted under the existing licence, and therefore the volume of water that would remain in the deprived reach. Derivation of the flow data used in the modelling is described in Section 2 and Appendix A.

The modelling is repeated with the proposed licence conditions, and the improvement in flows in the deprived reach is quantified. Existing and proposed licence conditions are described in Sections 3 and 4 respectively. The impact of the proposed licence change on the amount of water available to abstract is described in Section 5.

2. Methodology

The analysis of the impact of abstraction on flow requires a time series of daily flow data for a point immediately upstream of the abstraction point. This flow data has been estimated using flows from Austins Bridge gauging station. This is described in Appendix A and summarised below.

The gauged flow data recorded at Austins Bridge has been naturalised to take account of the abstractions, discharges and reservoirs in the catchment. This generates a natural flow sequence, which represents the flow that would have been observed in the absence of artificial influences on flow (such as abstraction). This natural flow sequence is then scaled to the abstraction location in a process known as transposition. The resulting flow data for the abstraction location is therefore modelled rather than directly observed. The flow at the abstraction point is derived using the following equation:

West Webburn at Old Walls natural flow = Austins Bridge natural flow * 0.075

Daily mean flow data for the period 01/01/1991 to 31/12/2022 has been used.

As shown in Appendix A, the derived natural flow data is a good fit to spot flow measurements of the actual flow upstream of the Old Walls abstraction point. The flow upstream of the Old Walls abstraction is considered natural. This shows that the above naturalisation method is suitable for this analysis.

We have modelled the potential impact of the abstraction using Excel formulae that calculate the maximum volume of water that could have been abstracted on each day, given the flow in the river and the abstraction licence conditions. This theoretical maximum abstraction is then subtracted from the natural flow to calculate the flow that would have remained in the river in the deprived reach downstream of the abstraction point in this scenario. This is known as the residual flow. Natural and residual flows are presented in Sections 3 and 4.

Finally, the data has been analysed to calculate the difference in the volume of water available for abstraction under the current and proposed licence conditions. Weekly

abstraction returns have been submitted by the licence holder in line with their current licence conditions. These have been used to calculate monthly average abstraction rates over the period 2016-2021 for comparison with the water available under the current and proposed licence scenarios. This is described in Section 5.

3. Impact of existing licence on river flow

The Old Walls abstraction licence (14/46/004/0685) authorises abstraction by gravity from the West Webburn river at NGR SX 700 749 for the purpose of power generation. Authorised quantities are as follows:

Daily licence quantity: 69,120 cubic metres per day (m^3/d)
Annual licence quantity: 16,054,984 cubic metres per year (m^3/a)
Maximum instantaneous rate: 0.80 cubic metres per second (m^3/s)
Authorised months: All year

Additionally, the licence includes a prescribed flow of 0.025 m^3/s which applies to the ‘flow over the notch of the Jordan Weir at NG4 SX 700 749”. This prescribed flow is less than Qn99.9, and flow did not drop this low naturally in the 1991-2020 period. Although this prevents abstraction of the entire river flow, the abstraction can cause the flow in the deprived reach to flatline at 0.025 m^3/s for long periods of time.

Abstraction at the maximum rate authorised by the licence is referred to as the fully licensed abstraction scenario. The flow downstream of the abstraction is referred to as the residual flow and is the flow that remains in the river in the deprived reach.

The residual flows in the deprived reach are shown in Figure 2. This figure shows the impact of abstracting at the fully licenced rate in a recent dry year (2022). The Environmental Flow Indicator (EFI) is also shown. The Environment Agency uses the EFI to assess where abstraction pressures may start to cause an undesirable effect on river habitats and species.

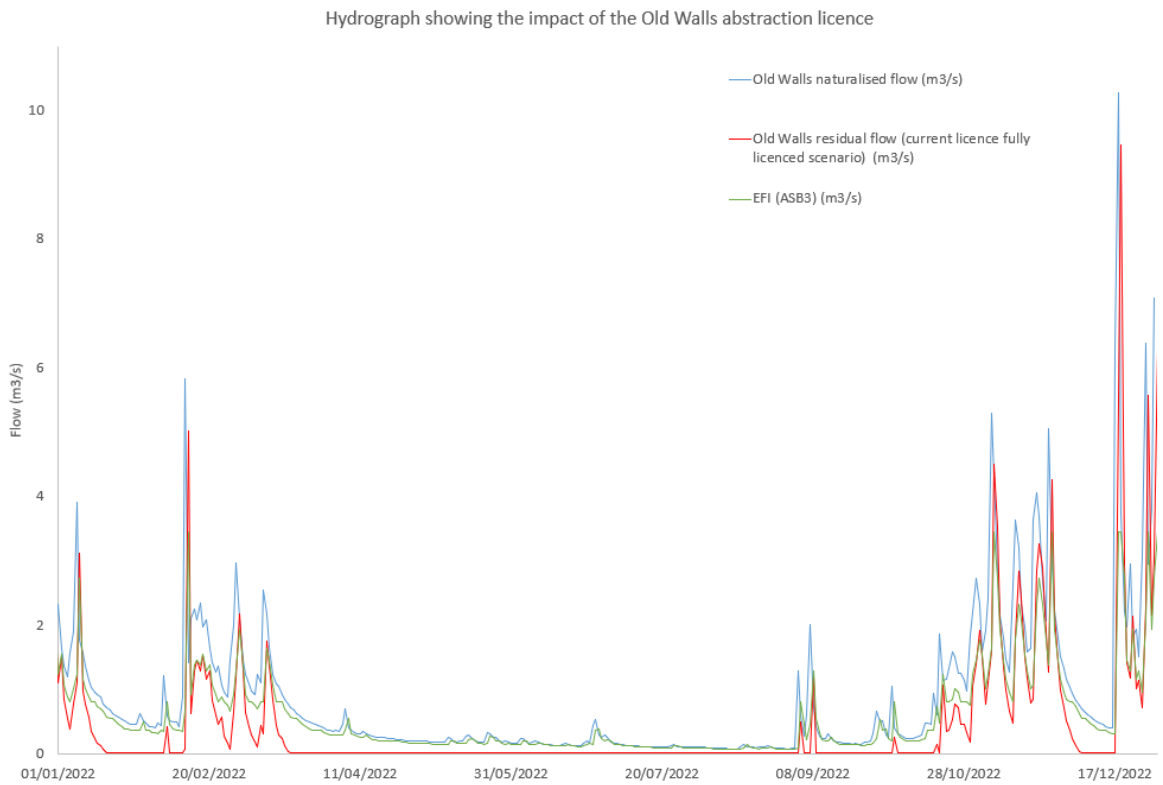

Figure 2 – hydrograph showing the impact of the current Old Walls abstraction licence, showing residual flows in the deprived reach for 2022 along with natural and EFI flows.

It can be seen from Figure 2 that residual flows (red line) flatline below the EFI for long periods during the summer of 2022, which has been chosen as a recent dry year, at times of low flow. There is no variability in flow during this time. Residual flows are below the EFI (green line) between the middle of March and start of September, and for shorter periods at times of low flow throughout the autumn and winter. The difference between the EFI and the residual flow represents water required by the environment but would have been abstracted instead. A larger, annotated version of Figure 2 is shown in Appendix B.

Figure 3 shows a Flow Duration Curve, which enables assessment of the impact of abstraction on flow over a longer period than the hydrograph in Figure 2. The data used covers the 30-year period from 1991 to 2020. This is the standard period used for assessment of water resources availability by the Environment Agency and is equivalent to the standard long-term average period used for rainfall by the Met Office. It therefore represents a reasonable period for quantifying the impacts of abstraction over a longer period.

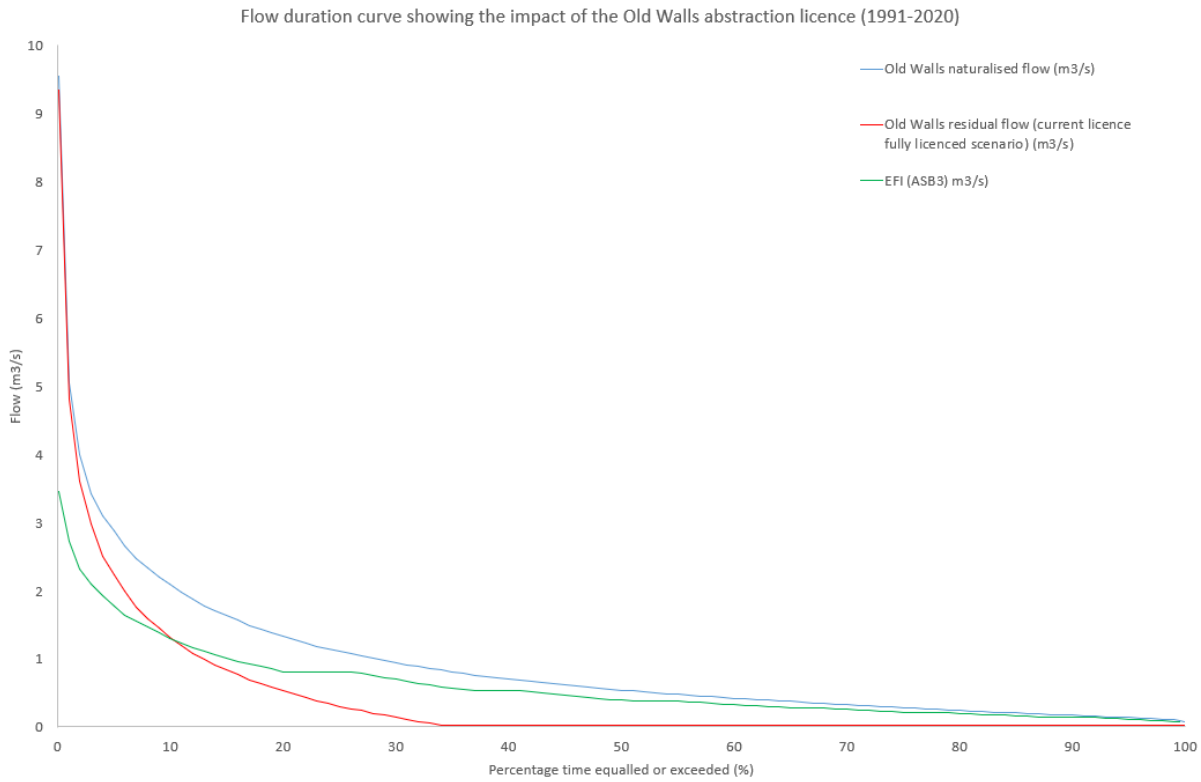

Figure 3 – Flow duration curve showing the fully licenced impact of the current Old Walls abstraction licence, showing residual flows in the deprived reach along with natural and EFI flows for the period 1991-2020.

The flow duration curve shows the proportion of time that a given flow is equalled or exceeded. For example, the flow that is equalled or exceeded for 95% of the time is a low flow, the flow that is equalled or exceeded for 99% of the time is a very low flow. Conversely, the flow that is equalled or exceeded for 1% of the time is a very high flow. These percentages are usually referred to as percentiles. The flow that is equalled or exceeded for 95% of the time is known as the 95th percentile, abbreviated to Q95. This is a standard measure of low flow calculated from the natural flow data.

It can be seen from Figure 3 that the residual flow (red line) is significantly below the natural flow (blue line) and, for flows below Q8, the residual flow is also below the EFI (green line). This equates to 92% of the time during 1991-2020 period. For 65% of the time (at flows below Q35), the flow flatlines at 0.025 m^3/s (HOF).

A larger, annotated version of Figure 3 is shown in Appendix B.

3.1 Abstraction as a proportion of flow

The average impact of abstraction at a range of flows under the current licence is shown in Table 1, along with the allowable abstraction to protect EFI.

Flow	Percentile	Allowable abstraction as % of natural flow (to protect EFI)	Abstraction as % of natural flow (Current licence)
High	30	23	84
Moderate to high	50	25	95
Low to moderate	70	17	93
Low	95	10	83
Very low	99	13	77

Table 1 – maximum licensed abstraction (current licence) and allowable abstraction to protect EFI, as a percent of natural flow . The percentiles 95, 70, 50 and 30 are the standard percentile at which compliance with the EFI is reported. Q99 is included to demonstrate impact on very low (drought) flows. This data is shown as a chart (Figure 6) in Section 5.

Table 1 shows that:

- Abstraction under the current licence is a very large proportion of flow at all flows.
- Abstraction at the current licence is much higher than allowable abstraction to protect EFI at all flows.
- The biggest impact on flow is at Q50.

Additionally, our calculations show that on average over the period 1991-2020, residual flows under the current licence scenario would be below Qn95 (a standard measure of low flow) for 70% of the time, equivalent to 255 days a year on average. This compares to natural flows that would be below Qn95 for 5% of the time (an average of 18 days per year).

3.2 Impact on environmental flow

Our calculations show that residual flows under the current licence scenario would be below the EFI for 336 days on average (1991-2020) and for 339 days in a dry year (2022).

The current licence therefore has the potential to significantly impact the flow in the deprived reach.

4. Impact of proposed licence on river flow

Based on the Environment Agency Guidance for run-of-river hydropower development, the EA have proposed licence conditions to ensure river flows are sufficient to support the ecology of the West Webburn river in the deprived reach. These conditions do not ensure EFI is achieved across the whole FDC. This is because our licencing approach for non-consumptive hydropower schemes allows a small deviation from EFI as the impact is only for a limited length of the overall waterbody and therefore the risk of not achieving good status is lower compared to a consumptive abstraction. These conditions include:

- An increased Hands-Off Flow (HOF) which is the flow below which abstraction for the purpose of hydropower generation must cease
- a '35% take' which means that only 35% of the flow above the HOF may be abstracted
- a 'sweetening flow' which is a volume of water that may be abstracted when the flow in the river is below the HOF. The sweetening flow is designed to prevent the leat drying during extended periods of low flows to protect the ecology within the leat itself. The abstracted water cannot be used for power generation.

The proposed licence conditions are as follows:

Daily licence quantity: 69,120 m^3/d (unchanged)
Annual licence quantity: 10,502,497 m^3/a (reduced)
Instantaneous rate: 0.80 m^3/s (unchanged)
Authorised months: All year (unchanged)
HOF: 0.146 m^3/s (increased)
Percentage take: 35% (new)
Sweetening flow: 0.020 m^3/s (new). If flow in the river drops below 0.040 m^3/s then abstraction into the leat for the purpose of sweetening flow must cease. The water abstracted for the sweetening flow cannot be used for power generation.

The residual flows in the deprived reach obtained by modelling the proposed licence conditions are shown in Figure 4. This figure replicates Figure 2 but with the addition of the proposed licence scenario. It shows the impact of abstraction in a dry year.

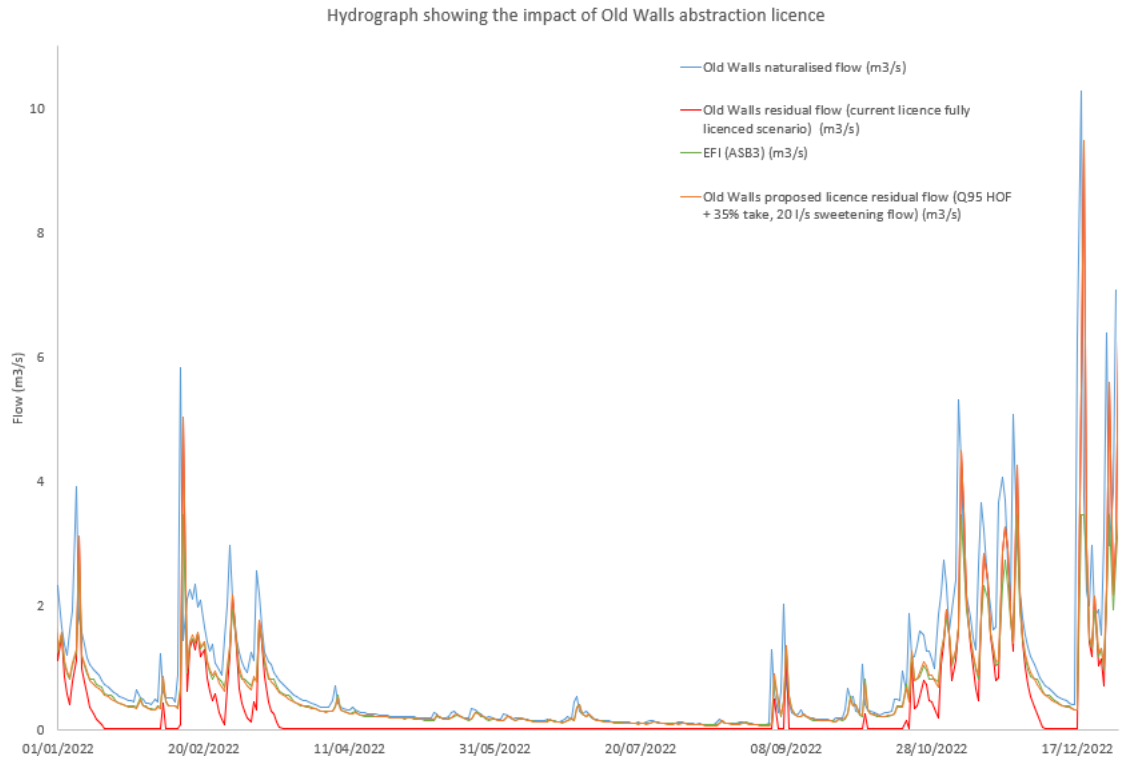

Figure 4 – hydrograph for the West Webburn river at Old Walls showing residual flows in the deprived reach for 2022 (showing impact of abstraction at the current and proposed fully licensed rates, compared with natural and EFI flows).

Figure 4 shows that residual flows in the proposed licence scenario (orange line) are generally very similar to the EFI. There are times where residual flow is marginally below the EFI, but residual flows are still higher than in the current licence scenario. The new 35% take condition ensures flow variability is maintained at all flows. The difference between the proposed licence scenario (orange line) and the current licence scenario (red line) is the water that the environment will gain by introduction of the proposed licence conditions. It is also water that will no longer be available for abstraction and therefore water that the licence holder will lose. The potential significance of this is considered in Section 5. A larger, annotated versions of Figure 4 is shown in Appendix C.

Figure 5 shows the 1991-2020 Flow Duration Curve with the proposed licence scenario added.

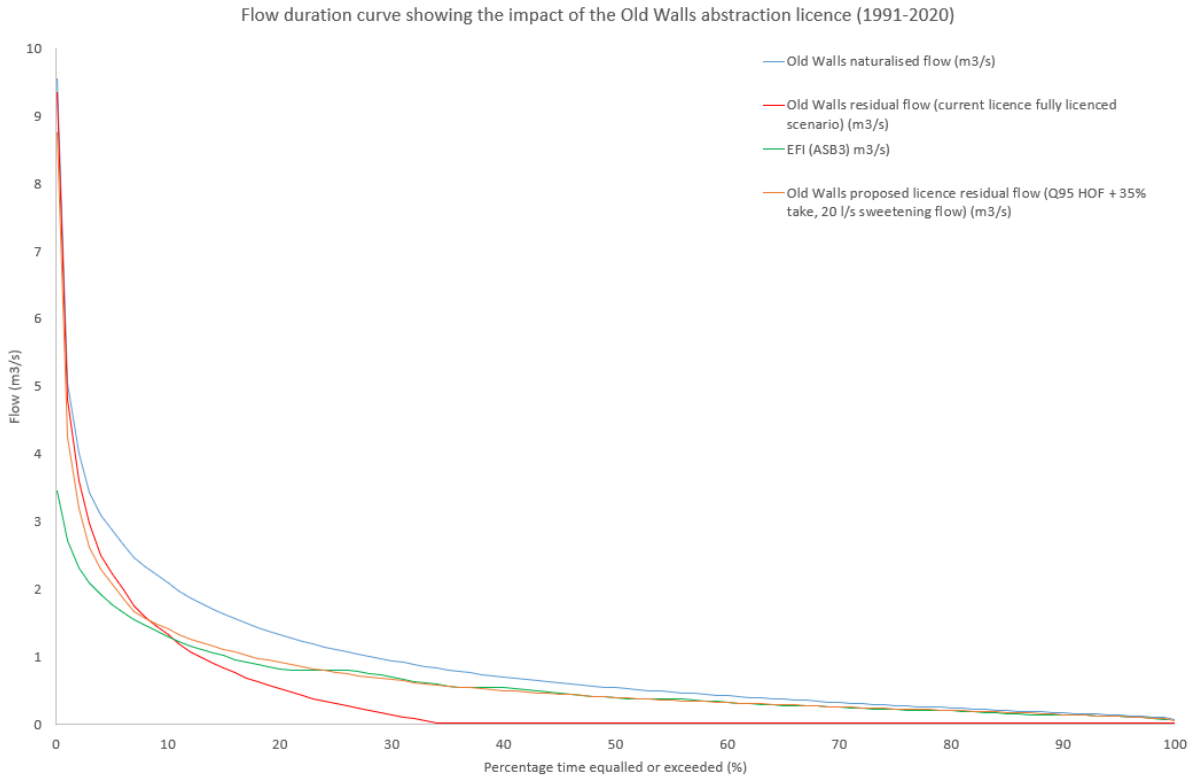

Figure 5 – Flow Duration Curve for the West Webburn river at Old Walls showing residual flows in the deprived reach (1991-2020) (showing impact of fully licenced abstraction in the current and proposed licence scenarios, compared to natural and EFI flows)

Figure 5 shows that in the current licence scenario, the residual flow drops and remains below the EFI at Q9 and below. In the proposed licence scenario, residual flows remain above the EFI until Q24. At flows at and below Q24, residual flows are only marginally below the EFI at some percentiles. This is a big improvement since in the current licence scenario, residual flows flatline at the prescribed flow, which is significantly below the EFI, for 65% of the time. This improvement is due to the introduction of the 35% take condition and the increased hands-off flow.

At very low flows (below Q95), abstraction of the sweetening flow causes residual flows to drop below the EFI, although flows are still significantly higher than under the current licence scenario at these flows.

A larger, annotated version of Figure 5 is shown in Appendix C.

Based on the 1991-2020 record and under the proposed licence conditions, the licence holder would not have been able to abstract the current annual quantity of 16,054,984 m^3/a, as river flows would have restricted abstraction to 9,547,725 m^3/a. Therefore, the EA proposes a reduced annual quantity of 10,502,497 m^3/a. This is 9,547,725 m^3/a plus a 10% buffer to allow the licence holder to benefit from additional flows that may be available in the future due to changes in rainfall patterns. The proposed annual quantity is considered sustainable as the potential for environmental impact by the abstraction is mitigated by the HOF, percentage take and daily licence quantity.

4.1 Abstraction as a proportion of flow

The average impact of abstraction on a range of flows under the proposed licence is compared to the impact under the current licence and the allowable impact to protect EFI in Table 3.

Flow	Percentile	Allowable abstraction as % of flow (to protect EFI)	Abstraction as % of flow (Current licence)	Abstraction as % of flow (Proposed licence)
High	30	23	84	30
Mod to high	50	25	95	26
Low to mod	70	17	93	20
Low	95	10	83	14
Very low	99	13	77	18

Table 3 – maximum licensed abstraction as a percent of natural flow (current and proposed licence). This data is shown as a chart (Figure 6) in Section 5.

Table 3 shows that:

- Abstraction is a much smaller proportion of flow at low flows under the proposed licence compared to abstraction under the current licence.
- Abstraction under the proposed licence is mariginally higher than allowable abstraction to achieve EFI, at all flows.
- The biggest impact on flow under the proposed licence is at Q50 but it is lower than under the current licence
- Under the proposed licence the percentage impact is lower at Q95 than at Q99. This reflects the fact that the sweetening flow is a larger proportion of the flow at very low flows.

Under the proposed licence, residual flows would be below Qn95 (a standard measure of low flow) for 8% of the time, equivalent 30 days on average. This is a slightly higher frequency than in the natural flow scenario (as a sweetening flow can be abstracted when flow is below the HOF) but a significant improvement on the current licence scenario where residual flows would be below Qn95 for 255 days a year.

4.2 Impact on environmental flow

Under the proposed licence conditions, residual flows would be below the EFI for 197 days on average (1991-2020) and for 181 days in a dry year (2022) equivalent to 50% of the year. This is compared to the current licence in Table 4.

	Days below EFI Current licence	**Days below EFI Proposed licence**	**Difference**
Average (1991-2020)	336	197	139
Dry year (2022)	339	181	158

Table 4 – number of days per year where residual flow is below EFI in current and proposed licence scenarios

There are significantly fewer days where residual flow is below the EFI in the proposed licence scenario, both on average (1991-2020) and in a dry year (2022). Additionally, even though there are still many days below the EFI in the proposed licence scenario, many of these days are only very slightly below the EFI and largely result from the fact that the 35% take allows abstraction of a slightly larger proportion of the flow than permitted by the EFI. In the 2022 dry year, the difference equates to an additional 158 days with flow above the EFI. The proposed licence conditions therefore provide a considerable improvement on the current licence scenario.

5. Impact of proposed licence change on potential abstraction volumes

The modelled abstraction data has been analysed to calculate the difference in the volume of water available for abstraction under the current and proposed licence conditions.

Table 6 shows the number of days that abstraction for power generation would be possible (at any volume) and the number of days that abstraction would be possible at the maximum licensed instantaneous rate under the current and proposed licence conditions.

	Period	Current licence	Proposed licence
Number of days per year where abstraction for power generation is possible	1991-2020	365	179
	2022	365	140
Number of days per year abstraction at maximum rate	1991-2020 average	126	27
	2022	116	26

Table 6 – number of days (per year) when abstraction for power generation is possible and the number of days abstraction would be possible at the maximum licensed rate, on average over the long-term period assessed (1991-2020) and in a dry year (2022).

The number of days where abstraction for power generation is possible decreases from all year in the current licence scenario to 179 days on average over 1991-2020 and 140 days in 2022 (a dry year). Days where abstraction for hydropower is possible has been calculated by finding days where the natural flow is above the Hands-Off flow, and there is at least 0.008 m3/s available for abstraction (this is the hydropower start up flow).

Under the current licence, abstraction at the maximum rate of 0.8 m^3/s could occur on 126 days a year on average over 1991-2020, decreasing to 116 days in a dry year (2022). Under the proposed licence, this decreases to 27 days on average over 1991-2020 and 26 days in a dry year (2022).

Figure 6 compares the average monthly actual abstraction (2000-2022) calculated from weekly returns provided by the licence holder, to the monthly average abstraction allowed under the current and proposed licence scenarios (2000-2022).

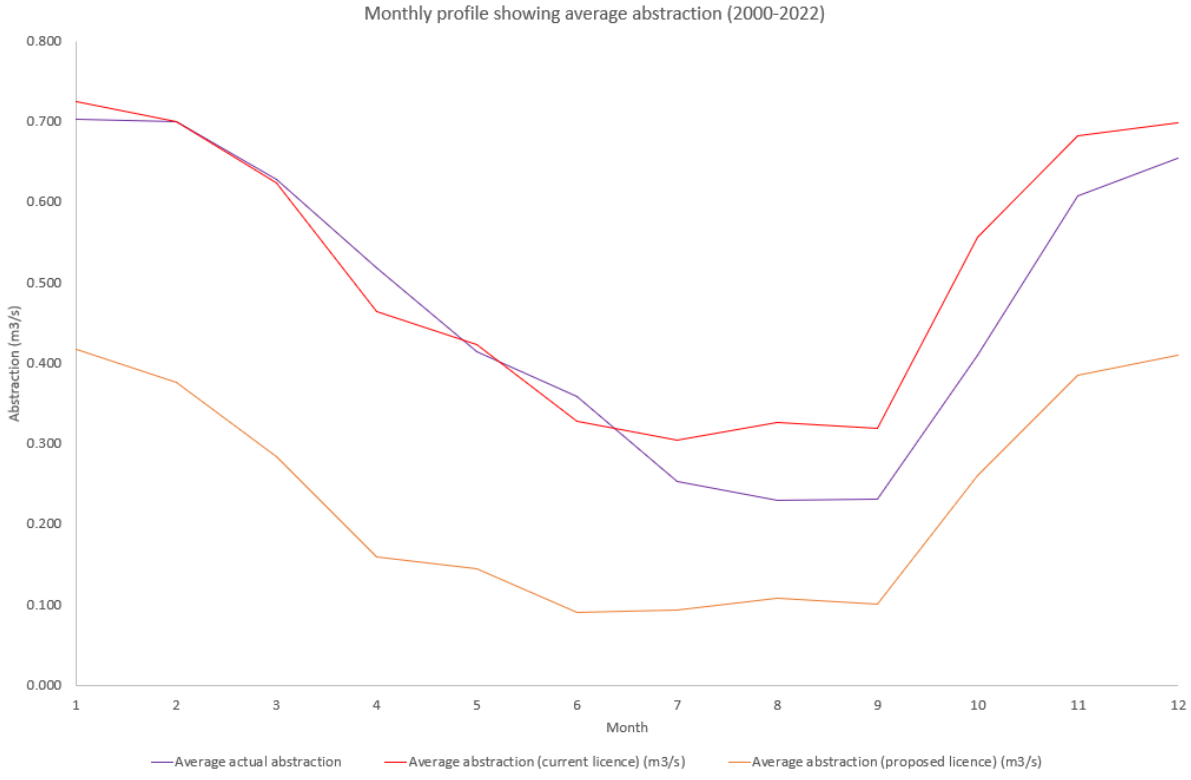

Figure 6 – Monthly profile showing the average 'actual abstraction', and abstraction allowed under the current and proposed fully licenced scenarios (2000-2022)

This shows that actual abstraction (purple line) is similar to the abstraction allowed under the current licence (red line) between January and June. From July to December the actual abstraction is less than the abstraction allowed under the current licence; on average (2000-2022) annual actual abstraction is 92% of the annual fully licenced abstraction (current licence). Actual abstraction is higher than abstraction allowed under the proposed licence throughout the year; on average (2000-2022) annual fully licenced (proposed licence) abstraction is 46% of the annual fully licenced abstraction (current licence). Table 7 shows the minimum, median and maximum difference between annual average actual abstraction and average annual fully licenced abstraction (proposed licence) over the period 2000-2022. This indicates the likely impact the proposed licence will have on the licence holder.

	Difference between annual average actual abstraction and annual fully licenced abstraction (proposed licence) (m3/year)
Maximum (2000-2022)	10,283,318
Median (2000-2022)	7,696,837
Minimum (2000-2022)	5,214,142

6. Conclusion

Abstraction under the current licence could cause a significant impact on flow in the deprived reach. The current hands-off flow is less than the natural Q99.9 flow, and abstraction can cause the flow to flatline for long periods at this threshold. Residual flows would be below the EFI for 336 days on average (1991-2020) and for 339 days in a dry year (2022). Flows would be at or below the natural Q95 (approximately 0.146 m3/s) for 70% of the time in the 'fully licensed' scenario (over 1991-2020). This represents a potential significant detrimental impact on the ecology and habitats within the deprived reach.

Inclusion of the proposed licence conditions, proposed by the EA based on the Environment Agency Guidance for run-of-river hydropower, sufficiently mitigates the impact of the abstraction. Abstraction under the proposed licence conditions is a much smaller proportion of flow across the flow duration curve. The inclusion of the proposed hands-off flow and 35% take conditions reduces the number of days per year where flows are below the EFI from 336 days to 197 days on average (1991-2020) and from 339

to 181 days in a dry year. Under the proposed licence, even where flows do not meet the EFI, residual flows are much higher than under the current licence and flow variability is protected.

Introduction of the proposed licence conditions will reduce the amount of water available for abstraction. However, the proposed conditions will provide a fairer share of water for the West Webburn river, whilst still allowing the licence holder to abstract for the purpose of power generation. This will provide significant environmental benefits and will largely mitigate the risk to the ecology from the abstraction.

Appendix A – Naturalised flow estimates

There is no continuous measurement of flow on the West Webburn river at the abstraction location. In this situation flows can be estimated by using data from a nearby gauging station and scaling it to the required location. This assumes that the catchments of two locations have similar rainfall and that the rivers respond to rainfall in a similar way. Ideally therefore the 'donor' gauge is located in the same catchment, either directly upstream or downstream of the ungauged location.

In this instance, the nearest appropriate gauging station is at Austins Bridge on the River Dart, around 14 km downstream of the abstraction point. The locations are shown on the map in Figure A1.

The gauged flow data recorded at Austins Bridge has been 'naturalised' to take account of the abstractions, discharges and reservoirs in the catchment. This generates a natural flow sequence, which represents the flow that would have been observed in the absence of artificial influences on flow (such as abstraction). This natural flow sequence is then scaled to the abstraction location in a process known as transposition. The resulting flow data for the abstraction location is therefore modelled rather than directly observed. The flow at the abstraction point is derived using the following equation:

West Webburn at Old Walls natural flow = Austins Bridge natural flow * 0.075

Daily mean flow data for the period 01/01/1991 to 31/12/2020 has been used to derive long term Flow Duration Curves (see main report). Additionally, data for 01/01/2022 to 31/12/2022 has been used to represent a recent dry year.

In order to check the validity of the modelled flows, the data has been compared to 'spot flow' measurements taken at the abstraction location. These measurements are instantaneous measurements of the flow taken using a current meter or other portable equipment, rather than using a permanent gauging station.

For the West Webburn River abstraction location, there are five spot flow measurements over the period 1991-2018. Figure A2 show the natural flow upstream of the Old Walls abstraction point for 1991, with the spot flow measurements plotted. Figure A3 shows the same for 1997. Figure A4 shows the same for 2018. It can be seen from the graphs that the modelled flows are a good fit to the spot flow measurements. This means the modelled natural flow data is a good representation of the flow at the abstraction point and is suitable for use in the assessment.

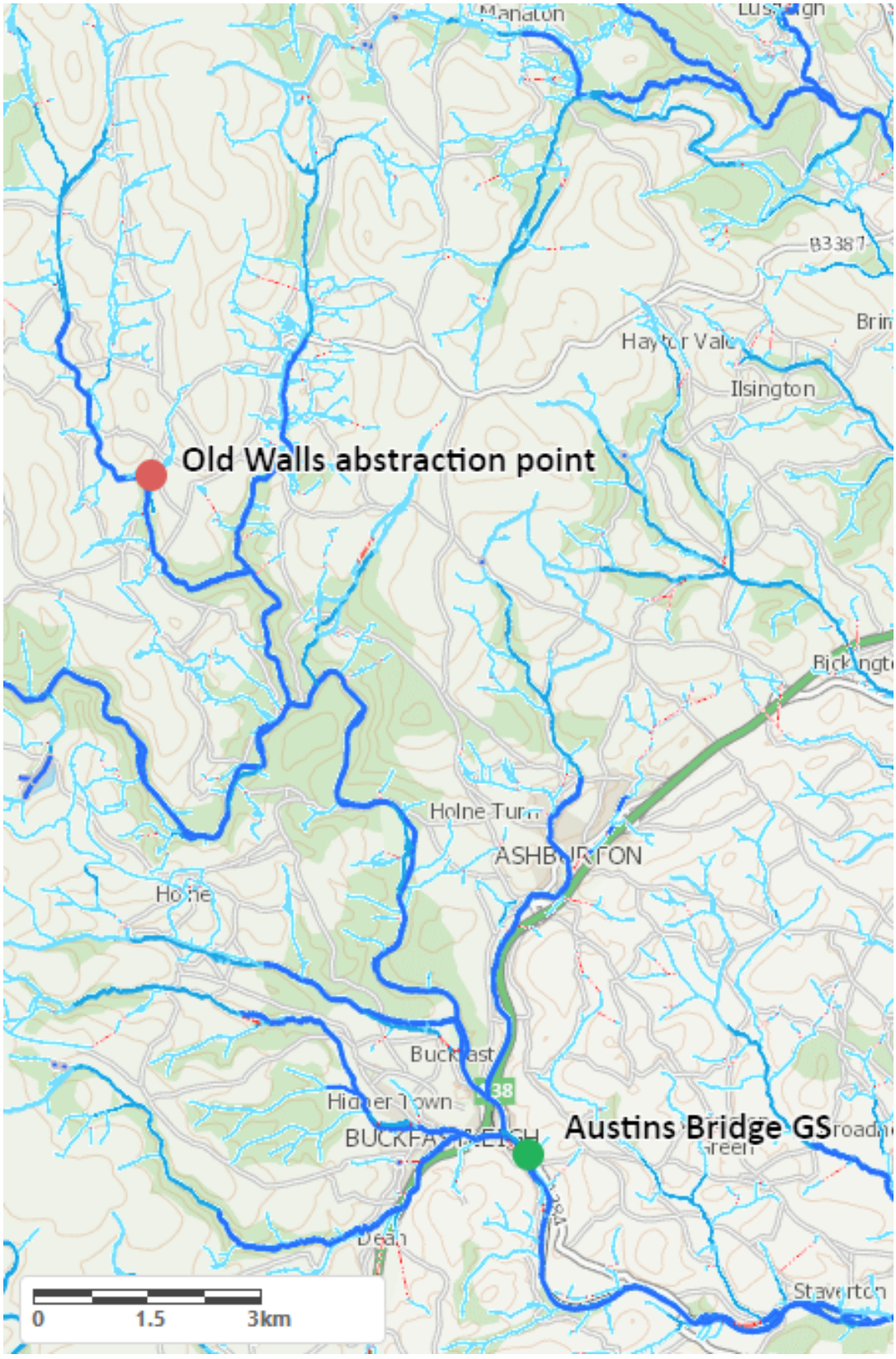

Figure A1 – Map showing the abstraction point (top left) and Austins Bridge gauging station (bottom right)

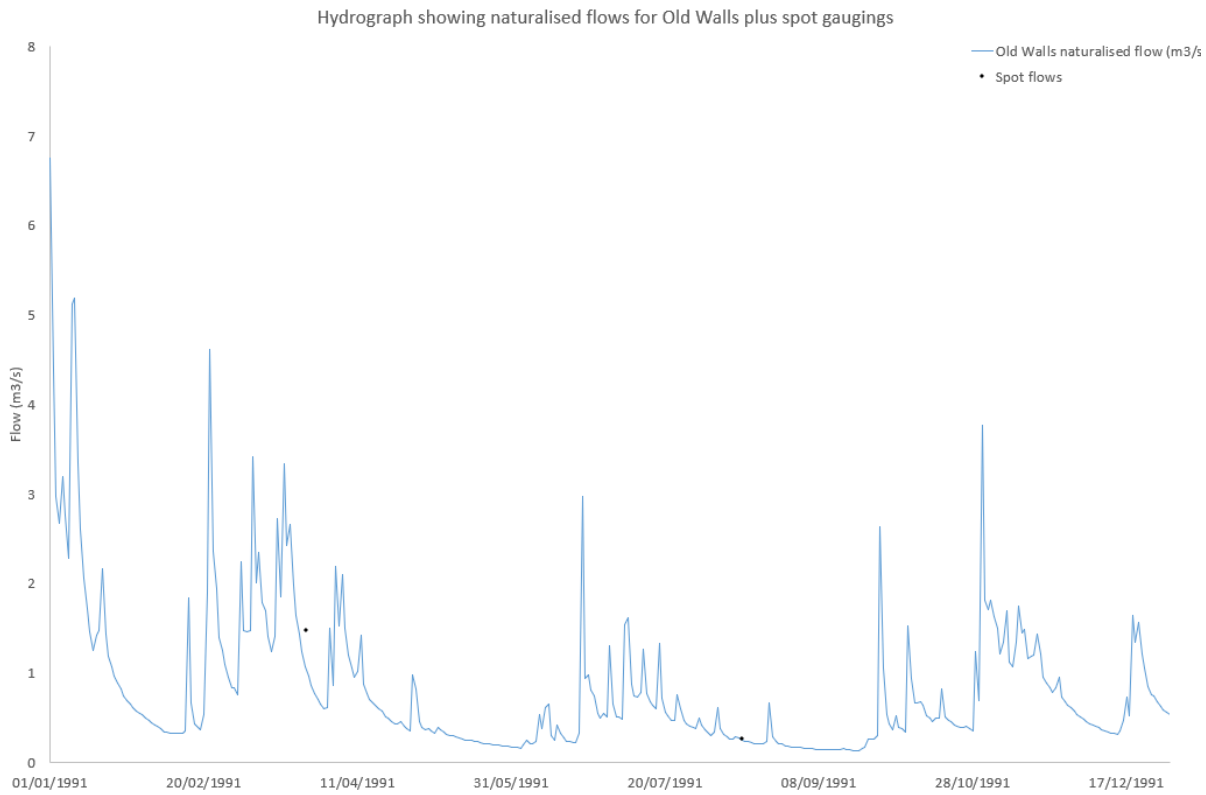

Figure A2 – Hydrograph for Old Walls abstraction point showing spot flow measurements for validation (1991)

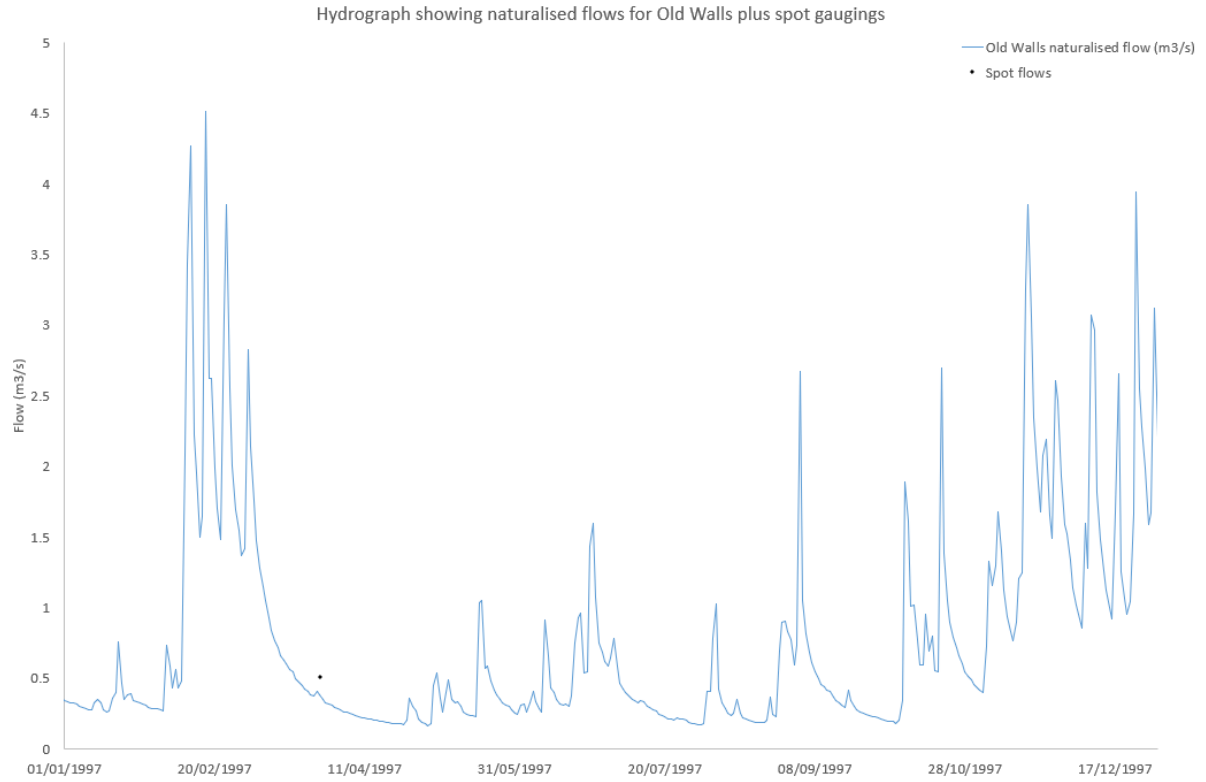

Figure A3 – Hydrograph for Old Walls abstraction point showing spot flow measurements for validation (1997)

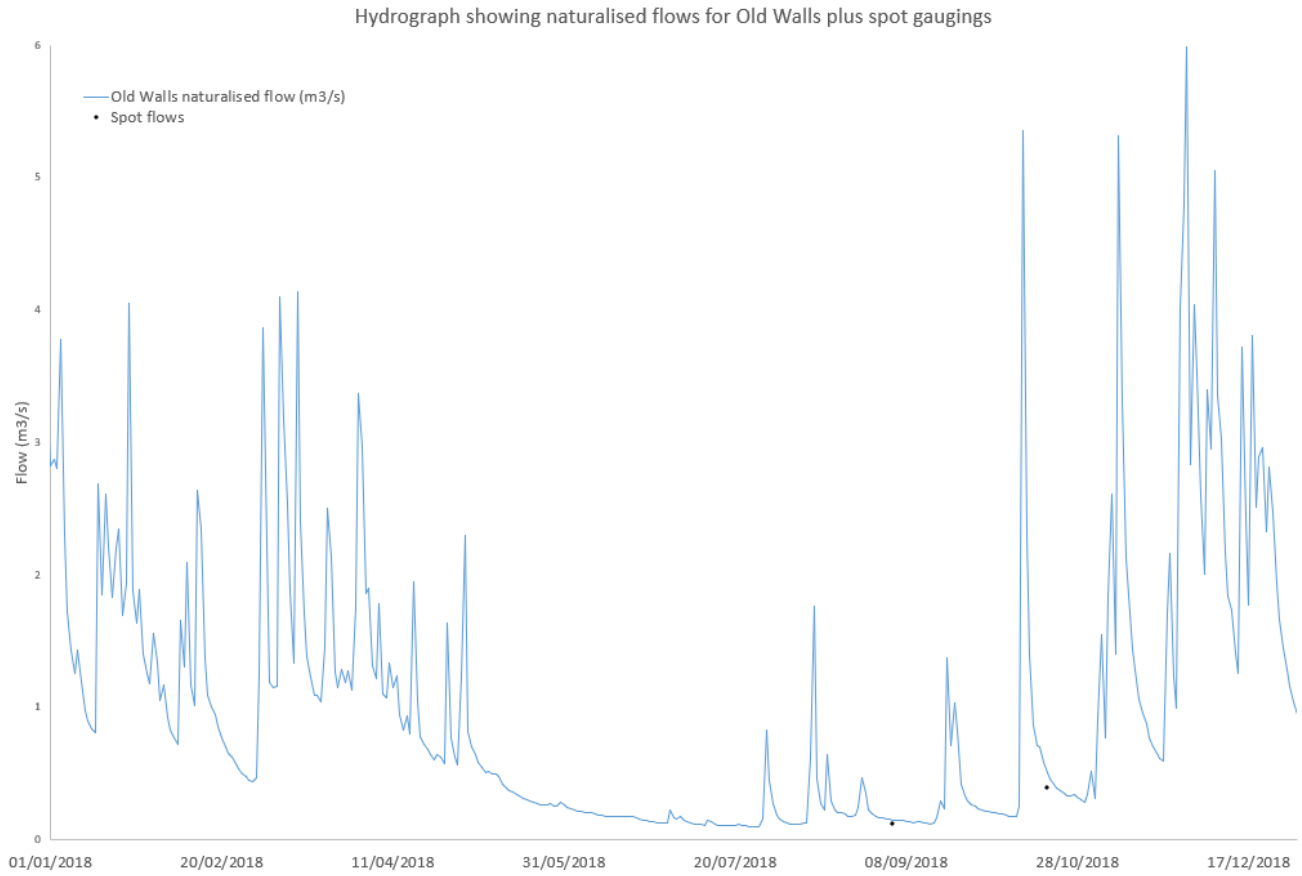

Figure A4 – Hydrograph for Old Walls abstraction point showing spot flow measurements for validation (2018)

Appendix B – Annotated versions of Figures 2 and 3

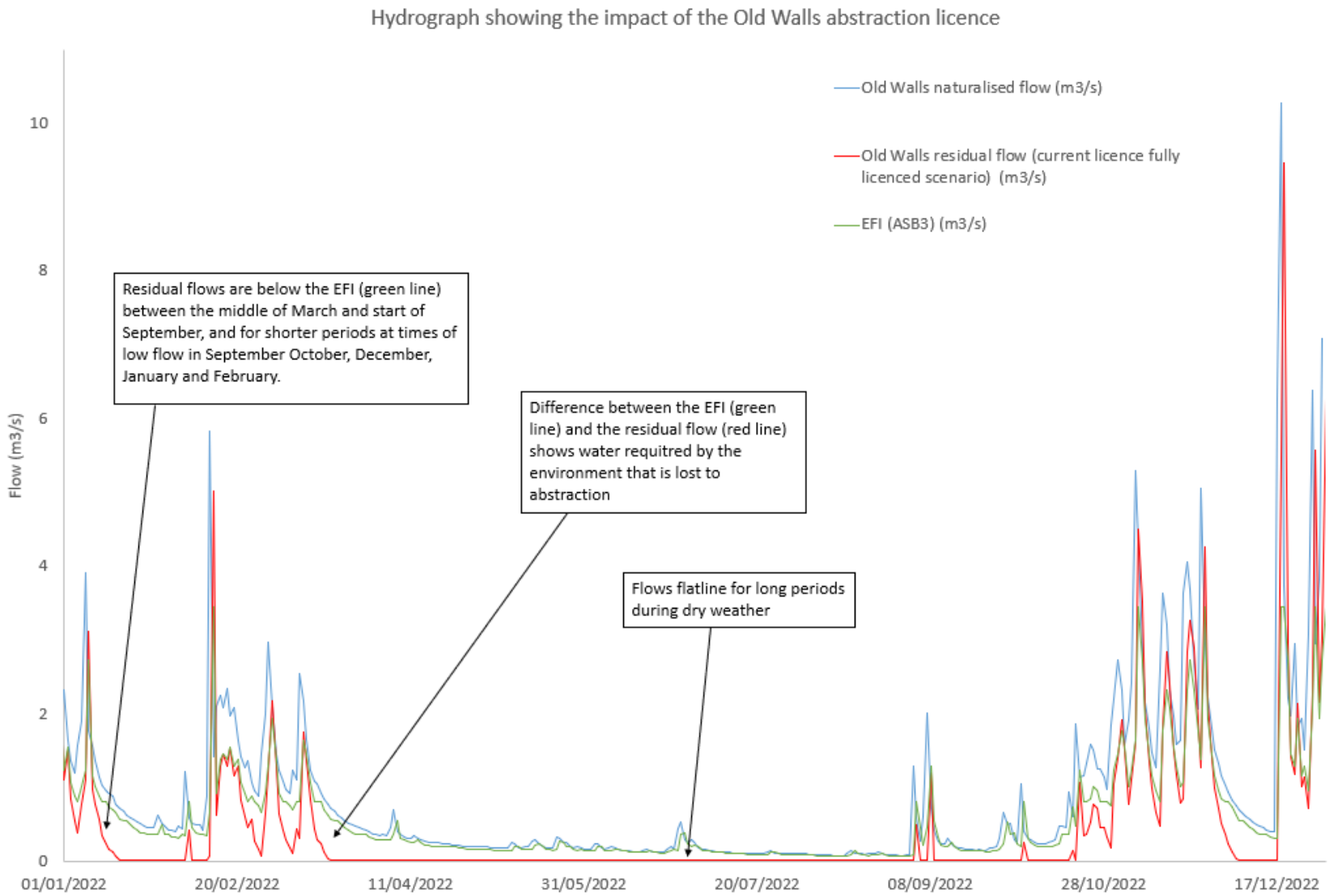

Figure 2 – hydrograph showing the impact of the current Old Walls abstraction licence, showing residual flows in the deprived reach for 2022 along with natural and EFI flows.

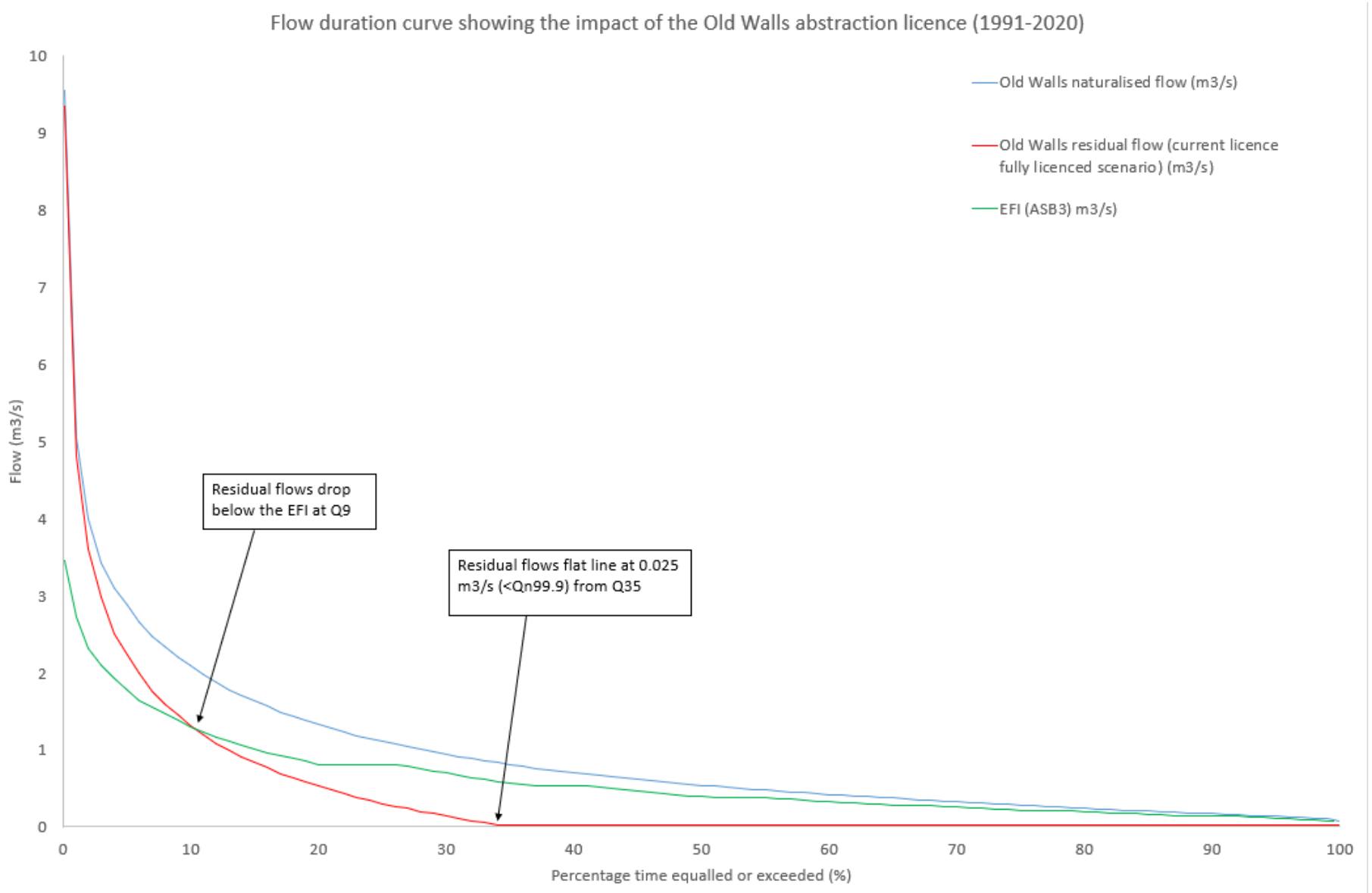

Figure 3 – Flow duration curve showing the fully licenced impact of the current Old Walls abstraction licence, showing residual flows in the deprived reach along with natural and EFI flows for the period 1991-2020.

Appendix C – Annotated versions of Figures 4 and 5

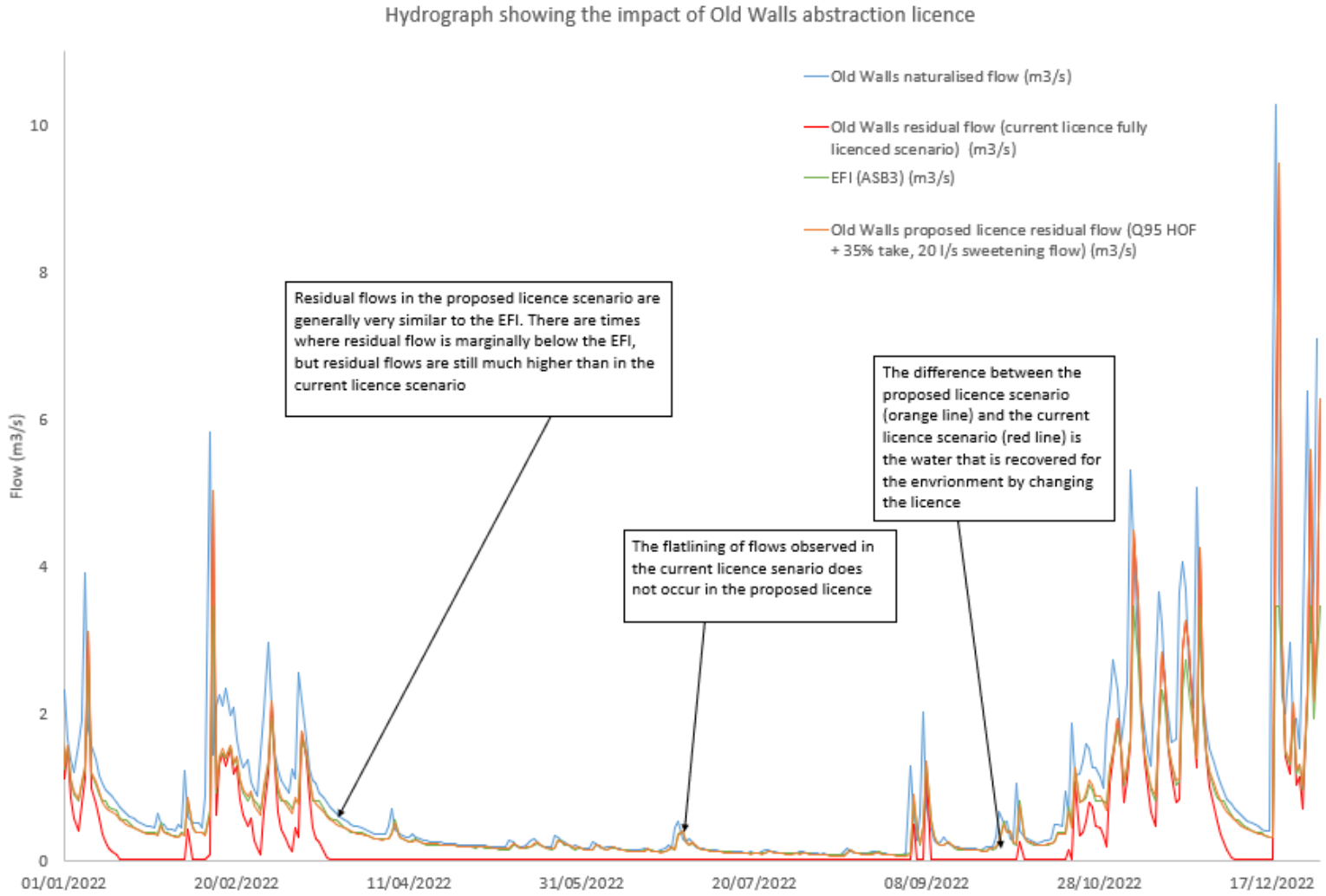

Figure 4 – hydrograph for the West Webburn river at Old Walls showing residual flows in the deprived reach for 2022 (showing impact of abstraction at the current and proposed fully licensed rates, compared with natural and EFI flows).

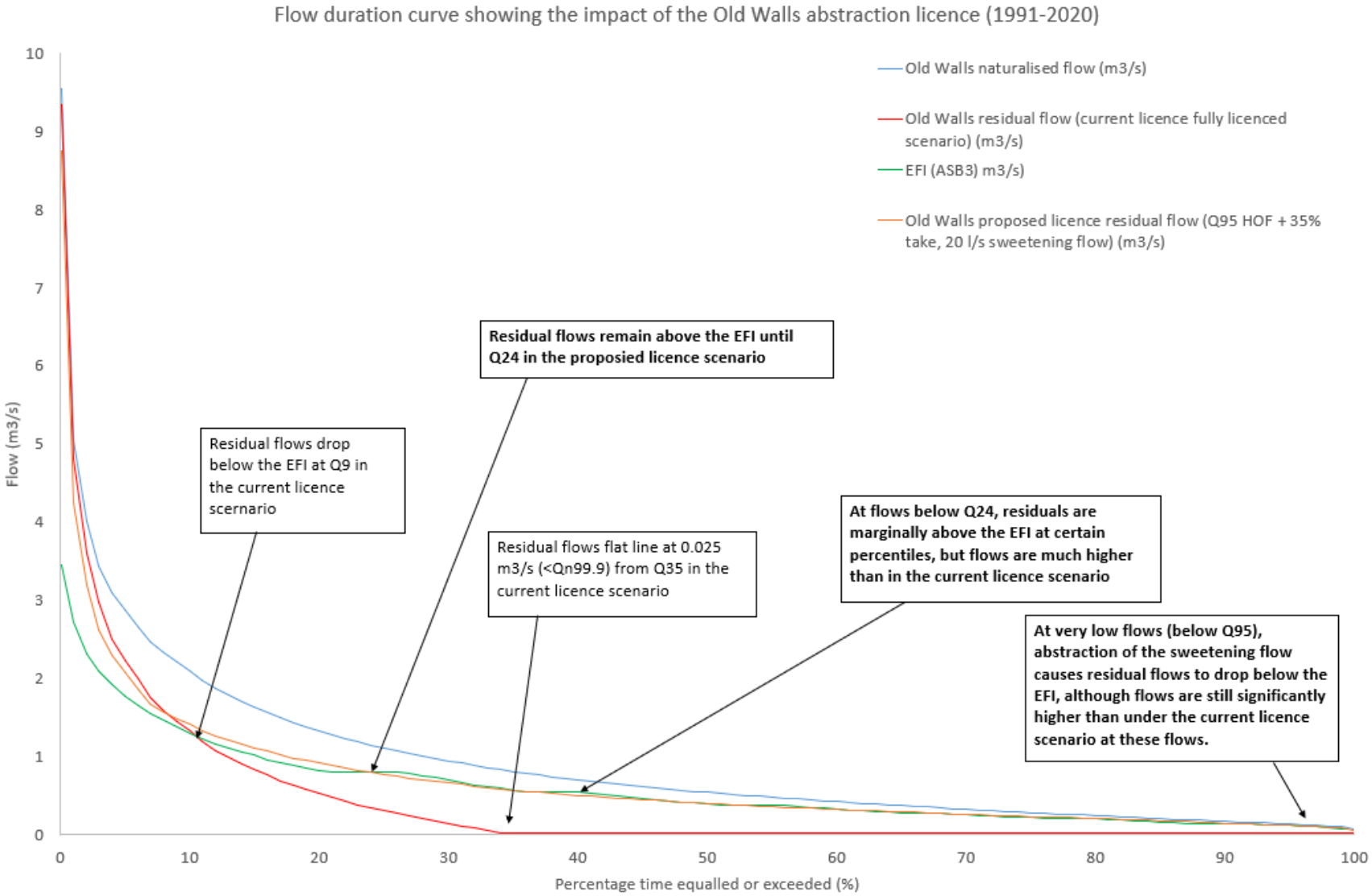

Figure 5 – Flow Duration Curve for the West Webburn river at Old Walls showing residual flows in the deprived reach (1991-2020) (showing impact of fully licenced abstraction in the current and proposed licence scenarios, compared to natural and EFI flows)