HOAROAK WATER - FLOW ASSESSMENT
Revised Oct-2018b

Introduction

An assessment was undertaken to determine whether the LowFlows Enterprise software provides an accurate prediction of the flow characteristics with the East Lyn Catchment (Hoaroak Water being a tributary of the East Lyn).

There have been no spot gaugings on Hoaroak Water, but the Environment Agency provided the following gaugings for the East Lyn at Brendon (Grid Ref. SS777481). This location has a catchment area of 46.9km².

Spot Gauging : the East Lyn at Brendon		
DATE	TIME	FLOW (m3/s)
04/02/2005	12:46:00	1.120
21/07/2005	13:22:59	0.348
08/09/2005	16:12:59	0.243
05/01/2006	11:16:59	1.690
19/09/2006	10:11:00	0.205
13/02/2007	10:31:59	3.690
08/03/2007	10:51:59	5.210
10/12/2007	13:54:00	7.980
21/02/2008	12:23:00	0.868

These gauge points can be used to develop an estimated Flow Duration Curve for the East Lyn using a 'matched pairs' analysis, as described below. This curve can then be compared to the Flow Duration Curve predicted by LowFlows.

'Matched Pairs' Analysis

Analogue Gauge

In this analysis, the spot-gaugings at the site in question (ie. Brendon) are compared with the Average Daily Flow (ADF) data from a nearby 'analogue' gauging station.

Two analogue gauges were considered:

- Horner Water at West Luccombe (catchment area of 20.8 km²).
- The River Yeo at Collard Bridge (catchment area of 79.6km²).

However the National River Flow Archive notes that the runoff into Horner Water is influenced by Nutscale Reservoir, which especially affects the lower flows. The site on the River Yeo has minimal influences on either runoff or abstraction, and since it also has a more comparable catchment area, was selected as the more suitable analogue gauge.

Methodology

Following the 'matched pairs' methodology of Young et al.[1], the steps are as follows:

1. *Confirm a reasonable match in the two sets of data-points (i.e. the spot flows on the East Lyn and the ADF values on the Yeo on the same dates):*

[1] *How much water can a river give? Uncertainty and the flow duration curve.* Paul Copestake & Andrew Young, BHS 10th National Hydrology Symposium, 2008

In this case, Figure 1 plots each pair of points for the 9 dates listed above against the exceedance value for each ADF value on the River Yeo. The long-term FDC for the Yeo is also shown, passing through those 9 ADF data points. Note that the Yeo and the East Lyn are plotted on different scales. It can be seen that the spot-flows on the East Lyn are well-matched to the shape of the FDC for the Yeo.

2. *Plot the daily spot-gaugings from the site against the equivalent ADF values from the analogue gauge, using a log-log scale. Determine the equation of the best fit line through these points.*

   Figure 2 plots the East Lyn data-points on the Y-axis vs the Yeo ADF data on the X-axis, showing a good linear correlation.

   The equation of this line is then taken as the presumed relationship between the long-term flow characteristics for the 2 sites, in this case y = 0.8721x - 0.0826 (where x and y are still logarithmic values).

3. *Using the above equation, plot the modelled Flow Duration Curve for the gauged site, based on the long-term Flow Duration Curve for the analogue site.*

   Figure 3 plots the predicted Flow Duration Curve for the East Lyn, also showing the 9 spot-flows to confirm the good fit.

4. *Compare this curve with that produced by the chosen flow model (i.e. LowFlows in this case).*

   Figure 4 superimposes the FDC predicted by the LowFlows model onto the curve produced by the matched-pairs analysis

Conclusions

- Figure 4 confirms an almost identical match between the two predicted Flow Duration Curves from Q99 up to Q20.

- There is some modest divergence at flows above Q20, with LowFlows predicting slightly greater flows. The two sets of Exceedance data are tabulated in full below, together with the ratio of Matched Pairs vs LowFlows, confirming that this ratio only drops below 95% at Q15 and higher.

THE EAST LYN AT BRENDON			
	A	**B**	
Exceedance	Matched Pairs	LowFlows	**Ratio A:B**
	m³/sec	m³/sec	%
1%	7.534	9.631	78.2%
2%	6.533	7.630	85.6%
5%	4.953	5.470	90.6%
10%	3.771	4.009	94.1%
15%	3.093	3.229	95.8%
20%	2.643	2.690	98.2%
25%	2.249	2.283	98.5%
30%	1.934	1.967	98.3%
40%	1.447	1.506	96.1%
50%	1.143	1.180	96.9%
60%	0.920	0.923	99.7%
70%	0.727	0.721	100.8%
75%	0.627	0.632	99.2%
80%	0.537	0.547	98.2%
85%	0.454	0.467	97.2%
90%	0.382	0.391	97.6%
95%	0.298	0.305	97.8%
99%	0.175	0.204	86.0%

- Quantification of the uncertainty was undertaken by APEM (see Section 7 of the Main Report). Their analysis concluded that "the *modelled flows on the East Lyn using the matched pairs analysis are within the 68% confidence intervals of the regression for flows from Q99.9 to Q1. The LowFlows output therefore represents an accurate prediction of flow characteristics in the East Lyn catchment and no scaling or adjustment of flows predicted by LowFlows is deemed necessary for Hoaroak Water."* [NB. the 68% confidence interval is consistent with EA's HydroLOC (Hydrological Level of Uncertainty) tool]

- One can therefore conclude that it is valid to use the LowFlows model as a predictive tool for Hoaroak Water (a major tributary to the East Lyn) without further adjustment.

- The resulting Flow Duration Curve for Hoaroak, generated by LowFlows, is tabulated below and depicted in Figure 5. This curve will be used in the prescribed flow and energy output calculations within the Abstraction License application.

%Exc.	Hoaroak LowFlows
	m^3/s
1%	1.785
5%	1.015
10%	0.744
15%	0.599
18%	0.534
20%	0.499
25%	0.424
30%	0.365
35%	0.319
40%	0.280
50%	0.219
60%	0.172
70%	0.134
75%	0.118
80%	0.102
90%	0.073
95%	0.057
99%	0.038
MEAN FLOW:	**0.339**

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Figure 1 : Comparison of spot-flows : East Lyn vs River Yeo

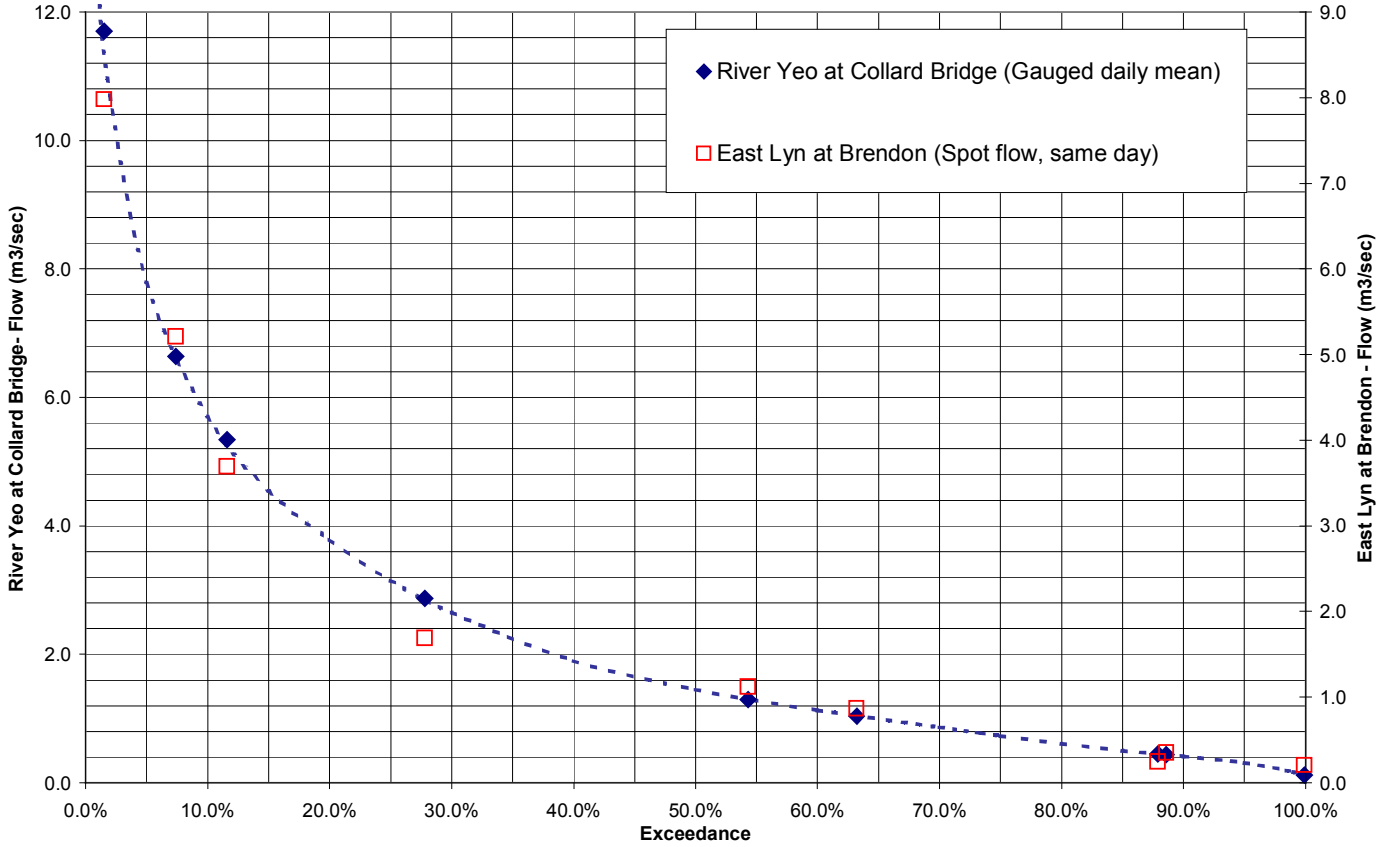


Figure 2 : Correlation of Daily Flows (Log-Log)

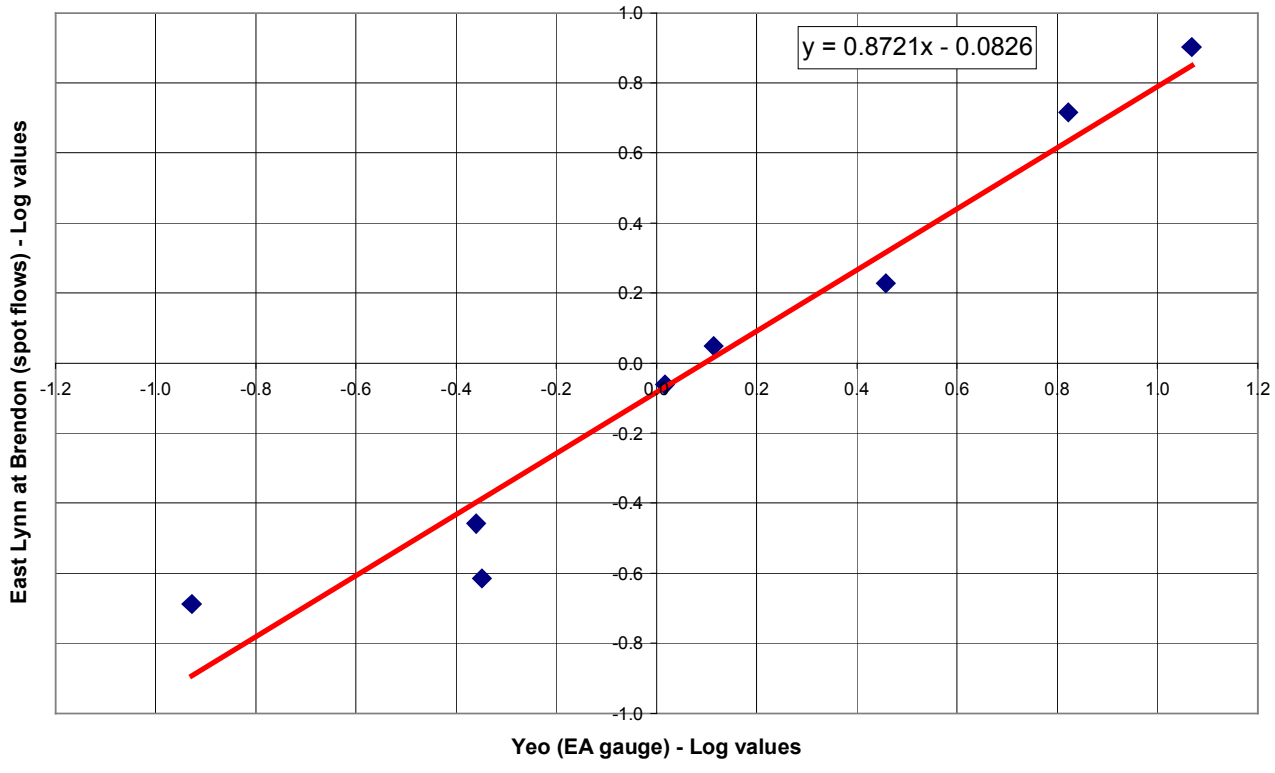


Figure 3 : East Lyn at Brendon – Flow Duration Curve deduced by a Matched-Pairs analysis

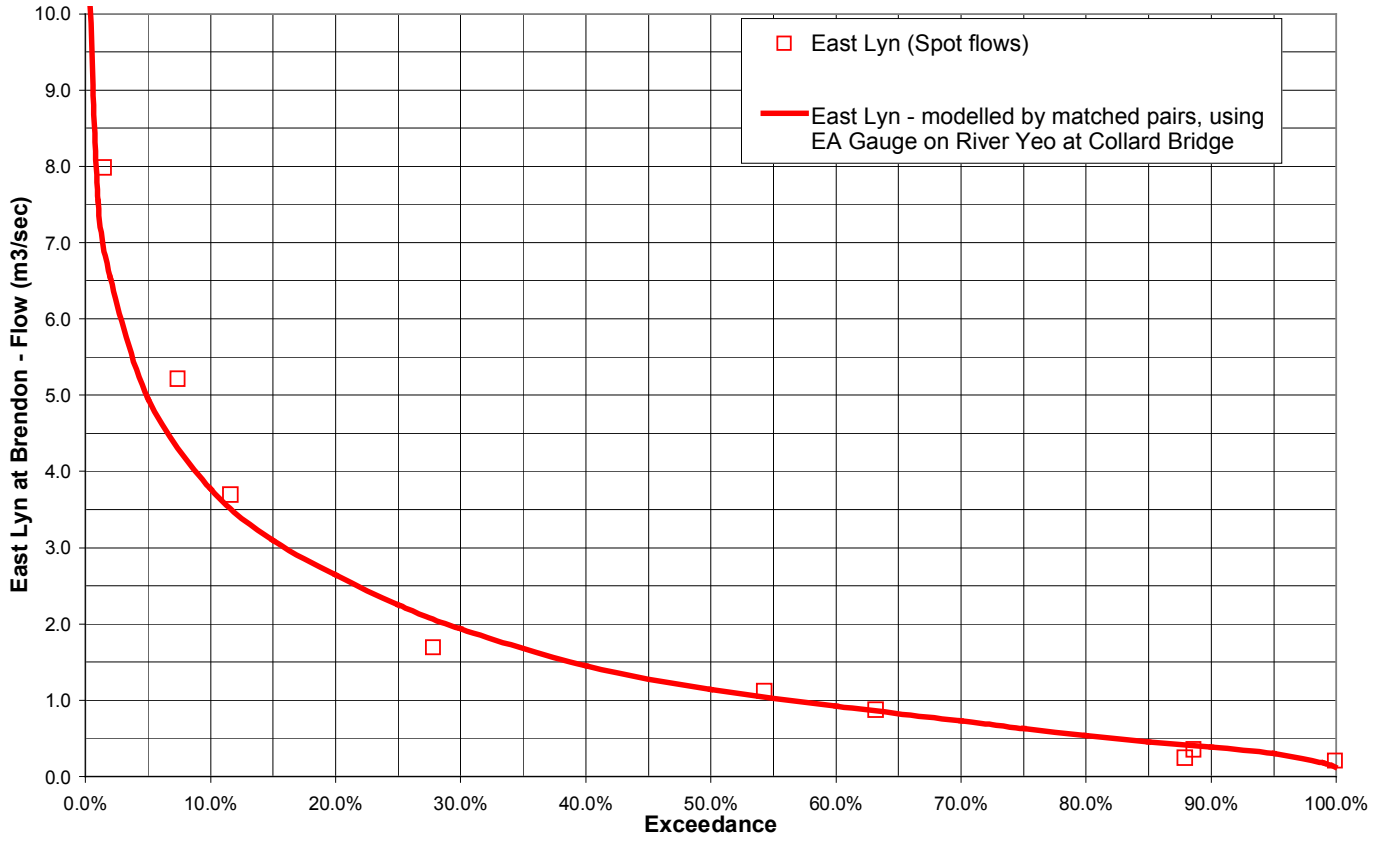


Figure 4 : East Lyn at Brendon - Comparison of LowFlows vs Matched-Pairs analysis

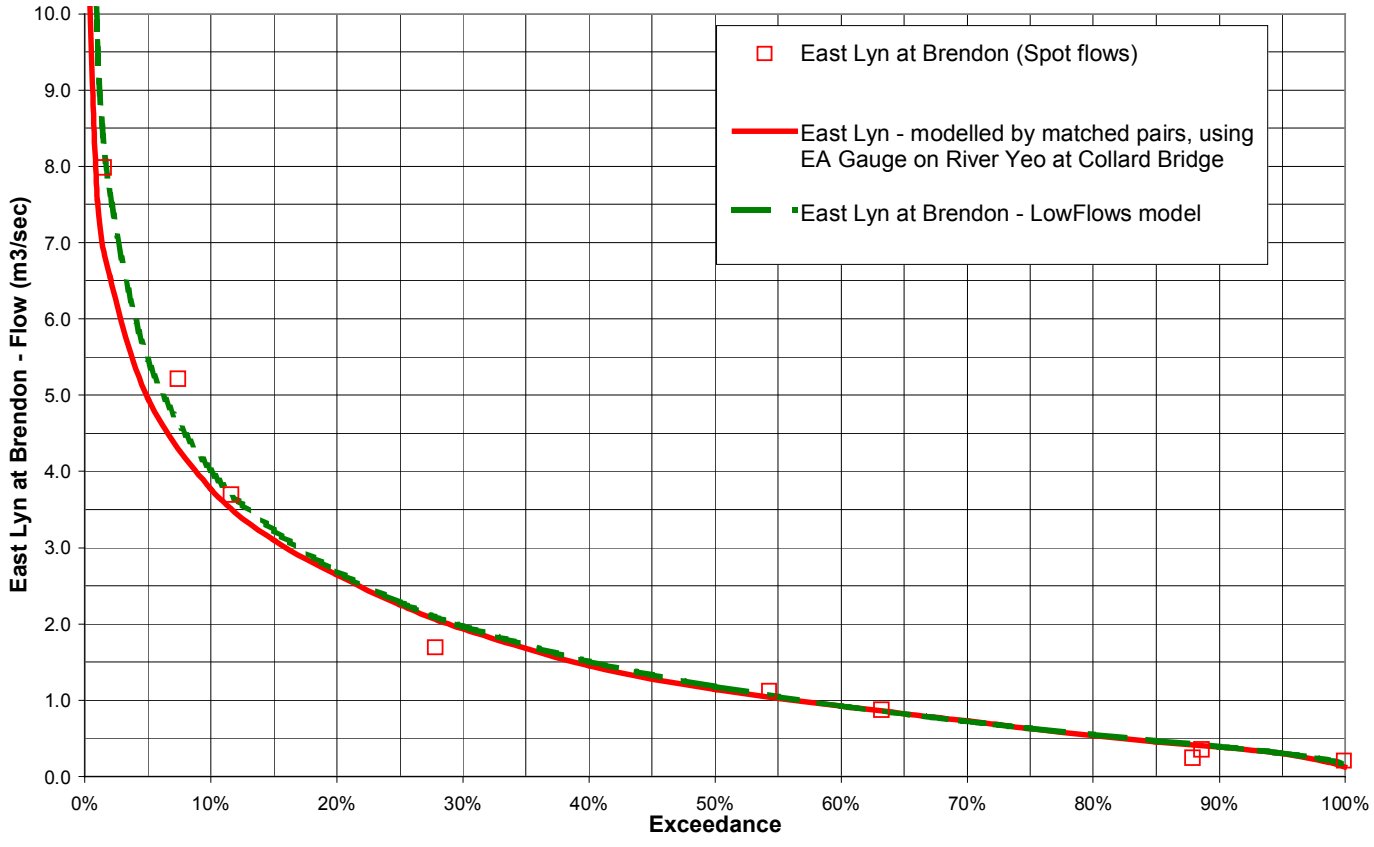
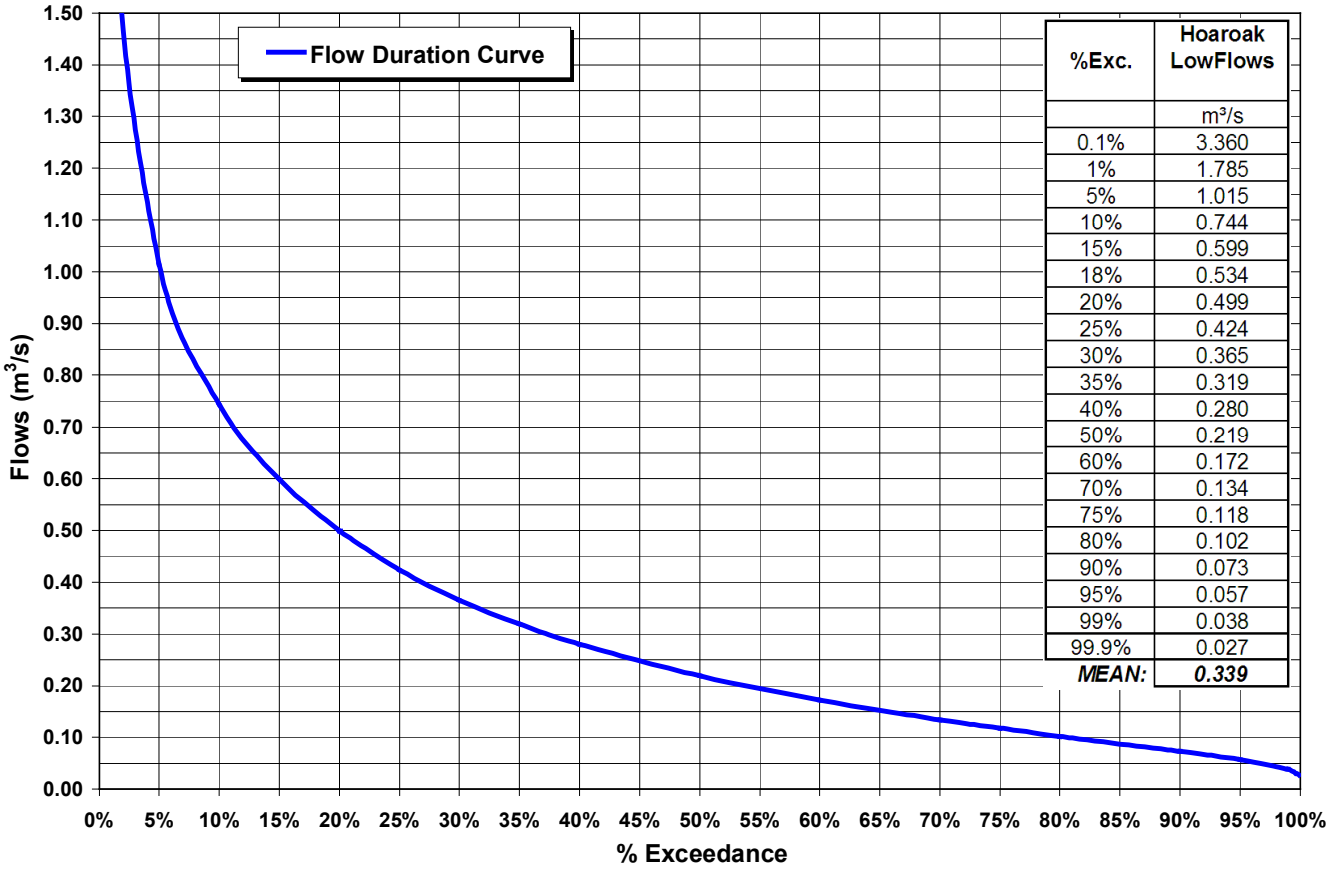


Figure 5 : Derived Flow Duration Curve for Hoaroak Water
(LowFlows, adjusted by matched-pairs analysis of local gaugings)



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