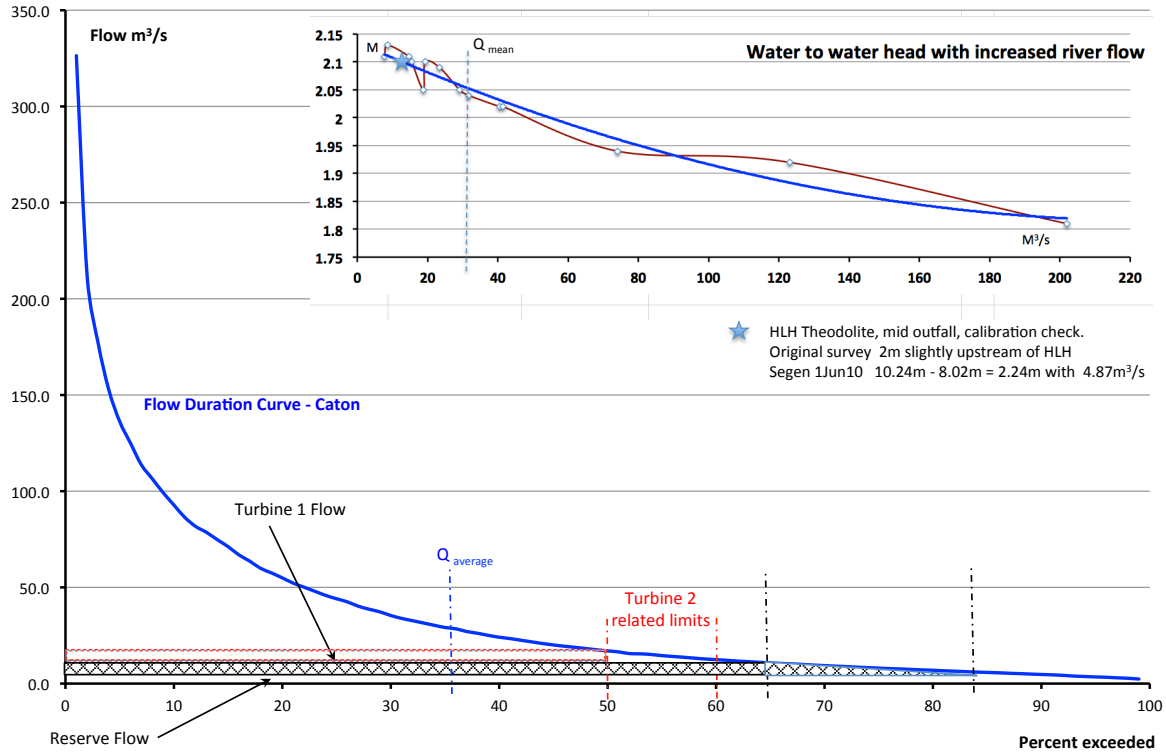
Electrical Power Generation - Forge Weir, Halton

Q%	m^3/s
1	326.4
2	211.7
3	177.3
4	152.6
5	136.2
6	124.9
7	113.7
8	106.5
9	99.3
10	92.8
11	86.4
12	81.7
13	78.6
14	74.8
15	71.2
16	66.9
17	63.6
18	59.9
19	57.5
20	54.9
21	52.2
22	50.1
23	48.0
24	45.8
25	44.1
26	42.5
27	40.2
28	38.7
29	37.3
30	35.4
31	33.9
32	32.7
33	31.5
34	30.3
35	29.2
36	28.5
37	27.1
38	26.2
39	25.1
40	24.1
41	23.4
42	22.5
43	21.7
44	20.8
45	20.1
46	19.4
47	18.8
48	18.2
49	17.6
50	17.0
51	16.5
52	15.6
53	15.5
54	15.1
55	14.5
56	14.1
57	13.7
58	13.2
59	12.8
60	12.4
61	12.1
62	11.7
63	11.4
64	11.1
65	10.8
66	10.5
67	10.2
68	10.0
69	9.6
70	9.4
71	9.1
72	8.8
73	8.5
74	8.3
75	8.1
76	7.8
77	7.6
78	7.4



CALCULATIONS FOR THE FIRST, FOLLOWED BY THE SECOND TURBINE

Hands off, reserve flow for fish passage			4.74 m^3/s	Q_{90}
Water flow for turbines, up to			12.00	
River flow utilisation, total			16.74	
Turbine 1	100 kWe	Nominal flow	5.96 m^3/s at 2m head	
Gross Head	2.1m			
Nett head less an estimated 9% losses		1.911	6.24 m^3/s	
			10.98 Total	Q_{65}
Variation with lost head, worst case. (Inset graph)			1.85m, 150m^3/s river,	Q_4
Compensated flow, worst case			6.74 m^3/s and	Q_{63}
Flow is available & hence not influential on MW-hr calculation			11.48 M^3/s total	
			92.5%	
Turbine runs at full power for 65% of the 8,760hrs pa			569.4 MW-hr pa	
Part load running down to 25% of full power flow			1.49 m^3/s cut off	
			6.23 Total or	Q_{83}
Apportioning the triangle area from the rectangle area				
Rectangle	6.24 x 65	405.6	569.4 MW-hr pa	
Triangle	(83-65) x 6.24/2	56.16	78.84 MW-hr	
			648.2 MW-hr	Gross
Worst case 94% mechanical to electrical			609.35 MW-hr	Net

Cash flow calculation has used	
593.75	MW-hr nett

Shutdown period Q100 minus Q83 = 17% — 62.05 days for planned maintenance

Repeat for the addition of a second turbine, assuming 100kWe - and see where the limitations are.
The reserve flow remains the same and the 12m^3/s extraction becomes a limiting factor

Both 100kW turbines at full power requires		17.22	which is over the 16.74 allowance
Both will run at less than full power at	97%	of 200kWe	194.4 kW

Alternatively, keep the first turbine at full power and the second turbine maximum flow is 5.76 m^3/s
Equivalent river flow will thus be 16.73 Q_{50}
The second turbine cut-off will be when the water availability falls below it's 1.49m^3/s 12.47 Q_{60}
The areas of the additional rectangle and triangle are:-

Rectangle	5.76 x 50	288	
Triangle	(60-50) x 5.76/2	28.8	
	Area units	316.8	**444.7 MW-hr gross**
Worst case 94% mechanical to electrical		418.1	MW-hr

There will also be some high river flow loss of head, not compensated - say 5% 397.15 MW-hr
Grant Total MW-hr pa Net **1006.5**
The period of shutdown will be longer than turbine one, although in reality they will both share, shutdown time.