Appendix 11.4

Hydromorphology Assessment
Part 5

10.4 Annex 11.4.4 Details of the Design

11.4.4.1 Design Freeze information (4th Iteration) for river crossings and outfall locations

ID	Location	Current structure			New structure						Change (where +ve is increase and -ve is decrease)	
		Current structure type	Current structure length (m)	Current structure bed Slope (m/m)	Design structure type	Design structure length (m)	Design Upstream bed invert level (mAOD)	Design Downstream bed invert level (mAOD)	Design bed Slope (m/m)	Crossing to be upsized to take 1:200-year flow	Change in Length (m)	Change in Gradient
59	Track	Channel	N/A	N/A	Bridge	No data	No data	No data	No data		No data	No data
61	Track	Channel	N/A	N/A	Pipe Culvert	No data	No data	No data	No data		No data	No data
63	Track	Channel	N/A	N/A	Pipe Culvert	No data	No data	No data	No data		No data	No data
64	Track	Channel	N/A	N/A	Box Culvert	No data	No data	No data	No data		No data	No data
64		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
65	Main Line	Pipe Culvert	32.3	0.0704	Box Culvert	27.0	393.8	393.6	0.0083	Yes	-5.3	-0.0620
65		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
65		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
65		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
65		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
65		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
65	Track	Pipe Culvert	17.3	0.0118	Pipe Culvert	9.4	411.0	410.0	0.1032		-7.9	0.0913
65	Track	Pipe Culvert	20.7	0.0546	Pipe Culvert	11.0	411.0	409.9	0.1080		-9.8	0.0534
66		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
66	Main Line	Pipe Culvert	26.8	0.0461	Pipe Culvert	35.3	393.2	392.6	0.0161	Yes	8.5	-0.0300
67		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
67		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
67	Main Line	Channel	N/A	N/A	Pipe Culvert	43.9	392.5	390.6	0.0425	Yes	No data	No data
68		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
68		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
68		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
68		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
68	Main Line	Pipe Culvert	20.5	0.0561	Pipe Culvert	41.7	391.8	391.5	0.0083	Yes	21.2	-0.0478
68	Track	Channel			Pipe Culvert	No data	No data	No data	No data		No data	No data
69		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
69		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
69		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
69	Main Line	Pipe Culvert	29.8	0.0498	Pipe Culvert	No data	No data	No data	No data	Yes	No data	No data
69	Track	Channel	N/A	N/A	Pipe Culvert	35.2	390.0	389.8	0.0083		No data	No data
70		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
70	Main Line	Pipe Culvert	38.7	0.0677	Pipe Culvert	9.8	410.3	408.7	0.1705		-28.9	0.1029
70	Track	Channel	N/A	N/A	Pipe Culvert	40.2	389.4	389.1	0.0083		No data	No data
71		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
71		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
71	Main Line	Pipe Culvert	20.6	0.0525	Pipe Culvert	No data	No data	No data	No data		No data	No data
71	Track	Channel	N/A	N/A	Pipe Culvert	40.2	388.7	388.4	0.0083		No data	No data
72	Main Line		13.4	0.0397	Bridge	No data	No data	No data	No data	Yes	No data	No data
72		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
72		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
72	207	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data

ID	Location	Current structure			New structure						Change (where +ve is increase and -ve is decrease)	
		Current structure type	Current structure length (m)	Current structure bed Slope (m/m)	Design structure type	Design structure length (m)	Design Upstream bed invert level (mAOD)	Design Downstream bed invert level (mAOD)	Design bed Slope (m/m)	Crossing to be upsized to take 1:200-year flow	Change in Length (m)	Change in Gradient
74		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
74		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
74		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
74	Main Line	Pipe Culvert	38.9	0.0038	Pipe Culvert	22.3	385.7	385.5	0.0084	Yes	-16.6	0.0046
74	Track	Channel	N/A	N/A	Pipe Culvert	32.2	386.2	385.9	0.0083		No data	No data
75		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
75	Main Line	Pipe Culvert	31.9	0.0118	Pipe Culvert	70.7	384.5	383.9	0.0083	Yes	38.8	-0.0035
76	Main Line	Pipe Culvert	27.5	0.0352	Box Culvert	44.8	379.2	376.5	0.0590	Yes	17.3	0.0238
76	Track	Pipe Culvert	31.7	0.0280	Box Culvert	30.5	374.0	372.2	0.0586	Yes	-1.2	0.0306
76		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
76		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
76	213	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
76	214	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
77	Main Line		18.7	0.0385	Bridge	No data	No data	No data	No data	Yes	No data	No data
77		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
77		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
78		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
78		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
78	Main Line	culvert	25.2	0.0200	Pipe Culvert	48.9	374.5	373.7	0.0170	Yes	23.7	-0.0029
79	Track	Channel	No data	No data	Box Culvert	39.0	371.9	370.7	0.0294		No data	No data
79		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
79		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
81	Main Line	Pipe Culvert	No data	No data	Box Culvert	61.1	368.3	367.8	0.0083	Yes	No data	No data
81		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
81		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
81		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
81		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
81		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
81		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
82	Main Line		13.3	0.0459	Bridge	No data	No data	No data	No data	Yes	No data	No data
82	Track	New structure	N/A	N/A	Bridge	No data	No data	No data	No data		No data	No data
82		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
82		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
82		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
82	222	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
83		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
86		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
86		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
86	Main Line	Pipe Culvert	17.1	-	Pipe Culvert	98.0	372.4	368.4	0.0404	Yes	80.9	No data
86	Track	Channel			Pipe Culvert	16.7	373.7	372.9	0.0483		16.7	0.0483
87		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
87		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data

ID	Location	Current structure			New structure						Change (where +ve is increase and -ve is decrease)	
		Current structure type	Current structure length (m)	Current structure bed Slope (m/m)	Design structure type	Design structure length (m)	Design Upstream bed invert level (mAOD)	Design Downstream bed invert level (mAOD)	Design bed Slope (m/m)	Crossing to be upsized to take 1:200-year flow	Change in Length (m)	Change in Gradient
87		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
87		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
87	Main Line	Pipe Culvert	63.3	0.0455	Pipe Culvert	66.9	372.5	371.5	0.0153	Yes	3.6	-0.0302
87	Track	Pipe Culvert	42.0	-	Pipe Culvert	12.6	374.4	373.6	0.0648	Yes	-29.4	No data
89		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
89	Main Line				Pipe Culvert	No data	No data	No data	No data	Yes	No data	No data
89	233	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
90	Main Line	Pipe Culvert	24.7	0.0900	Pipe Culvert	68.7	365.7	364.3	0.0200	Yes	44.1	-0.0700
94		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
94	Main Line	Pipe Culvert	18.0	0.0198	Pipe Culvert	33.7	359.4	358.2	0.0362	Yes	15.7	0.0164
95		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
95		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
95		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
95		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
95	Main Line	Pipe Culvert	26.8	0.1200	Pipe Culvert	51.0	356.0	352.4	0.0696	Yes	24.2	-0.0504
96		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
96		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
96	Main Line	Pipe Culvert	17.2	0.0164	Pipe Culvert	46.3	354.7	354.3	0.0083	Yes	29.2	-0.0080
97		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
97		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
97	Main Line	Pipe Culvert	40.8	0.1249	Pipe Culvert	39.6	351.4	349.4	0.0500	Yes	-1.1	-0.0749
98		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
98		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
98	Main Line	Channel	No data	No data	Pipe Culvert	32.9	350.2	350.0	0.0083		No data	No data
99		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
99		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
99	Main Line	Channel	No data	No data	Pipe Culvert	45.8	348.9	341.9	0.1532		No data	No data
100	Main Line	Pipe Culvert	31.2	No data	Box Culvert	48.5	345.5	342.1	0.0687	Yes	17.3	No data
100		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
100		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
100	Track	Channel	No data	No data	Pipe Culvert	6.9	340.3	339.8	0.0737		No data	No data
100	Track	Channel	No data	No data	Pipe Culvert	18.3	340.4	339.7	0.0381		No data	No data
101		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
101		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
101		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
101		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
101	Main Line	Culvert	44.4	-	Pipe Culvert	68.1	346.0	339.7	0.0923	Yes	23.7	No data
101	Track	Channel	No data	No data	Pipe Culvert	22.0	338.8	336.3	0.1103		No data	No data
102		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
102		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
102		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
102	Main Line	culvert	required	-	Pipe Culvert	20.4	346.2	342.0	0.2042	Yes	No data	No data

ID	Location	Current structure			New structure						Change (where +ve is increase and -ve is decrease)	
		Current structure type	Current structure length (m)	Current structure bed Slope (m/m)	Design structure type	Design structure length (m)	Design Upstream bed invert level (mAOD)	Design Downstream bed invert level (mAOD)	Design bed Slope (m/m)	Crossing to be upsized to take 1:200-year flow	Change in Length (m)	Change in Gradient
102	Track	Channel	N/A	N/A	Pipe Culvert	86.5	339.5	338.1	0.0157		No data	No data
103	Track	Channel	N/A	N/A	Pipe Culvert	76.5	336.5	335.4	0.0147		No data	No data
104	Main Line		17.2	0.0871	Bridge	No data	No data	No data	No data	Yes	No data	No data
104		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
104		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
104		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
104	259	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
106	Main Line	Pipe Culvert	26.5	No data	Box Culvert	30.2	337.1	336.8	0.0083	Yes	3.7	No data
106		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
106		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
106		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
106		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
106		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
106	Track	Pipe Culvert	No data	No data	Pipe Culvert	7.3	346.0	345.5	0.0612		No data	No data
106	Track	Pipe Culvert	No data	No data	Pipe Culvert	15.8	346.4	345.3	0.0707		No data	No data
107	Main Line	Stone culvert	59.0	0.0164	Box Culvert	49.3	331.6	331.2	0.0083	Yes	-9.7	-0.0081
107		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
107		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
107		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
107		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
107	Track	Channel	N/A	N/A	Pipe Culvert	8.3	345.5	345.0	0.0703		No data	No data
109	Main Line	Pipe Culvert	31.0	0.0149	Box Culvert	43.5	325.5	325.1	0.0083		12.5	-0.0065
109		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
109	Track	Channel	N/A	N/A	Pipe Culvert	4.1	329.1	329.0	0.0083		No data	No data
109	Track	Channel	N/A	N/A	Pipe Culvert	6.1	341.9	341.8	0.0099		No data	No data
109	Track	Channel	N/A	N/A	Pipe Culvert	10.6	348.9	348.6	0.0311		No data	No data
110		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
110	Main Line	Pipe Culvert	28.2	-0.0049	Pipe Culvert	48.1	321.9	321.2	0.0144	Yes	19.9	0.0194
110	Track	Channel	N/A	N/A	Pipe Culvert	8.1	322.5	321.3	0.1483		No data	No data
110	Track	Channel	N/A	N/A	Pipe Culvert	13.0	331.9	330.9	0.0751		No data	No data
111	Main Line	Pipe Culvert	22.6	0.0196	Box Culvert	53.1	321.9	320.6	0.0239		30.5	0.0043
111		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
111	Track	Channel	N/A	N/A	Pipe Culvert	11.3	331.1	331.0	0.0083		No data	No data
111	Track	Channel	N/A	N/A	Pipe Culvert	18.9	317.7	317.5	0.0083		No data	No data
111	Track	Channel	N/A	N/A	Pipe Culvert	21.1	331.5	330.1	0.0668		No data	No data
111	277	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
112	Main Line	Pipe Culvert	20.5	0.0195	Box Culvert	49.2	320.9	319.6	0.0279	Yes	28.7	0.0084
112		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
112		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
112	Track	Channel	N/A	N/A	Pipe Culvert	10.7	322.1	321.6	0.0457		No data	No data
112	Track	Channel	N/A	N/A	Pipe Culvert	13.8	316.3	315.7	0.0448		No data	No data
114	Main Line	Box culvert	17.3	0.0206	Box Culvert	43.2	319.3	317.4	0.0435	Yes	25.9	0.0229

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		Current structure type	Current structure length (m)	Current structure bed Slope (m/m)	Design structure type	Design structure length (m)	Design Upstream bed invert level (mAOD)	Design Downstream bed invert level (mAOD)	Design bed Slope (m/m)	Crossing to be upsized to take 1:200-year flow	Change in Length (m)	Change in Gradient
114		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
114		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
114	Track	Channel	N/A	N/A	Pipe Culvert	14.9	316.9	316.3	0.0435		No data	No data
114	282	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
114	286	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
115	Main Line	Pipe Culvert	18.2	0.0112	Box Culvert	62.4	317.4	316.8	0.0099		44.2	-0.0012
115		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
115		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
116	Main Line	Pipe Culvert	21.8	0.1345	Box Culvert	51.7	318.0	314.1	0.0750		29.9	-0.0595
116		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
117		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
117		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
117	Main Line	Pipe Culvert	22.0	-	Pipe Culvert	61.0	317.0	313.0	0.0658		39.0	No data
118	Main Line	Pipe Culvert	27.8	No data	Box Culvert	64.5	318.4	312.5	0.0909		36.7	No data
118		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
119	Main Line	Pipe Culvert	27.5	0.1503	Box Culvert	81.1	318.4	312.5	0.0723		53.6	-0.0780
119		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
120		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
120	Main Line	Pipe Culvert	24.4	0.1120	Pipe Culvert	49.0	322.8	321.0	0.0362	Yes	24.6	-0.0758
120	Track	Channel	N/A	N/A	Pipe Culvert	No data	No data	No data	No data		No data	No data
121	Main Line		13.6	0.0849	Bridge	No data	No data	No data	No data	Yes	No data	No data
122		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
122		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
122	Main Line	Pipe Culvert	48.6	0.1101	Pipe Culvert	85.6	321.0	312.5	0.0996		37.0	-0.0105
122	293	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
123	Track	Channel	N/A	N/A	Box Culvert	72.2	321.2	314.8	0.0876		No data	No data
123		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
124	Track	Channel	N/A	N/A	Box Culvert	86.5	322.1	311.5	0.1219		No data	No data
124		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
125	Main Line	Pipe Culvert	21.9	0.0704	Box Culvert	73.9	322.1	313.4	0.1176		52.0	0.0472
125		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
126		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
126		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
126	Main Line	Pipe Culvert	34.7	0.0107	Pipe Culvert	49.9	322.9	321.6	0.0250		15.2	0.0143
127	Main Line	Pipe Culvert	30.2	0.0421	Pipe Culvert	48.7	318.8	317.7	0.0221		18.5	-0.0200
128		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
128	Main Line	Pipe Culvert	20.6	0.1540	Pipe Culvert	67.3	318.5	312.7	0.0866	Yes	46.7	-0.0673
129	Main Line	Pipe Culvert	48.7	0.1098	Box Culvert	35.4	314.0	312.4	0.0447	Yes	-13.4	-0.0651
130	Main Line		25.8	0.1426	Bridge	No data	No data	No data	No data	Yes	No data	No data
130	306	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
132		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
132	Main Line	Pipe Culvert	27.0	0.0032	Pipe Culvert	29.7	308.1	307.8	0.0083	Yes	2.7	0.0052

ID	Location	Current structure			New structure						Change (where +ve is increase and -ve is decrease)	
		Current structure type	Current structure length (m)	Current structure bed Slope (m/m)	Design structure type	Design structure length (m)	Design Upstream bed invert level (mAOD)	Design Downstream bed invert level (mAOD)	Design bed Slope (m/m)	Crossing to be upsized to take 1:200-year flow	Change in Length (m)	Change in Gradient
132	Track	Channel	N/A	N/A	Pipe Culvert	6.3	299.0	298.4	0.0946		No data	No data
84/85		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
84/85		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
84/85	Main Line	Pipe Culvert	26.5	-	Pipe Culvert	101.4	371.4	370.3	0.0115	Yes	74.9	No data
84/85	Track	Channel	N/A	N/A	Pipe Culvert	13.1	374.8	373.7	0.0837		No data	No data
92/93		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
92/93		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
92/93	Main Line	Pipe Culvert	24.9	0.0345	Pipe Culvert	35.3	363.6	362.7	0.0232	Yes	10.3	-0.0113
92/93	Track	Channel	N/A	N/A	Pipe Culvert	25.1	No data	No data	No data		No data	No data
River Truim from source to Allt Cuaich		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
River Truim from source to Allt Cuaich		Channel	N/A	N/A	Drain outfall	No data	No data	No data	No data		No data	No data
River Truim from source to Allt Cuaich	207	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
River Truim from source to Allt Cuaich	214	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
River Truim from source to Allt Cuaich	225	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
River Truim from source to Allt Cuaich	254	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data
River Truim-lower catchment	277	Channel	N/A	N/A	SuDS Outfall	No data	No data	No data	No data		No data	No data

11.4.4.2 Design Freeze information (4th Iteration) for channel realignments

Channel Base Width b (m)	Minimum Channel Depth d (m)	Maximum Channel Depth (m)	Channel Side Slopes (1:x)	Diversion Length (m)	Longitudinal Gradient (m/m) s	Top Width T (m)	Wetted Perimeter p (m)	Flow Area A (m2)	Velocity (1:200-year flow) v (m/s)	Channel Capacity Q (m3/s)	200yr Design Flow (m3/s)	Preferred River Type (based on slope and low sinuosity planform and energy info)	Stream Power/unit width	Stream power comments
1.00	0.50	2.63	2	90.80	0.001	3.0	3.236	1.000	0.29	0.29	1.400	Plane-Riffle morphology	3	Low energy- likely to experience sedimentation
0.50	0.50	2.01	2	26.91	0.001	2.5	2.736	0.750	0.27	0.20	0.044	Plane-Riffle morphology	4	Low energy- likely to experience sedimentation
0.50	0.50	1.80	2	47.00	0.001	2.5	2.736	0.750	0.27	0.20	0.155	Plane-Riffle morphology	4	Low energy- likely to experience sedimentation
1.00	0.70	0.87	3	81.89	0.001	5.2	5.427	2.170	0.34	0.74	1.660	Plane-Riffle morphology	7	Low energy- likely to experience sedimentation
1.00	1.00	3.73	2	59.90	0.001	5.0	5.472	3.000	0.42	1.27	1.095	Plane-Riffle morphology	12	Low energy- likely to experience sedimentation
0.75	0.70	3.44	2	124.31	0.003	3.6	3.880	1.505	0.62	0.93	1.643	Plane-Riffle morphology	41	High energy-likely to erode constructed features
0.50	0.50	0.96	2	92.52	0.004	2.5	2.736	0.750	0.53	0.40	0.418	Plane-Riffle morphology	31	Low energy- likely to experience sedimentation
0.50	0.50	2.32	2	113.96	0.009	2.5	2.736	0.750	0.79	0.59	0.137	Plane bed	102	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.01	2	7.84	0.010	2.5	2.736	0.750	0.84	0.63	0.100	Step-Pool or Plane bed	122	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	6.11	2	35.91	0.010	2.5	2.736	0.750	0.84	0.63	0.736	Step-Pool or Plane bed	124	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.65	2	27.46	0.011	2.5	2.736	0.750	0.90	0.67	0.106	Step-Pool or Plane bed	150	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.70	1.42	3	35.88	0.012	4.7	4.927	1.820	1.13	2.05	0.803	Step-Pool or Plane bed	483	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.15	2	147.26	0.013	2.5	2.736	0.750	0.95	0.72	0.723	Step-Pool or Plane bed	180	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.48	2	23.42	0.013	2.5	2.736	0.750	0.96	0.72	0.128	Step-Pool or Plane bed	184	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.36	2	41.81	0.014	2.5	2.736	0.750	0.98	0.74	0.509	Step-Pool or Plane bed	197	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.27	2	38.51	0.014	2.5	2.736	0.750	1.00	0.75	0.131	Step-Pool or Plane bed	206	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	0.54	2	39.78	0.014	2.5	2.736	0.750	1.00	0.75	0.841	Step-Pool or Plane bed	206	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.70	2.25	2	35.05	0.014	3.6	3.880	1.505	1.26	1.89	1.643	Step-Pool or Plane bed	347	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.70	3.23	2	116.29	0.018	3.3	3.630	1.330	1.35	1.80	0.803	Step-Pool or Plane bed	618	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	0.71	2	30.51	0.019	2.5	2.736	0.750	1.16	0.87	0.803	Step-Pool or Plane bed	325	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	0.90	3	25.96	0.019	3.5	3.662	1.000	1.16	1.16	0.395	Step-Pool or Plane bed	432	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.10	4	105.31	0.019	4.5	4.623	1.250	1.15	1.44		Step-Pool or Plane bed	537	Laterally dynamic - likely to recover sinuosity after straightening

Channel Base Width b (m)	Minimum Channel Depth d (m)	Maximum Channel Depth (m)	Channel Side Slopes (1:x)	Diversion Length (m)	Longitudinal Gradient (m/m) s	Top Width T (m)	Wetted Perimeter p (m)	Flow Area A (m2)	Velocity (1:200-year flow) v (m/s)	Channel Capacity Q (m3/s)	200yr Design Flow (m3/s)	Preferred River Type (based on slope and low sinuosity planform and energy info)	Stream Power/unit width	Stream power comments
0.50	0.50	-	2	11.30	0.020	2.5	2.736	0.750	1.19	0.90	0.395	Step-Pool or Plane bed	351	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.50	1.84	2	44.29	0.022	2.8	2.986	0.875	1.31	1.15	0.817	Step-Pool or Plane bed	329	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.00	2	20.54	0.023	2.5	2.736	0.750	1.28	0.96	0.159	Step-Pool or Plane bed	433	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	6.10	3	64.84	0.023	3.5	3.662	1.000	1.28	1.28	0.736	Step-Pool or Plane bed	576	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.70	1.05	2	116.34	0.023	3.3	3.630	1.330	1.55	2.07	0.803	Step-Pool or Plane bed	932	Laterally dynamic - likely to recover sinuosity after straightening
0.50	1.00	4.05	3	207.90	0.024	6.5	6.825	3.500	1.99	6.95	1.736	Step-Pool or Plane bed	3271	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.25	4	24.24	0.025	4.5	4.623	1.250	1.32	1.65	0.606	Step-Pool or Plane bed	810	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.24	2	21.73	0.026	2.5	2.736	0.750	1.36	1.02	0.817	Step-Pool or Plane bed	520	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.41	2	32.12	0.028	2.5	2.736	0.750	1.41	1.06	0.287	Step-Pool or Plane bed	582	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.89	3	64.10	0.028	3.5	3.662	1.000	1.41	1.41	0.538	Step-Pool or Plane bed	774	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.14	2	32.43	0.030	2.5	2.736	0.750	1.46	1.10	0.509	Step-Pool or Plane bed	645	Laterally dynamic - likely to recover sinuosity after straightening
1.00	1.00	1.77	2	9.87	0.031	5.0	5.472	3.000	2.37	7.12	7.159	Step-Pool	2193	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.50	6.73	2	98.25	0.033	2.8	2.986	0.875	1.60	1.40	0.418	Step-Pool	605	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.53	2	44.54	0.034	2.5	2.736	0.750	1.56	1.17	0.723	Step-Pool	778	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.19	4	35.83	0.035	4.5	4.623	1.250	1.56	1.96	0.403	Step-Pool	1342	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.33	2	5.38	0.037	2.5	2.736	0.750	1.62	1.22	1.179	Step-Pool	884	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.70	2	5.54	0.037	2.5	2.736	0.750	1.62	1.22	0.170	Step-Pool	885	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	0.90	2	62.97	0.039	2.5	2.736	0.750	1.67	1.25	1.660	Step-Pool	956	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.75	2	28.22	0.039	2.5	2.736	0.750	1.67	1.25	0.412	Step-Pool	956	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.78	3	11.35	0.042	3.5	3.662	1.000	1.73	1.73	1.400	Step-Pool	1421	Laterally dynamic - likely to recover sinuosity after straightening

Channel Base Width b (m)	Minimum Channel Depth d (m)	Maximum Channel Depth (m)	Channel Side Slopes (1:x)	Diversion Length (m)	Longitudina l Gradient (m/m) s	Top Width T (m)	Wetted Perimeter p (m)	Flow Area A (m2)	Velocity (1:200-year flow) v (m/s)	Channel Capacity Q (m3/s)	200yr Design Flow (m3/s)	Preferred River Type (based on slope and low sinuosity planform and energy info)	Stream Power/unit width	Stream power comments
1.00	0.50	8.00	2	111.45	0.043	3.0	3.236	1.000	1.90	1.90	1.660	Step-Pool	799	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.85	2	143.60	0.043	2.5	2.736	0.750	1.75	1.31		Step-Pool	1107	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	8.10	3	122.17	0.045	3.5	3.662	1.000	1.79	1.79	0.678	Step-Pool	1576	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.06	2	8.19	0.046	2.5	2.736	0.750	1.81	1.36	0.817	Step-Pool	1225	Laterally dynamic - likely to recover sinuosity after straightening
1.00	1.00	1.18	2	250.36	0.046	5.0	5.472	3.000	2.87	8.62	7.159	Step-Pool or Cascade	3889	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.70	4.53	2	117.41	0.047	3.6	3.880	1.505	2.31	3.47	3.636	Step-Pool	2133	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	5.93	2	27.11	0.048	2.5	2.736	0.750	1.85	1.39	1.077	Step-Pool	1306	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.98	2	50.14	0.049	2.5	2.736	0.750	1.87	1.40	0.464	Step-Pool	1347	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.14	4	126.26	0.051	4.5	4.623	1.250	1.89	2.36	0.403	Step-Pool	2361	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.70	1.98	2	172.87	0.057	3.6	3.880	1.505	2.54	3.82	0.509	Step-Pool	2848	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	6.43	2	51.31	0.058	2.5	2.736	0.750	2.03	1.52	0.287	Step-Pool	1734	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	5.32	2	50.39	0.059	2.5	2.736	0.750	2.05	1.54	0.165	Step-Pool	1779	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.45	2	28.01	0.062	2.5	2.736	0.750	2.10	1.57	0.452	Step-Pool	1904	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	6.97	2	39.48	0.062	2.5	2.736	0.750	2.10	1.58	0.131	Step-Pool	1917	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.13	2	21.57	0.063	2.5	2.736	0.750	2.12	1.59	0.044	Step-Pool	1963	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.05	2	53.90	0.063	2.5	2.736	0.750	2.12	1.59	0.817	Step-Pool	1972	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.73	2	44.06	0.064	2.5	2.736	0.750	2.14	1.60	0.841	Step-Pool	2010	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.70	4.37	2	53.02	0.064	3.6	3.880	1.505	2.69	4.05	1.044	Step-Pool	3389	Laterally dynamic - likely to recover sinuosity after straightening
1.00	1.00	6.72	2	38.51	0.064	5.0	5.472	3.000	3.39	10.17	7.159	Step-Pool or Cascade (due to velocity)	6381	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	6.72	2	4.68	0.070	2.5	2.736	0.750	2.23	1.67	0.464	Step-Pool	2299	Laterally dynamic - likely to recover sinuosity after straightening

Channel Base Width b (m)	Minimum Channel Depth d (m)	Maximum Channel Depth (m)	Channel Side Slopes (1:x)	Diversion Length (m)	Longitudinal Gradient (m/m) s	Top Width T (m)	Wetted Perimeter p (m)	Flow Area A (m2)	Velocity (1:200-year flow) v (m/s)	Channel Capacity Q (m3/s)	200yr Design Flow (m3/s)	Preferred River Type (based on slope and low sinuosity planform and energy info)	Stream Power/unit width	Stream power comments
1.00	0.70	1.12	2	8.93	0.070	3.8	4.130	1.680	2.90	4.88	1.044	Step-Pool or Cascade (due to velocity)	3350	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.74	2	25.67	0.074	2.5	2.736	0.750	2.30	1.72	0.965	Step-Pool	2499	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.27	3	73.49	0.074	3.5	3.662	1.000	2.29	2.29	0.736	Step-Pool	3323	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.03	2	7.89	0.076	2.5	2.736	0.750	2.33	1.74	0.137	Step-Pool	2601	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.39	2	27.82	0.083	2.5	2.736	0.750	2.43	1.82	0.606	Step-Pool	2969	Laterally dynamic - likely to recover sinuosity after straightening
1.00	1.00	5.13	3	13.99	0.088	7.0	7.325	4.000	3.97	15.89	1.643	Step-Pool or Cascade (due to velocity)	13777	Laterally dynamic - likely to recover sinuosity after straightening
0.25	0.25	0.54	4	15.53	0.093	2.3	2.312	0.313	1.61	0.50	0.368	Step-Pool	1832	Laterally dynamic - likely to recover sinuosity after straightening
1.00	1.00	3.80	2	14.77	0.093	5.0	5.472	3.000	4.09	12.26	1.095	Step-Pool or Cascade (due to velocity)	11178	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	0.98	2	19.87	0.102	2.5	2.736	0.750	2.70	2.02	0.610	Cascade	4044	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	7.05	2	101.05	0.106	2.5	2.736	0.750	2.75	2.06	0.678	Cascade	4284	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.48	2	8.85	0.107	2.5	2.736	0.750	2.76	2.07	0.070	Cascade	4345	Laterally dynamic - likely to recover sinuosity after straightening
1.00	0.70	4.57	2	28.91	0.107	3.8	4.130	1.680	3.59	6.03	3.636	Cascade	6331	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.70	1.74	3	34.27	0.107	5.0	5.177	1.995	3.46	6.91	1.095	Cascade	9670	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	36.58	0.111	2.5	2.736	0.750	2.81	2.11	1.077	Cascade	4591	Laterally dynamic - likely to recover sinuosity after straightening
1.00	0.70	-	3	18.35	0.112	5.2	5.427	2.170	3.63	7.88	0.137	Cascade	8658	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.17	2	14.40	0.114	2.5	2.736	0.750	2.84	2.13	0.100	Cascade	4756	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.79	2	17.84	0.116	2.5	2.736	0.750	2.88	2.16	0.106	Cascade	4922	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.03	2	16.21	0.122	2.5	2.736	0.750	2.95	2.21	1.400	Cascade	5290	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.00	2	5.88	0.122	2.5	2.736	0.750	2.95	2.21	0.418	Cascade	5290	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	62.72	0.131	2.5	2.736	0.750	3.05	2.29	1.077	Cascade	5886	Laterally dynamic - likely to recover sinuosity after straightening

Channel Base Width b (m)	Minimum Channel Depth d (m)	Maximum Channel Depth (m)	Channel Side Slopes (1:x)	Diversion Length (m)	Longitudinal Gradient (m/m) s	Top Width T (m)	Wetted Perimeter p (m)	Flow Area A (m2)	Velocity (1:200-year flow) v (m/s)	Channel Capacity Q (m3/s)	200yr Design Flow (m3/s)	Preferred River Type (based on slope and low sinuosity planform and energy info)	Stream Power/unit width	Stream power comments
0.50	0.50	1.74	2	7.08	0.134	2.5	2.736	0.750	3.09	2.32	0.610	Cascade	6090	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.79	2	17.00	0.139	2.5	2.736	0.750	3.15	2.36	0.070	Cascade	6434	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.71	2	32.89	0.157	2.5	2.736	0.750	3.34	2.51	0.965	Cascade	7723	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.50	2.84	2	17.49	0.170	2.8	2.986	0.875	3.64	3.18	0.368	Cascade	7076	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.84	4	24.00	0.172	4.5	4.623	1.250	3.47	4.34	0.607	Cascade	14625	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.88	2	34.08	0.173	2.5	2.736	0.750	3.51	2.63	0.678	Cascade	8933	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.70	-	2	12.62	0.181	3.3	3.630	1.330	4.36	5.79	0.803	Cascade	20569	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	7.54	3	55.74	0.191	3.5	3.662	1.000	3.68	3.68	0.606	Cascade	13782	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.55	2	23.25	0.199	2.5	2.736	0.750	3.76	2.82	0.744	Cascade	11021	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.16	2	13.76	0.200	2.5	2.736	0.750	3.77	2.83	0.089	Cascade	11104	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	8.45	2	48.09	0.201	2.5	2.736	0.750	3.78	2.84	0.250	Cascade	11187	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.81	2	40.07	0.205	2.5	2.736	0.750	3.82	2.87	0.403	Cascade	11523	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	56.03	0.207	2.5	2.736	0.750	3.84	2.88	0.250	Cascade	11692	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.43	2	48.96	0.213	2.5	2.736	0.750	3.90	2.92	0.155	Cascade	12204	Laterally dynamic - likely to recover sinuosity after straightening
0.75	0.50	2.52	2	19.13	0.230	2.8	2.986	0.875	4.23	3.70	0.464	Cascade	11135	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	26.51	0.274	2.5	2.736	0.750	4.42	3.31	0.250	Cascade	17806	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.26	4	25.42	0.277	4.5	4.623	1.250	4.40	5.50	0.744	Cascade	29890	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	4.36	2	16.57	0.318	2.5	2.736	0.750	4.76	3.57	0.736	Cascade	22262	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	1.23	2	8.88	0.338	2.5	2.736	0.750	4.91	3.68	0.607	Cascade	24395	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	15.27	0.402	2.5	2.736	0.750	5.35	4.01	0.089	Cascade	31642	Laterally dynamic - likely to recover sinuosity after straightening

Channel Base Width b (m)	Minimum Channel Depth d (m)	Maximum Channel Depth (m)	Channel Side Slopes (1:x)	Diversion Length (m)	Longitudinal Gradient (m/m) s	Top Width T (m)	Wetted Perimeter p (m)	Flow Area A (m2)	Velocity (1:200-year flow) v (m/s)	Channel Capacity Q (m3/s)	200yr Design Flow (m3/s)	Preferred River Type (based on slope and low sinuosity planform and energy info)	Stream Power/unit width	Stream power comments
0.50	0.50	-	2	20.85	0.417	2.5	2.736	0.750	5.45	4.09	0.287	Cascade	33430	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	2.71	2	24.93	0.430	2.5	2.736	0.750	5.53	4.15	0.509	Cascade	35005	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	7.78	0.500	2.5	2.736	0.750	5.97	4.48	1.736	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	9.01	0.500	2.5	2.736	0.750	5.97	4.48	0.170	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	9.94	0.500	2.5	2.736	0.750	5.97	4.48	1.179	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	6.65	0.500	2.5	2.736	0.750	5.97	4.48	0.452	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	9.83	0.500	2.5	2.736	0.750	5.97	4.48	0.100	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	7.37	0.500	2.5	2.736	0.750	5.97	4.48	0.106	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	11.66	0.500	2.5	2.736	0.750	5.97	4.48	0.128	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	8.39	0.500	2.5	2.736	0.750	5.97	4.48	0.391	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	5.19	0.500	2.5	2.736	0.750	5.97	4.48	0.464	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	7.64	0.500	2.5	2.736	0.750	5.97	4.48	0.403	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	10.00	0.500	2.5	2.736	0.750	5.97	4.48	0.736	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	-	2	5.83	0.602	2.5	2.736	0.750	6.55	4.91	0.412	Cascade	58030	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	3.64	3	18.19	0.618	3.5	3.662	1.000	6.62	6.62	0.678	Cascade	80210	Laterally dynamic - likely to recover sinuosity after straightening
0.50	0.50	5.64	2	7.09	0.644	2.5	2.736	0.750	6.77	5.08	0.155	Cascade	64159	Laterally dynamic - likely to recover sinuosity after straightening

11.4.4.3. Design Fix information (7th Iteration) for channel crossings

Chainage	Location	ID	Size Estimate	Upstream watercourse bed invert level	Downstream watercourse bed invert level	Culvert Structure Length	Gradient
20140	Mainline	65	1800 x 1200 box [Roof slab 200mm]	393.84	393.53	32.99	0.009
20210	Mainline	66	900mm pipe	393.19	392.51	31.78	0.021
20355	Mainline	67	1200 x 1200 Box	392.52	391.07	32.86	0.044
20430	Mainline	68	900mm pipe	391.84	391.40	37.15	0.012
20470	Mainline	69	900mm pipe	390.04	389.21	35.32	0.024
20530	Mainline	70	1200mm pipe	389.40	389.07	40.52	0.008
20630	Mainline	71	900mm pipe	388.74	388.03	46.63	0.015
20770	Mainline	72	Bridge	-	-	-	-
20880	Mainline	74	900 Pipe	386.18	385.80	35.77	0.010
21010	Mainline	75	900 Pipe	385.02	384.57	35.42	0.013
21360	Mainline	76	3000 X 1800 Box (Roof Slab 250)	376.50	375.79	44.82	0.016
21450	Mainline	77	Bridge	-	-	-	-
21620	Mainline	78	900 Pipe	374.54	373.79	48.93	0.015
21760	Mainline	79	2000 X 1200 Box (Roof Slab 225)	371.89	370.48	40.93	0.035
22130	Mainline	81	2700 X 1000 Box (Roof Slab 250)	368.57	368.10	54.57	0.009
22240	Mainline	82	Bridge				
22410	Mainline	83	Removed	-	-	-	-
22670	Mainline	84	900 Pipe	-	-	-	-
22750	Mainline	85	1500 x 1000 [Roof slab 200mm]	371.64	370.57	71.10	0.015
22770	Mainline	86	900 Pipe	373.31	369.10	67.05	0.063
22950	Mainline	87	900 Pipe	373.29	372.97	31.20	0.010
23360	Mainline	89	450mm pipe	367.29	365.11	95.39	0.023
23440	Mainline	90	2000 x 1000 box [Roof slab 225mm]	366.33	364.26	70.61	0.029
23500	Mainline	91	Removed	-	-	-	-
23670	Mainline	93	1200mm pipe	364.12	363.14	45.73	0.022
23975	Mainline	94	900mm pipe	359.37	357.36	53.44	0.038
24155	Mainline	95	900mm pipe	356.40	355.15	38.35	0.033
24220	Mainline	96	900mm pipe	354.89	354.35	36.18	0.015
24550	Mainline	97	1200mm pipe	351.43	350.51	36.69	0.025
24620	Mainline	98	900mm pipe	351.45	350.39	34.86	0.030
24870	Mainline	99	1800mm pipe	349.16	347.63	39.06	0.039
25420	Mainline	100	2250 x 1500 box [Roof slab 225mm]	345.48	344.33	40.40	0.028
25540	Mainline	101	900mm pipe	345.73	345.30	53.72	0.008
25790	Mainline	102	1200 mm pipe	339.45	338.10	88.78	0.015
25950	Mainline	103	1200 mm pipe	336.54	335.41	97.67	0.011
26040	Mainline	104	Bridge	-	-	-	-
26200	Mainline	106	1000 x 750 box [Roof slab 175]	337.09	336.47	37.50	0.017
26600	Mainline	107	2000 x 1000 box [Roof slab 225mm]	331.62	331.18	40.21	0.011
26920	Mainline	109	1500 x 1000 [Roof slab 200mm]	325.47	324.52	46.00	0.021
27230	Mainline	110	900 x 900 Box	323.14	322.83	33.13	0.009
27460	Mainline	111	1500 x 1000 [Roof slab 200mm]	322.04	320.59	53.35	0.027

Chainage	Location	ID	Size Estimate	Upstream watercourse bed invert	Downstream watercourse bed	Culvert Structure Length	Gradient
27725	Mainline	112	1500 x 1000 [Roof slab 200mm]	320.51	319.95	63.50	0.009
27840	Mainline	113	Removed	-	-	-	-
27970	Mainline	114	2400 x 1000 [Roof slab 225mm]	319.30	317.25	46.63	0.044
28050	Mainline	115	2400 x 1200 [Roof slab 225mm]	317.42	316.82	62.53	0.010
28300	Mainline	116	1000 x 750 box [Roof slab 175]	317.98	315.04	51.51	0.057
28440	Mainline	117	900mm pipe	317.03	314.25	60.80	0.046
28550	Mainline	118	1500 x 1000 box [Roof slab 200mm]	318.38	317.97	40.52	0.010
28800	Mainline	119	1500mm pipe	320.89	320.54	36.24	0.010
29090	Mainline	120	900mm Pipe	324.47	321.03	48.88	0.070
29175	Mainline	121	Bridge				
29350	Mainline	122	900mm pipe	320.80	320.24	59.60	0.009
29425	Mainline	123	1500 x 1000 [Roof slab 200mm]	321.29	320.57	58.22	0.012
29510	Mainline	124	1500 x 1000 [Roof slab 200mm]	323.13	322.67	50.46	0.009
29590	Mainline	125	1500 x 1000 [Roof slab 200mm]	324.15	321.79	54.16	0.044
29670	Mainline	126	1200 Pipe	323.49	323.13	38.02	0.009
30190	Mainline	127	1200 Pipe	318.80	317.70	50.43	0.022
30270	Mainline	128	1200 Pipe	317.87	317.43	46.85	0.009
30510	Mainline	129	1500 x 1000 [Roof slab 200mm]	314.03	312.45	35.35	0.045
30670	Mainline	130	Bridge				
30900		132	1200 Pipe	308.07	307.82	30.12	0.008
	Track	61-AT1-MTS1	1200mm pipe	421.09	421.01	7.78	0.01
	Track	61-AT2-MTS1	1200mm pipe	420.17	420.03	14.26	0.01
	Track	63-AT1-MTS1	900mm pipe	417.47	417.38	9.39	0.01
	Track	63-AT2-MTS1	900mm pipe	418.05	417.96	8.68	0.01
20140	Track	65-AT1-MTS1	900mm pipe	410.94	410.83	9.18	0.01
20140	Track	65-AT2-MTS1	900mm pipe	411.22	410.83	11.53	0.03
20355	Track	67-AT1-MTS1	900mm pipe	407.19	407.10	10.65	0.01
20530	Track	70-AT1-MTS1	900mm pipe	410.23	410.15	8.94	0.01
20530	Track	70-AT2-MTS1	900mm pipe	406.39	406.19	11.77	0.02
20630	Track	71	900mm pipe	387.72	387.61	8.42	0.012
20880	Track	74	900mm pipe	385.55	385.52	3.46	0.01
21010	Track	75	900mm pipe	384.32	384.21	9.86	0.011
21360	Track	76-AT1-MT03	3000 X 1800 Box (Roof Slab 250)	375.79	375.10	30.67	0.02
	Track	81-AT1-MT05	1200mm pipe	372.49	372.28	17.13	0.01
22750	Track	85-AT1-MT07	1500 x 1000 [Roof slab 200mm]	371.98	371.76	8.07	0.03
22770	Track	86-AT1-MT07	900mm pipe	373.74	373.68	9.56	0.01
22950	Track	87-AT1-MT07	900mm pipe	373.73	373.67	9.79	0.01
	Track	92-AQUA	1200mm pipe	364.12	363.14	45.73	0.02
25420	Track	100-AT1-MT08	1200mm pipe	340.94	340.41	11.52	0.05
25420	Track	100-AT2-MT08	1200mm pipe	340.32	339.76	9.96	0.06
25540	Track	101-AT1-MT08	900mm pipe	341.81	341.49	15.84	0.02
25790	Track	102-AT1-MT09	1200mm pipe	341.81	341.49	15.98	0.02

Chainage	Location	ID	Size Estimate	Upstream watercourse bed invert	Downstream watercourse bed	Culvert Structure Length	Gradient
27725	Track	112-AT1-MT10	1500 x 1000 [Roof slab 200mm]	322.48	322.37	13.46	0.01
27725	Track	112-AT1-MT11	1500 x 1000 [Roof slab 200mm]	318.65	318.51	13.48	0.01
27970	Track	114-AT1-MT11	2400 x 1000 [Roof slab 225mm]	316.98	316.86	12.41	0.01
	Track	118-AT1-MT11	900mm pipe	313.55	312.92	12.52	0.05
28800	Track	119-AT1-MT11	1500mm pipe	314.60	313.01	14.25	0.111
29090	Track	120-AT1-MT11	900mm Pipe	311.83	310.73	17.26	0.064
30900	Track	132-AT1-MT13	1200mm pipe	298.97	298.38	10.50	0.06

11.4.4.4. Design Fix information (7th Iteration) for channel realignments

Hydro ID	Hydro ID Crossing Mainline Chainage	Location (i.e. upstream or downstream of the A9)	Channel Base Width b (m)	Minimum Channel Depth d (m)	Maximum Channel Depth (m)	Channel Side Slopes (1:x)	Diversion Length (m)	Longitudinal Gradient s	Top Width T (m)	Wetted Perimeter p (m)	Flow Area A (m2)	Velocity (1:200-year flow) v (m/s)	Channel Capacity Q (m3/s)	200yr Design Flow (m3/s)	Suggested River Type	Stream Power/unit width	Stream power comments
65	20140	DS	0.50	1.00	3.57	3	215.80	0.017	6.5	6.825	3.500	1.67	5.85	1.736	Plane bed	1950	Laterally dynamic - likely to recover sinuosity after straightening
65	20140	US	0.50	0.50	-	2	11.74	0.500	2.5	2.736	0.750	5.97	4.48	1.736	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
66	20210	US	0.50	0.50	-	2	13.00	0.590	2.5	2.736	0.750	6.48	4.86	0.170	Cascade	56261	Laterally dynamic - likely to recover sinuosity after straightening
67	20355	DS	0.50	0.50	4.09	2	5.38	0.037	2.5	2.736	0.750	1.62	1.22	1.179	Step-Pool	884	Laterally dynamic - likely to recover sinuosity after straightening
67	20355	US	0.50	0.50	-	2	20.17	0.055	2.5	2.736	0.750	1.98	1.48	1.179	Step-Pool	1601	Laterally dynamic - likely to recover sinuosity after straightening
68	20430	US	0.50	0.50	-	2	13.66	0.451	2.5	2.736	0.750	5.67	4.25	0.089	Cascade	37601	Laterally dynamic - likely to recover sinuosity after straightening
68	20430	DS	0.50	0.50	1.16	2	13.66	0.451	2.5	2.736	0.750	5.67	4.25	0.089	Cascade	37601	Laterally dynamic - likely to recover sinuosity after straightening
69	20470	DS	0.50	0.50	2.45	2	28.01	0.062	2.5	2.736	0.750	2.10	1.57	0.452	Step-Pool	1904	Laterally dynamic - likely to recover sinuosity after straightening
69	20470	US	0.50	0.50	-	2	12.50	0.500	2.5	2.736	0.750	5.97	4.48	0.452	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
70	20530	DS	0.50	0.50	1.74	2	25.67	0.074	2.5	2.736	0.750	2.30	1.72	0.965	Step-Pool	2499	Laterally dynamic - likely to recover sinuosity after straightening
70	20530	US	0.50	0.50	4.84	2	32.89	0.157	2.5	2.736	0.750	3.34	2.51	0.965	Cascade	7723	Laterally dynamic - likely to recover sinuosity after straightening
71	20630	DS	0.50	0.50	2.01	2	7.84	0.010	2.5	2.736	0.750	0.84	0.63	0.100	Plane bed	124	Laterally dynamic - likely to recover sinuosity after straightening
71	20630	DS	0.50	0.50	4.17	2	14.40	0.114	2.5	2.736	0.750	2.85	2.14	0.100	Cascade	4780	Laterally dynamic - likely to recover sinuosity after straightening
71	20630	US	0.50	0.50	-	2	11.92	0.480	2.5	2.736	0.750	5.85	4.39	0.100	Cascade	41285	Laterally dynamic - likely to recover sinuosity after straightening
74	20880	DS	0.50	0.50	4.65	2	34.28	0.011	2.5	2.736	0.750	0.89	0.66	0.106	Plane bed	143	Laterally dynamic - likely to recover sinuosity after straightening
74	20880	AT (Existing)	0.50	0.50	2.79	2	27.24	0.038	2.5	2.736	0.750	1.65	1.23	0.106	Step-Pool	920	Laterally dynamic - likely to recover sinuosity after straightening
74	20880	US	0.50	0.50	-	2	15.55	0.384	2.5	2.736	0.750	5.23	3.92	0.106	Cascade	29541	Laterally dynamic - likely to recover sinuosity after straightening
75	21010	DS	0.50	0.50	6.42	2	33.08	0.013	2.5	2.736	0.750	0.96	0.72	0.128	Plane bed	184	Laterally dynamic - likely to recover sinuosity after straightening
75	21010	US	0.50	0.50	-	2	23.39	0.270	2.5	2.736	0.750	4.39	3.29	0.128	Cascade	17417	Laterally dynamic - likely to recover sinuosity after straightening
75	21010	AT (Existing)	0.50	0.50	3.25	2	35.05	0.006	2.5	2.736	0.750	0.65	0.49	0.128	Plane bed	58	High energy streams likely to erode constructed features

Hydro ID	Hydro ID Crossing Mainline Chainage	Location (i.e. upstream or downstream of the A9)	Channel Base Width b (m)	Minimum Channel Depth d (m)	Maximum Channel Depth (m)	Channel Side Slopes (1:x)	Diversion Length (m)	Longitudinal Gradient s	Top Width T (m)	Wetted Perimeter p (m)	Flow Area A (m2)	Velocity (1:200-year flow) v (m/s)	Channel Capacity Q (m3/s)	200yr Design Flow (m3/s)	Suggested River Type	Stream Power/unit width	Stream power comments
76	21360	US (south)	1.50	0.50	2.07	2	11.08	0.070	3.5	3.736	1.250	2.55	3.19	7.159	Step-Pool	1459	Laterally dynamic - likely to recover sinuosity after straightening
76	21360	US (north)	1.50	1.00	2.91	2	259.41	0.034	5.5	5.972	3.500	2.58	9.04	7.159	Step-Pool	2009	Laterally dynamic - likely to recover sinuosity after straightening
76	21360	DS	1.00	0.90	9.19	2	39.56	0.077	4.6	5.025	2.520	3.50	8.83	7.159	Step-Pool	6666	Laterally dynamic - likely to recover sinuosity after straightening
78	21620	US	0.50	0.50	1.27	2	38.51	0.014	2.5	2.736	0.750	1.00	0.75	0.131	Plane bed	206	Laterally dynamic - likely to recover sinuosity after straightening
78	21620	DS	0.50	0.50	3.83	2	19.41	0.100	2.5	2.736	0.750	2.67	2.00	0.131	Cascade	3926	Laterally dynamic - likely to recover sinuosity after straightening
79	21760	US (north)	0.75	0.70	1.03	2	127.33	0.020	3.6	3.880	1.505	1.50	2.26	1.643	Plane bed	592	Laterally dynamic - likely to recover sinuosity after straightening
79	21760	US (south)	0.75	0.70	1.93	2	33.25	0.033	3.6	3.880	1.505	1.93	2.91	1.643	Step-Pool	1255	Laterally dynamic - likely to recover sinuosity after straightening
79	21760	DS	0.75	0.60	5.13	3	10.84	0.035	4.4	4.545	1.530	1.81	2.77	1.643	Step-Pool	1268	Laterally dynamic - likely to recover sinuosity after straightening
81	22130	US (along A9)	1.00	0.70	0.87	3	81.89	0.001	5.2	5.427	2.170	0.34	0.74	1.660	Plane-Riffle	7	Low energy- likely to experience sedimentation
81	22130	DS	0.50	0.50	0.90	2	63.14	0.024	2.5	2.736	0.750	1.31	0.98	1.660	Plane bed	462	Laterally dynamic - likely to recover sinuosity after straightening
81	22130	US (along slip road)	1.00	0.50	8.00	2	111.45	0.043	3.0	3.236	1.000	1.90	1.90	1.660	Step-Pool	799	Laterally dynamic - likely to recover sinuosity after straightening
83	22410	US (south)	0.50	0.50	2.10	4	105.31	0.019	4.5	4.623	1.250	1.15	1.44		Plane bed	537	Laterally dynamic - likely to recover sinuosity after straightening
83	22410	US (north)	0.50	0.50	4.85	2	143.60	0.043	2.5	2.736	0.750	1.75	1.31		Step-Pool	1107	Laterally dynamic - likely to recover sinuosity after straightening
85	22750	DS	0.50	0.50	0.71	2	30.51	0.019	2.5	2.736	0.750	1.16	0.87	0.803	Plane bed	325	Laterally dynamic - likely to recover sinuosity after straightening
85	22750	US	0.50	0.70	1.42	3	35.88	0.012	4.7	4.927	1.820	1.13	2.05	0.803	Plane bed	483	Laterally dynamic - likely to recover sinuosity after straightening
85	22750	US	0.50	0.70	3.23	2	116.29	0.018	3.3	3.630	1.330	1.35	1.80	0.803	Plane bed	618	Laterally dynamic - likely to recover sinuosity after straightening
85	22750	US	0.50	0.70	1.05	2	116.34	0.023	3.3	3.630	1.330	1.55	2.07	0.803	Plane bed	932	Laterally dynamic - likely to recover sinuosity after straightening
85	22750	US (between AT & A9)	0.50	0.70	-	2	12.62	0.181	3.3	3.630	1.330	4.36	5.79	0.803	Cascade	20569	Laterally dynamic - likely to recover sinuosity after straightening
86	22770	DS	0.50	0.50	1.00	2	20.54	0.023	2.5	2.736	0.750	1.28	0.96	0.159	Plane bed	433	Laterally dynamic - likely to recover sinuosity after straightening
86	22770	US	0.50	0.50	2.08	2	40.82	0.046	2.5	2.736	0.750	1.81	1.36	0.159	Step-Pool	1225	Laterally dynamic - likely to recover sinuosity after straightening
87	22950	US	0.50	0.50	1.58	2	111.67	0.010	2.5	2.736	0.750	0.84	0.63	0.137	Plane bed	124	Laterally dynamic - likely to recover sinuosity after straightening

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87	22950	US (between AT & A9)	1.00	0.70	-	3	19.29	0.100	5.2	5.427	2.170	3.43	7.45	0.137	Cascade	7305	Laterally dynamic - likely to recover sinuosity after straightening
87	22950	DS	0.50	0.50	2.03	2	22.06	0.227	2.5	2.736	0.750	4.02	3.02	0.137	Cascade	13427	Laterally dynamic - likely to recover sinuosity after straightening
89	23360	DS	0.75	0.70	5.46	2	117.41	0.047	3.6	3.880	1.505	2.31	3.47	3.636	Step-Pool	2133	Laterally dynamic - likely to recover sinuosity after straightening
89	23360	US	1.00	0.70	4.73	2	28.91	0.107	3.8	4.130	1.680	3.59	6.03	3.636	Cascade	6331	Laterally dynamic - likely to recover sinuosity after straightening
90	23440	US	0.50	0.50	3.36	2	41.81	0.014	2.5	2.736	0.750	0.98	0.74	0.509	Plane bed	197	Laterally dynamic - likely to recover sinuosity after straightening
90	23440	US	0.75	0.70	1.98	2	172.87	0.057	3.6	3.880	1.505	2.54	3.82	0.509	Step-Pool	2848	Laterally dynamic - likely to recover sinuosity after straightening
93	23670	DS	0.50	0.50	6.69	2	35.91	0.010	2.5	2.736	0.750	0.84	0.63	0.736	Plane bed	124	Laterally dynamic - likely to recover sinuosity after straightening
93	23670	US (between aqueduct & A9)	0.50	0.50	4.25	3	64.84	0.023	3.5	3.662	1.000	1.28	1.28	0.736	Plane bed	576	Laterally dynamic - likely to recover sinuosity after straightening
93	23670	US	0.50	0.50	3.27	3	73.49	0.074	3.5	3.662	1.000	2.29	2.29	0.736	Step-Pool	3323	Laterally dynamic - likely to recover sinuosity after straightening
94	23975	DS	0.50	0.50	4.19	4	35.83	0.035	4.5	4.623	1.250	1.56	1.96	0.403	Step-Pool	1342	Laterally dynamic - likely to recover sinuosity after straightening
94	23975	US	0.50	0.50	5.80	3	108.03	0.068	3.5	3.662	1.000	2.20	2.20	0.403	Step-Pool	2928	Laterally dynamic - likely to recover sinuosity after straightening
95	24155	US	0.50	0.50	-	2	10.05	0.402	2.5	2.736	0.750	5.35	4.01	0.391	Cascade	31642	Laterally dynamic - likely to recover sinuosity after straightening
95	24155	US	0.50	0.50	-	2	7.07	0.500	2.5	2.736	0.750	5.97	4.48	0.391	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
96	24220	DS	0.50	0.50	2.19	2	28.22	0.039	2.5	2.736	0.750	1.67	1.25	0.412	Step-Pool	956	Laterally dynamic - likely to recover sinuosity after straightening
96	24220	US	0.50	0.50	-	2	21.41	0.263	2.5	2.736	0.750	4.33	3.25	0.412	Cascade	16744	Laterally dynamic - likely to recover sinuosity after straightening
97	24550	DS	0.50	0.50	2.61	2	16.10	0.159	2.5	2.736	0.750	3.37	2.52	0.464	Cascade	7871	Laterally dynamic - likely to recover sinuosity after straightening
97	24550	US	0.50	0.50	-	2	14.95	0.468	2.5	2.736	0.750	5.77	4.33	0.464	Cascade	39747	Laterally dynamic - likely to recover sinuosity after straightening
98	24620	DS	0.50	0.50	3.24	2	47.31	0.204	2.5	2.736	0.750	3.81	2.86	0.403	Cascade	11439	Laterally dynamic - likely to recover sinuosity after straightening
98	24620	US	0.50	0.50	-	2	24.86	0.221	2.5	2.736	0.750	3.97	2.98	0.403	Cascade	12898	Laterally dynamic - likely to recover sinuosity after straightening
99	24870	DS	0.50	0.50	9.41	2	17.84	0.351	2.5	2.736	0.750	5.00	3.75	0.736	Cascade	25816	Laterally dynamic - likely to recover sinuosity after straightening
99	24870	US	0.50	0.50	-	2	13.54	0.468	2.5	2.736	0.750	5.77	4.33	0.736	Cascade	39747	Laterally dynamic - likely to recover sinuosity after straightening

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100	25420	DS (AT_1)	0.75	0.70	2.64	2	17.42	0.012	3.6	3.880	1.505	1.17	1.75	1.095	Plane bed	275	Laterally dynamic - likely to recover sinuosity after straightening
100	25420	DS (AT_2)	0.75	0.70	3.01	2	99.35	0.012	3.6	3.880	1.505	1.17	1.75	1.095	Plane bed	275	Laterally dynamic - likely to recover sinuosity after straightening
100	25420	DS	0.50	0.50	5.03	2	21.33	0.190	2.5	2.736	0.750	3.68	2.76	1.095	Cascade	10282	Laterally dynamic - likely to recover sinuosity after straightening
100	25420	US	0.50	0.50	2.00	2	17.00	0.203	2.5	2.736	0.750	3.80	2.85	1.095	Cascade	11355	Laterally dynamic - likely to recover sinuosity after straightening
101	25540	DS	0.50	0.50	2.31	2	11.64	0.050	2.5	2.736	0.750	1.89	1.42	0.070	Step-Pool	1388	Laterally dynamic - likely to recover sinuosity after straightening
101	25540	US	0.50	0.50	3.79	2	17.03	0.240	2.5	2.736	0.750	4.13	3.10	0.070	Cascade	14596	Laterally dynamic - likely to recover sinuosity after straightening
102	25790	DS	0.50	0.50	2.34	4	24.24	0.025	4.5	4.623	1.250	1.32	1.65	0.606	Plane bed	810	Laterally dynamic - likely to recover sinuosity after straightening
102	25790	US (between AT & A9)	0.50	0.50	2.39	2	27.82	0.083	2.5	2.736	0.750	2.43	1.82	0.606	Step-Pool	2969	Laterally dynamic - likely to recover sinuosity after straightening
102	25790	US	0.50	0.50	7.54	3	55.74	0.191	3.5	3.662	1.000	3.68	3.68	0.606	Cascade	13782	Laterally dynamic - likely to recover sinuosity after straightening
103	25950	DS	0.50	0.50	2.01	2	26.91	0.001	2.5	2.736	0.750	0.27	0.20	0.044	Plane-Riffle	4	Low energy- likely to experience sedimentation
103	25950	US	0.50	0.50	2.13	2	21.57	0.063	2.5	2.736	0.750	2.12	1.59	0.044	Step-Pool	1963	Laterally dynamic - likely to recover sinuosity after straightening
106	26200	US (between AT & A9)	0.50	0.50	1.41	2	32.12	0.028	2.5	2.736	0.750	1.41	1.06	0.287	Plane bed	582	Laterally dynamic - likely to recover sinuosity after straightening
106	26200	DS	0.50	0.50	6.23	2	32.16	0.058	2.5	2.736	0.750	2.03	1.52	0.287	Step-Pool	1734	Laterally dynamic - likely to recover sinuosity after straightening
106	26200	US	0.50	0.50	-	2	20.85	0.417	2.5	2.736	0.750	5.45	4.09	0.287	Cascade	33430	Laterally dynamic - likely to recover sinuosity after straightening
107	26600	DS	1.50	0.70	12.15	2	68.49	0.003	4.3	4.630	2.030	0.63	1.28	1.077	Plane-Riffle	25	Stable
107	26600	US (approx. Ch. 26480)	0.50	0.50	-	2	36.58	0.111	2.5	2.736	0.750	2.81	2.11	1.077	Cascade	4591	Laterally dynamic - likely to recover sinuosity after straightening
107	26600	US (approx. Ch. 26600)	0.50	0.50	-	2	62.72	0.131	2.5	2.736	0.750	3.05	2.29	1.077	Cascade	5886	Laterally dynamic - likely to recover sinuosity after straightening
109	26920	US (approx. Ch. 26920)	0.50	0.50	-	2	56.03	0.207	2.5	2.736	0.750	3.84	2.88	0.250	Cascade	11692	Laterally dynamic - likely to recover sinuosity after straightening
109	26920	US (approx. Ch. 26760)	0.50	0.50	-	2	26.51	0.274	2.5	2.736	0.750	4.42	3.31	0.250	Cascade	17806	Laterally dynamic - likely to recover sinuosity after straightening
110	27230	US	0.50	0.50	-	2	11.30	0.020	2.5	2.736	0.750	1.19	0.90	0.395	Plane bed	351	Laterally dynamic - likely to recover sinuosity after straightening
110	27230	US (between AT & A9)	0.50	0.50	0.90	3	25.96	0.019	3.5	3.662	1.000	1.16	1.16	0.395	Plane bed	432	Laterally dynamic - likely to recover sinuosity after straightening

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111	27460	DS	0.60	0.60	0.84	2	147.08	0.008	3.0	3.283	1.080	0.85	0.92	0.723	Plane bed	120	Laterally dynamic - likely to recover sinuosity after straightening
111	27460	US	0.50	0.50	3.53	2	44.54	0.034	2.5	2.736	0.750	1.56	1.17	0.723	Step-Pool	778	Laterally dynamic - likely to recover sinuosity after straightening
112	27725	DS (of AT)	0.75	0.50	0.69	2	20.31	0.008	2.8	2.986	0.875	0.79	0.69	0.817	Plane bed	72	High energy streams likely to erode constructed features
112	27725	DS	0.75	0.50	0.57	2	53.90	0.017	2.8	2.986	0.875	1.15	1.01	0.817	Plane bed	224	Laterally dynamic - likely to recover sinuosity after straightening
112	27725	US	0.75	0.50	1.84	2	44.29	0.022	2.8	2.986	0.875	1.31	1.15	0.817	Plane bed	329	Laterally dynamic - likely to recover sinuosity after straightening
112	27725	US (between AT & A9)	0.50	0.50	2.24	2	21.73	0.026	2.5	2.736	0.750	1.36	1.02	0.817	Plane bed	520	Laterally dynamic - likely to recover sinuosity after straightening
114	27970	DS	1.00	0.50	1.79	2	90.80	0.001	3.0	3.236	1.000	0.29	0.29	1.400	Plane-Riffle	3	Low energy- likely to experience sedimentation
114	27970	DS (between AT & A9)	0.50	0.50	3.78	3	11.35	0.042	3.5	3.662	1.000	1.73	1.73	1.400	Step-Pool	1421	Laterally dynamic - likely to recover sinuosity after straightening
114	27970	US	0.50	0.50	3.03	2	16.21	0.122	2.5	2.736	0.750	2.95	2.21	1.400	Cascade	5290	Laterally dynamic - likely to recover sinuosity after straightening
115	28050	US	0.50	0.50	4.51	2	55.87	0.073	2.5	2.736	0.750	2.28	1.71	1.044	Step-Pool	2449	Laterally dynamic - likely to recover sinuosity after straightening
115	28050	DS	1.00	0.70	1.12	2	8.93	0.070	3.8	4.130	1.680	2.90	4.88	1.044	Step-Pool	3350	Laterally dynamic - likely to recover sinuosity after straightening
116	28300	US	0.50	0.50	0.96	2	92.52	0.004	2.5	2.736	0.750	0.53	0.40	0.418	Plane-Riffle	31	Stable
116	28300	DS	0.50	0.50	0.65	2	100.59	0.005	2.5	2.736	0.750	0.60	0.45	0.418	Plane bed	44	High energy streams likely to erode constructed features
117	28440	US	0.50	0.50	2.82	2	50.39	0.059	2.5	2.736	0.750	2.05	1.54	0.165	Step-Pool	1779	Laterally dynamic - likely to recover sinuosity after straightening
118	28550	US	0.50	0.50	4.07	3	64.10	0.028	3.5	3.662	1.000	1.41	1.41	0.538	Plane bed	774	Laterally dynamic - likely to recover sinuosity after straightening
119	28800	US	0.50	0.50	11.36	2	44.06	0.064	2.5	2.736	0.750	2.14	1.60	0.841	Step-Pool	2010	Laterally dynamic - likely to recover sinuosity after straightening
119	28800	DS	0.50	0.50	0.54	2	12.26	0.430	2.5	2.736	0.750	5.53	4.15	0.841	Cascade	35005	Laterally dynamic - likely to recover sinuosity after straightening
120	29090	DS (of AT)	0.50	0.50	1.80	2	47.00	0.001	2.5	2.736	0.750	0.27	0.20	0.155	Plane-Riffle	4	Low energy- likely to experience sedimentation
120	29090	DS	0.50	0.50	2.72	2	48.96	0.213	2.5	2.736	0.750	3.90	2.92	0.155	Cascade	12204	Laterally dynamic - likely to recover sinuosity after straightening
120	29090	US	0.50	0.50	3.36	2	20.57	0.300	2.5	2.736	0.750	4.62	3.47	0.155	Cascade	20399	Laterally dynamic - likely to recover sinuosity after straightening
122	29350	DS	0.25	0.25	0.84	4	15.53	0.093	2.3	2.312	0.313	1.61	0.50	0.368	Step-Pool	1832	Laterally dynamic - likely to recover sinuosity after straightening
122	29350	US	0.50	0.50	2.84	2	18.83	0.168	2.5	2.736	0.750	3.46	2.59	0.368	Cascade	8549	Laterally dynamic - likely to recover sinuosity after straightening

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123	29425	DS	0.50	0.50	-	2	58.45	0.166	2.5	2.736	0.750	3.44	2.58	0.464	Cascade	8396	Laterally dynamic - likely to recover sinuosity after straightening
123	29425	US	0.75	0.50	2.52	2	19.13	0.230	2.8	2.986	0.875	4.23	3.70	0.464	Cascade	11135	Laterally dynamic - likely to recover sinuosity after straightening
124	29510	US	0.50	0.50	1.74	2	7.08	0.134	2.5	2.736	0.750	3.09	2.32	0.610	Cascade	6090	Laterally dynamic - likely to recover sinuosity after straightening
124	29510	DS	0.50	0.50	-	2	34.15	0.339	2.5	2.736	0.750	4.91	3.69	0.610	Cascade	24504	Laterally dynamic - likely to recover sinuosity after straightening
125	29590	DS	0.50	0.50	-	4	51.55	0.225	4.5	4.623	1.250	3.97	4.96	0.607	Cascade	21882	Laterally dynamic - likely to recover sinuosity after straightening
125	29590	US	0.50	0.50	1.23	2	8.88	0.338	2.5	2.736	0.750	4.91	3.68	0.607	Cascade	24395	Laterally dynamic - likely to recover sinuosity after straightening
126	29670	DS	0.50	0.50	1.55	2	23.25	0.199	2.5	2.736	0.750	3.76	2.82	0.744	Cascade	11021	Laterally dynamic - likely to recover sinuosity after straightening
126	29670	US	0.50	0.50	4.26	4	25.42	0.277	4.5	4.623	1.250	4.40	5.50	0.744	Cascade	29890	Laterally dynamic - likely to recover sinuosity after straightening
127	30190	US (north)	0.50	0.50	8.10	3	122.17	0.045	3.5	3.662	1.000	1.79	1.79	0.678	Step-Pool	1576	Laterally dynamic - likely to recover sinuosity after straightening
127	30190	US (south)	0.50	0.50	7.05	2	101.05	0.106	2.5	2.736	0.750	2.75	2.06	0.678	Cascade	4284	Laterally dynamic - likely to recover sinuosity after straightening
127	30190	DS	0.50	0.50	1.88	2	34.08	0.173	2.5	2.736	0.750	3.51	2.63	0.678	Cascade	8933	Laterally dynamic - likely to recover sinuosity after straightening
127	30190	US	0.50	0.50	15.30	3	18.19	0.618	3.5	3.662	1.000	6.62	6.62	0.678	Cascade	80210	Laterally dynamic - likely to recover sinuosity after straightening
128	30270	DS	0.50	0.50	-	2	52.60	0.100	2.5	2.736	0.750	2.67	2.00	0.509	Cascade	3926	Laterally dynamic - likely to recover sinuosity after straightening
128	30270	US	0.50	0.50	2.71	2	24.93	0.430	2.5	2.736	0.750	5.53	4.15	0.509	Cascade	35005	Laterally dynamic - likely to recover sinuosity after straightening
129	30500	US	0.50	0.50	9.79	2	17.00	0.500	2.5	2.736	0.750	5.97	4.48	0.600	Cascade	43892	Laterally dynamic - likely to recover sinuosity after straightening
129	30500	DS	0.50	0.50	4.40	1	3.74	0.700	1.5	1.914	0.500	6.84	3.42	0.600	Cascade	46937	Laterally dynamic - likely to recover sinuosity after straightening
132	30900	US	0.50	0.50	4.22	1	4.78	0.850	1.5	1.914	0.500	7.53	3.77	0.590	Cascade	62806	Laterally dynamic - likely to recover sinuosity after straightening

11.4.4.5. Design Fix information (7th Iteration) for bridges and erosion protection

Structure ID	Watercourse	Proposed Structure Type	Existing Structure length (m)	Existing Length of Bank Protection (m)	Proposed Length (m) of Structure	Proposed Total Length of Bank Protection (m)
n/a	59	Bank protection	n/a			40
S1	72	Mainline Bridge	13.2	No existing bank protection	30.75	86.5
S2	77	Mainline Bridge	18.6	No existing bank protection	31.5	85
S3	82	Mainline Bridge	13.2	No existing bank protection	27.35	97.2
n/a	82	Access track crossing	n/a	n/a	8	n/a
S8	104	Mainline Bridge	12.3	90	33.5	83.85
n/a	104	Embankment toe protection	n/a	n/a	n/a	120
S10	121	Mainline Bridge	13.2	160	27.8	77.6
n/a	121	Access track crossing	n/a	n/a	8	n/a
S11	130	Mainline Bridge	26	52	32	64
S3a	Truim (River Truim from source to Allt Cuaich)	Mainline Bridge	n/a	n/a	17	0
n/a	Truim (River Truim from source to Allt Cuaich)	Embankment toe protection	n/a	n/a	n/a	40
n/a	Truim (River Truim from source to Allt Cuaich)	Replacement bank protection	n/a	135	n/a	135
n/a	Truim (Lower Catchment)	Bank protection	n/a	n/a	n/a	170

10.5 Annex 11.4.5 EIA Hydromorphological Assessment Tables

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
River Truim- lower catchment	High	Good (Water flow and level and Physical condition)	5 outfalls and 170m of new bank protection	No	Loss of small sections of natural bank due to headwalls and 170m due to bank protection Loss of very small section of natural bed for headwalls Fixing of channel position due to headwalls and bank protection- harder for channel to adjust to changes in sediment supply and discharge Changes to continuity of sediment transport caused by small changes in discharge and reduced supply from bank Small changes to flow (increased discharge) Small changes to continuity of sediment due to changes in discharge and reduced supply from bank Small changes to sediment dynamics due to changes in discharge and reduced sediment supply from bank	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
River Truim from source to Allt Cuaich	High	Good (Water flow and level and Physical condition)	2 outfalls, 135m of replacement bank protection, and 40m of erosion protection at the toe of the embankment	No	Loss of natural bank- more uniform form and loss of sediment supply due to outfalls. Note that new erosion protection is set back from the channel along the toe of embankment. Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to outfalls Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to set back erosion protection. Erosion protection is set back from the channel banks to allow channel space to move while protecting the toe of the embankment from excessive erosion Small change in flow (velocity and/or discharge) conditions due to outfalls Small change in sediment dynamics due to outfalls	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
130	High	Good (Water flow and level and Physical condition)	Replacement bridge- to be upsized to take 1:200 year flow and SUDS outfall	No	Loss of natural bank- more uniform form and loss of sediment supply in drain outfall locations Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply in drain outfall locations Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfalls and bridges) Small change in flow (velocity and/or discharge) conditions Small change in sediment dynamics Improved continuity of sediment transfer due to upsized bridge Change in sediment dynamics- Improved due to upsized bridge	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
129	Medium	Good (Water flow and level and Physical condition)	Construction of upsized and extended box culvert (35m)	No	Loss of natural bank- more uniform form and loss of sediment supply due to culvert extension Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert extension Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge More natural flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
128	Low	Good (Water flow and level and Physical condition)	50m channel realignment, 1 outfall and 1x replacement upsized and extended pipe culvert (49m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
127	Low	Good (Water flow and level and Physical condition)	48m channel realignment and extension and replacement of 1x Pipe culvert (49m)	No	Loss of natural bank - more uniform form (channel realignment) and loss of sediment supply due to longer, replacement culvert Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Little change in flow (velocity and/or discharge) conditions due to works Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
126	Medium	Good (Water flow and level and Physical condition)	2x drain outfall, 47m channel realignment and 1x replacement and extension of pipe culvert (50m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
125	Medium	Good (Water flow and level and Physical condition)	1x drain outfall, 32m channel realignment and 1x Box culvert to replace existing pipe (74m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply due to longer, replacement culvert Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfall and culvert) Change in flow (velocity and/or discharge) conditions due to works Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral- Change from pipe to box culvert will be beneficial to morphology and sediment transfer.
124	Medium	Good (Water flow and level and Physical condition)	1x drain outfall, 30m channel realignment and 1x Box culvert (87m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply due to longer, replacement culvert Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfall and culvert) Change in flow (velocity and/or discharge) conditions due to works Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral- Change from pipe to box culvert will be beneficial to morphology and sediment transfer.
123	Medium	Good (Water flow and level and Physical condition)	1x drain outfall, 69m channel realignment and 1x upsized box culvert to extend and replace a pipe culvert (72m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
121- Allt Garbh	High	Good (Water flow and level and Physical condition)	Summary of work (based on 4th iteration)	No	Loss of natural bank- more uniform form and loss of sediment supply in drain outfall locations	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply in drain outfall locations.												
					Fixing of channel position for increased length- harder for channel to adjust to changes in sediment supply and discharge (outfalls and bridges)												
					Small change in flow (velocity and/or discharge) conditions												
					Small change in sediment dynamics												
					Improved continuity of sediment transfer due to substrate in culvert												
					Change in sediment dynamics- Improved due to substrate in culvert and more natural flow												
119	Medium	Good (Water flow and level and Physical condition)	1 drain outfall, 81m of channel realignment, 1 x replacement pipe with box culvert (81m)	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfalls												
					Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall												
					Small changes in flow due to outfall (velocity and/or discharge)		0.5-1.5 Km	Very small		Minor	Slight beneficial		0.5-1.5 Km	Negligible		Negligible	Slight beneficial (change to box culvert is beneficial)
					Improved continuity of sediment transfer due to substrate in culvert												
					Change in sediment dynamics- Improved due to substrate in culvert and more natural flow												
118	Low	Good (Water flow and level and Physical condition)	1 drain outfall, 63m of channel realignment, 1 replacement pipe to box culvert (64m)	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfalls												
					Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall												
					Small changes in flow due to outfall (velocity and/or discharge)		0.5-1.5 Km	Very small		Minor	Neutral		0.5-1.5 Km	Negligible		Negligible	Neutral (change to box culvert is beneficial)
					Improved continuity of sediment transfer due to substrate in culvert												
					Change in sediment dynamics- Improved due to substrate in culvert and more natural flow												
117	Low	Good (Water flow and level and Physical condition)	2 drain outfalls, 49m of channel realignment, 1 x pipe culvert (61m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply due to longer, replacement culvert	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert and realignment												
					Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfall and culvert)												
					Small change in flow (velocity and/or discharge) conditions due to works		0.5-1.5 Km	Very small		Minor	Neutral		0.5-1.5 Km	Negligible		Negligible	Neutral
					Improved continuity of sediment transfer due to substrate in culvert												
					Change in sediment dynamics- Improved due to substrate in culvert and more natural flow												
116	Low	Good (Water flow and level and Physical condition)	1 drain outfall, 103m of channel realignment, 1 replacement pipe to box culvert (51m)	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfalls												
					Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall												
					Small changes in flow due to outfall (velocity and/or discharge)		0.5-1.5 Km	Very small		Minor	Neutral		0.5-1.5 Km	Negligible		Negligible	Neutral (change to box culvert is beneficial)
					Improved continuity of sediment transfer due to substrate in culvert												
					Change in sediment dynamics- Improved due to substrate in culvert and more natural flow												

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
115	Low	Good (Water flow and level and Physical condition)	2 drain outfalls, 60m of channel realignment, 1 replacement box culvert (62m).	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfalls Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Small changes in flow due to outfalls (velocity and/or discharge) Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow		0.5-1.5 Km	Very small		Minor	Neutral		0.5-1.5 Km	Negligible		Negligible	Neutral (change to box culvert is beneficial)
114	Medium (artificial channel)	Good (Water flow and level and Physical condition)	2 drain outfalls, 2 SUDs outfalls, 213m of channel realignment, 1 pipe culvert (14m) and one replacement of a pipe with an upsized box culvert (43m)	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow		0.5-1.5 Km	Very small		Minor	Slight beneficial (Upsized culvert with natural bed)		<0.5 Km (Extent of change in flow and sediment transport will be reduced as	Negligible		Negligible	Neutral- Culvert not upsized
112	High	Good (Water flow and level and Physical condition)	Construction of 2 drain outfalls, 170m of channel realignment, 2 new culverts (13m, 15m) and the upsize and replacement of a pipe culvert with a box culvert (49m)	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow		0.5-1.5 Km	Very small		Minor	Slight beneficial (Upsized culvert with natural bed and reduced scour)		0.5-1.5 Km	Very small		Minor	Slight beneficial (Upsized culvert with natural bed and reduced scour)
111	Medium	Good (Water flow and level and Physical condition)	1 SUD's outfall, 190m of channel realignment, 3 culverts (7m, 13m, 48m) , and the replacement of a pipe culvert with box culvert	No	Loss of natural bank - more uniform form (channel realignment and culverts) and loss of sediment supply due to replacement of culvert and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culverts, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culverts and outfall	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
					Small change in flow (velocity and/or discharge) conditions Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow		0.5-1.5 Km	Very small		Minor	Slight beneficial (Culvert with natural bed)		0.5-1.5 Km	Very small		Minor	Slight beneficial (Culvert with natural bed)
109	Low	Good (Water flow and level and Physical condition)	Construction of 1 drain outfall, 270m of channel realignment, 3 new culverts (4m, 7m 10m) and 1x pipe to box culvert (44m)	No	Loss of natural bank - more uniform form (channel realignment and culverts) and loss of sediment supply due to culverts and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culverts, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culverts and outfall Change in flow (velocity and/or discharge) conditions due to outfalls Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
107	High	Good (Water flow and level and Physical condition)	5 drain outfalls, 80m of channel realignment, 1 new culvert (1x8m and 1 replacement, upsized box culvert	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to new culverts and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culverts, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral (Beneficial due to culvert improvements, and realignment reducing excessive scour)
106	Medium	Good (Water flow and level and Physical condition)	5 drain outfalls, 100m of channel realignment, 2 new culverts (1x16m and 1x20m) and 1 replacement culvert (Pipe to box and upsized)	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Slight beneficial (Upsized culvert with natural bed)	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Slight beneficial (Upsized culvert with natural bed)
104	High	Bad-Water flow and level Good-Physical condition	Extension and upsizing of bridge, 3 drain outfall and a SUDS outfall	No	Loss of natural bank- more uniform form and loss of sediment supply in drain outfall locations Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply in drain outfall locations Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfalls and bridges) Small change in flow (velocity and/or discharge) conditions Small change in sediment dynamics Improved continuity of sediment transfer due to upsized bridge Change in sediment dynamics- Improved due to due to upsized bridge	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral (upsized bridge is beneficial)	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral (less beneficial as bridge is not to be upsized due to flood risk)
103	Low	Bad-Water flow and level Good-Physical condition	48m of channel realignment, replacement of 1 pipe culvert (1x76m)	No	Loss of natural bank - more uniform form and loss of sediment supply due to longer, replacement culvert and realignment Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert and realignment Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Small change in flow (velocity and/or discharge) conditions due to works Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral
102	Medium	Good (Water flow and level and Physical condition)	3 drain outfalls, 106m of channel realignment,1 new pipe culvert (1x16m) and replacement and upsize of existing culvert (1x86m)	No	Loss of natural bank - more uniform form (channel realignment, culverts and outfall) and loss of sediment supply Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culverts, realignments and outfalls Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Slight beneficial (Upsized culvert)	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Slight beneficial (Upsized culvert)

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
100	Medium	Good (Water flow and level and Physical condition)	2 drain outfalls, 252m of channel realignment, 3 additional box culverts and 1 Box culvert replacement of pipe- to be upsized (49m).	No	Loss of natural bank - more uniform form (channel realignment and culverts) and loss of sediment supply due to replacement of culvert and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Slight beneficial	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Slight adverse (culvert not upsized to give improvement and realignment may have adverse impacts on flows and sediment transport)
99	Low	Good (Water flow and level and Physical condition)	2 drain outfalls, 17m of channel realignment, 1 pipe culvert (1x76m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply due to longer, replacement culvert and additional culvert Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to works Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfall and culvert) Change in flow (velocity and/or discharge) conditions due to works Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
98	Low	Good (Water flow and level and Physical condition)	2 drain outfalls, 45m of channel realignment, 1 pipe culvert extension and upsize (1x33m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
95	Low	Good (Water flow and level and Physical condition)	4 drain outfalls, 7m of channel realignment, 1 pipe culvert extension and upsize (1x51m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Neutral	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Neutral (upsized culvert beneficial)
94	Low	Good (Water flow and level and Physical condition)	1 drain outfall, 183m of channel realignment, including change in drainage across catchments, 1 upsized pipe culvert (1x30m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Neutral	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Neutral (upsized culvert beneficial)

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
89	High	Good (Water flow and level and Physical condition)	Drain outfall, 180m of channel realignment, 1 replacement pipe culvert not to be upsized (1x90m).	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply due to longer, replacement culvert Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert and channel realignment Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfall and culvert) Little change in flow (velocity and/or discharge) conditions due to works Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Slight Beneficial	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very small	Long (more than 6 years)	Negligible Minor	Neutral Slight Beneficial
87	Low	Good (Water flow and level and Physical condition)	4 drain outfalls, 140m of channel realignment, Upsized replacement pipe culvert (1x67m) and additional pipe culvert (1x13m).	No	Loss of natural bank - more uniform form (channel realignment, additional culvert and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culverts and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral- Channel realignment may be beneficial
84/85	Medium	Good (Water flow and level and Physical condition)	311m of channel realignment, some of which is taking drainage from another catchment 3 pipe culverts and 2 drainage outfalls	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to realignment Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfall) Small change to flow (velocity and/or discharge) Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Minor	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
83	Low	Good (Water flow and level and Physical condition)	Drain outfall and 144m of channel realignment, taking flow from catchment to 82	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to , realignment Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfall) small change to flow (velocity and/or discharge) Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
82- Allt Coire Bhathaich	High	Good (Water flow and level and Physical condition)	Construction of 3 drain outfalls, 1 SUDs outfall, 2 Bridges, with abutments set back from the channel banks. Channel will take additional flow from crossing 83.	No	Loss of natural bank- more uniform form and loss of sediment supply in drain outfall locations Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply in drain outfall locations Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfalls and bridges) Increased discharge and potentially velocity due to flow from 83 Improved continuity of sediment transfer due to substrate in culvert	0	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral-beneficial as abutments will be set back further from bank

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
81	Medium	Good (Water flow and level and Physical condition)	Construction of 6 drain outfalls, 255m of channel realignment, 1 culvert replacement to be upsized (1x61m box culvert) and additional culvert.	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert, realignment and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge due to culvert and outfall Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Minor	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Minor	Neutral
79	Medium	Good (Water flow and level and Physical condition)	2 drain outfalls, 170m of channel realignment, 1 replacement culvert to be upsized (1x38m box culvert).	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral-culvert upsize and change to box are beneficial	Good to Moderate	<0.5 Km	Very Small	Long (more than 6 years)	Minor	Neutral-culvert change to box is beneficial
78	Low	Good (Water flow and level and Physical condition)	2 drain outfalls, 100m of channel realignment, 1 culvert replacement to be upsized (1x49m pipe culvert).	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
77- Allt Coire Uilleium	High	Good (Water flow and level and Physical condition)	2 drain outfalls, and bridge	No	Loss of natural bank- more uniform form and loss of sediment supply in drain outfall locations Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply in drain outfall locations Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfalls and bridges) Small change in flow (velocity and/or discharge) conditions Improved continuity of sediment transfer	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral-Beneficial. Bridge will be set back from channel allowing more natural banks, and channel adjustment than the baseline.	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral-Beneficial. Bridge will be set back from channel allowing more natural banks, and channel adjustment than the baseline.
76	Medium	Good (Water flow and level and Physical condition)	2 drain outfalls, 2 SUDs outfalls, 300m of channel realignment, 2 culverts (1x30m and 1x45m Pipe to Box culverts allowing natural bed)	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and additional culverts and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Very Small	Long (more than 6 years)	Negligible	Neutral

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
75	Low	Good (Water flow and level and Physical condition)	1 outfall, 34m of channel realignment, 1 culvert extension upsized (70m Pipe) and 1 new pipe culvert	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
74	Low	Good (Water flow and level and Physical condition)	3 outfalls, 50m of channel realignment, culvert upsized and extended in length (1x32m Pipe culvert), additional pipe culvert (1x8m)	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply (longer replacement culvert) Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (culvert and outfalls) Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
72- Allt Coire nan Cisteachan	High	Good (Water flow and level and Physical condition)	2 drain outfalls, and 2 bridges, with abutments set back from channel	No	Loss of natural bank- more uniform form and loss of sediment supply in drain outfall locations Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply in drain outfall locations Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfalls and bridges) Small change in flow (velocity and/or discharge) conditions Improved continuity of sediment transfer due to substrate in culvert	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral-Setting back of bridge abutments will be beneficial giving the channel more space in which to adjust
71	Low	Good (Water flow and level and Physical condition)	2 drain outfalls, 32m of channel realignment and the extension of 1 culvert and addition of a new culvert (1x40m and 1x4m- Pipes).	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply due to longer, replacement culvert and additional culvert Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culverts Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge (outfall and culverts) Change in flow (velocity and/or discharge) conditions due to works Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
70	Medium	Good (Water flow and level and Physical condition)	61m of channel realignment the replacement of 1 culverts (1x40m- Pipe) and addition of new culvert (10m)	No	Loss of natural bank - more uniform form (channel realignment) and loss of sediment supply due to longer, replacement culvert and additional culvert Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culverts Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Change in flow (velocity and/or discharge) conditions due to works Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
68	Medium	Good (Water flow and level and Physical condition)	4 drain outfalls into channel, 27m of channel realignment, with a cascade, the replacement and upsizing of the mainline culvert (1x41m pipe) and addition of 1 track culvert 1x11m- Pipe).	No	Loss of natural bank and reduced sediment supply- more uniform form (channel realignment, outfalls, culverts) and loss of sediment supply Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culverts and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5 Km	Negligible	Long (more than 6 years)	Negligible	Neutral
66	Low	Good (Water flow and level and Physical condition)	1 drain outfall into channel, 20m of channel realignment, with the possibility of a significant step/cascade, and the upsizing of 1 culvert (1x35m- Pipe).	No	Loss of natural bank - more uniform form (channel realignment and outfall) and loss of sediment supply longer replacement of culvert Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply due to culvert and outfall Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very Small	Long (more than 6 years)	Negligible Minor	Neutral	Good to Moderate	<0.5 Km 0.5-1.5 Km	Negligible Very Small	Long (more than 6 years)	Negligible Minor	Neutral
65	Medium	Good (Water flow and level and Physical condition)	3 new culverts with the mainline being upsized (1x27m- Upgrade from pipe to Box and 2x10m Box). 5 drain outfalls into channel, 212m of channel realignment, with a replacement significant step, and additional upstream flood storage	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and additional culverts and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow Improved continuity of sediment transfer due to upsized culvert and natural bed within culvert Change in sediment dynamics- Improved due to natural bed of culvert	Good to Moderate	<0.5 0.5 to < 1.5	Negligible Very Small	Long (more than 6 years)	Negligible Minor	Neutral Slight	Good to Moderate	<0.5 0.5 to < 1.5	Negligible Very Small	Long (more than 6 years)	Negligible Minor	Neutral
64- Allt Coire Bhotie	High	Good -Water flow and levels Good- Physical condition	NMU Bridge	No	Fixing of channel position between bridge piers- harder for channel to adjust to changes in sediment supply and discharge	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral
61	Medium	Good -Water flow and levels Good- Physical condition	Culvert under track and channel realignment	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and additional culverts and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral

Receptor	Sensitivity of Receptor	Existing WFD Status	Summary of work (based on 4th iteration)	Is the Threshold of Significant Impacts test failed?	Impacts	Worst case degree of change in WFD Status	Spatial extent of Impact	Scale of Impact	Duration of Impact	Magnitude of Impact	Significance (based on 4th iteration)	Residual worst case degree of change in WFD Status	Residual Spatial Extent	Residual scale of Impact	Residual Duration	Residual Magnitude	Residual impact significance following all mitigation
63	Medium	Good -Water flow and levels Good- Physical condition	Culvert under track and channel realignment	No	Loss of natural bank - more uniform form (channel realignment and culvert) and loss of sediment supply due to replacement of culvert and additional culverts and outfalls Loss of natural bed- more uniform form, reduced range of substrate and reduced sediment supply Fixing of channel position- harder for channel to adjust to changes in sediment supply and discharge Improved flow (velocity and/or discharge) conditions due to upsized culvert Improved continuity of sediment transfer due to substrate in culvert Change in sediment dynamics- Improved due to substrate in culvert and more natural flow	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral
59- Allt Coire Chuirn	High	Good -Water flow and levels Good- Physical condition	Bridge	No	Fixing of channel position between bridge piers- harder for channel to adjust to changes in sediment supply and discharge	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral	Good to Moderate	<0.5Km	Negligible	Long (more than 6 years)	Negligible	Neutral

10.6 Annex 11.4.6 Geomorphological Channel Design

Background

10.6.1 This note is intended to provide a summary of geomorphological information on the characteristics of different River Types found in the UK. This information is intended to provide guidance to the engineering team to aid in the design of sustainable channel realignments, with suitable morphology for the river setting.

Fluvial concepts theory

10.6.2 The established conceptual model of river system operation suggests that their key driving variables are the inputs of water and sediment. These independents interact with boundary characteristics (slope/ topography, bed and bank materials, and riparian vegetation) to generate the channel form (e.g. Knighton, 1998; Sear & Newson, 2010). Because of these interactions a variety of channel forms (geometric characters) exist. These are described across many planes of adjustment, within which there are a number of representative parameters. Knighton (1998) classifies these broadly as:

- Cross-sectional form (size and shape parameters, e.g. width, depth, area etc.);
- Bed configuration (e.g. sand or gravel beds);
- Channel pattern (form of channel as viewed from above, e.g. straight, meandering or braided; descriptive parameters include sinuosity, meander arc length etc.);
- Channel bed slope (i.e. gradient, which is related to channel pattern).

10.6.3 The adjustment of these channel geometry parameters and that of the shorter-term variations of flow geometry, are interdependent; therefore, a change in one parameter may manifest a response in others such that a river channel can perform its function, i.e. the transference of energy and matter, ideally in dynamic equilibrium (if conditions permit). Variations result in complex patterns of form, flow, and materials across both space and time.

10.6.4 This conceptual basis is important, as it establishes that channel design has to take into consideration the complexities of the river environment, and that by understanding these principles, more effective channels may be designed to work with nature.

Planform type

10.6.5 Mean valley slope and design bankfull discharge can be used to determine the most likely/ desirable channel planform type (Figure 11.4.5.1 and Table 11.4.5.1).

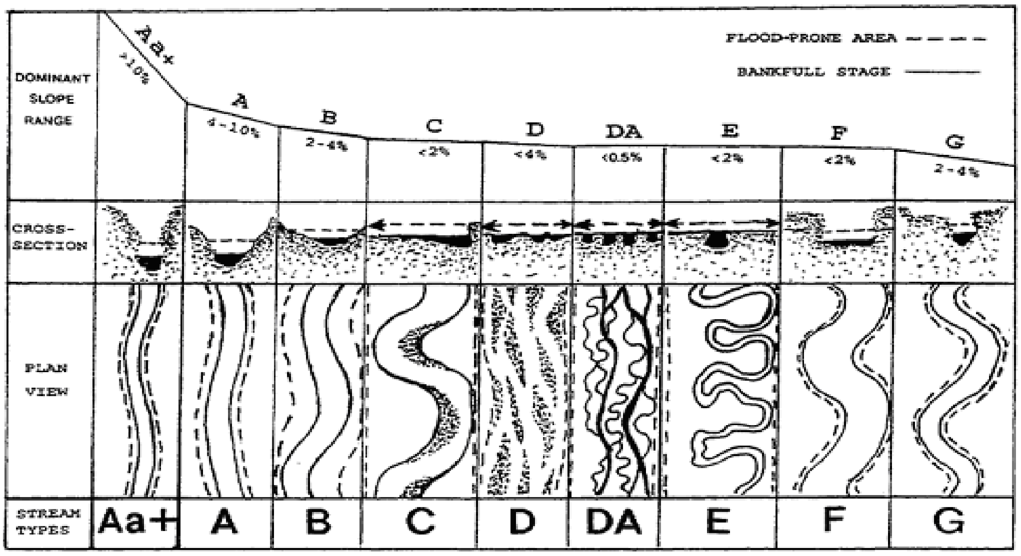

Figure 11.4.5.1 Longitudinal, cross sectional and plan views of major stream types (Rosgen, 1994)

Table 11.4.5.1 Channel characteristics based on Rosgen, 1994.

Characteristics	Type Aa+	Type A	Type B	Type C
General	Very steep, deeply entrenched, debris transport streams	Steep, entrenched, step-pool streams, high energy	Moderately entrenched, moderate gradient, riffle dominated channel with infrequent pools, stable planform and long profile	Low gradient, meandering, point bar, riffle/pool, alluvial channel with broad floodplain
Entrenchment ratio (width of flood prone area/bankfull channel width)	<1.4	<1.4	1.4-2.2	>2.2
Width/depth ratio	<12	<12	>12	>12
Sinuosity	1.0-1.1	1.0-1.2	>1.2	>1.4
Slope (m/m)	>0.1	0.04-0.1	0.02-0.039	<0.02
Slope (%)	>10	4-10	2-3.9	<2
Meander width ratio (beltwidth /bankfull width)	N/A	1-3	2-8	4-20

Bed morphology

10.6.6 Channel bed slope is a major driver of channel bed form (Rosgen, 1994); hence bed slope, planform and bed morphology are highly interrelated in natural channels. To best account for this association, mean channel bed slope and proposed planform information can be used in association with the literature (Figure 11.4.5.2 and Table 11.4.5.2) to suggest appropriate channel bed morphology.

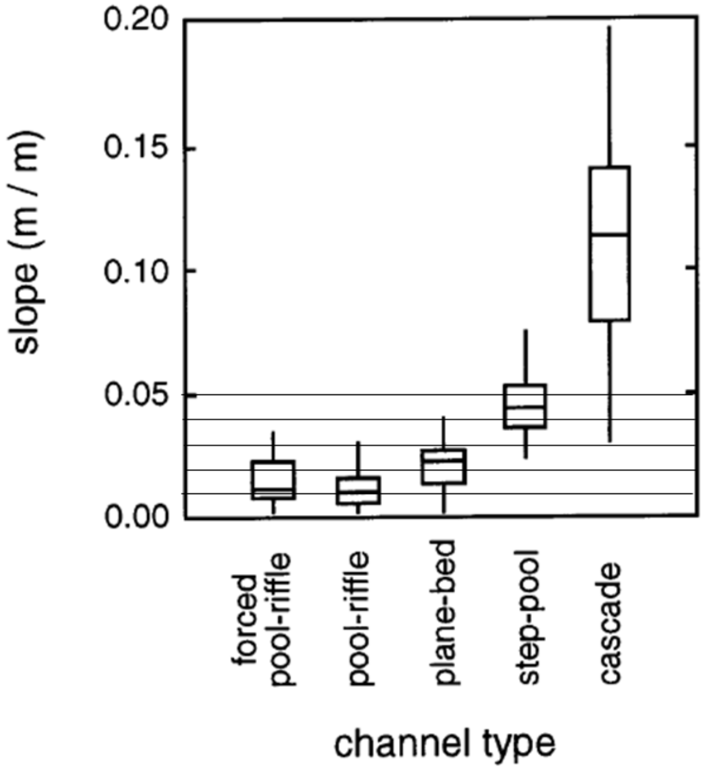

Figure 11.4.5.2 Slope distribution for different channel reaches (Montgomery and Buffington, 1997)

Table 11.4.5.2 River Types (based on SEPA, 2011)

Geology	Slope		Sinuosity	Type
Bedrock	Any		Any	Bedrock, Cascade
Not Bedrock	>0.1		Any	Bedrock, Cascade
	>0.03	≤0.1	Any	Step-pool, Plane Bed
	>0.005	≤0.03	≤1.1	Step-pool, Plane Bed
			>1.1	Plane-riffle, Braided, Wandering
	>0.001	≤0.005	Any	Plane-riffle, Braided, Wandering
	>0.0005	≤0.001	≤1.4	Plane-riffle, Braided, Wandering
			>1.4	Actively Meandering
	>0.0001	≤0.0005	Any	Actively Meandering
	≤0.0001		Any	Low Gradient Passive Meandering

Characteristics of Cascade morphology

10.6.7 The channel should typically have the characteristics outlined below and in Figures 11.4.5.3, 11.4.5.4 and 11.4.5.5 (Montgomery and Buffington, 1997):

- Tumbling flow around large clasts
- Steep slopes (over 0.1 m/m)
- Confined channel by valley sides
- Low sinuosity
- Lack of in channel storage
- Bed dominated by large particle size
- Supply limited channels

Figure 11.4.5.3. Example cascade (Montgomery and Buffington, 1997)F

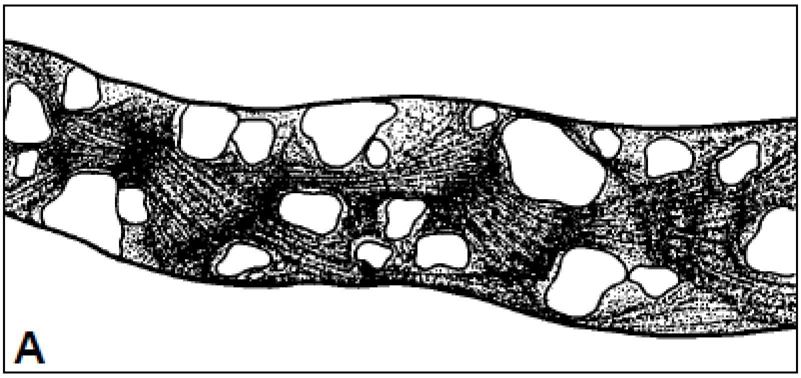

Figure 11.4.5.4. Example cascade planform (Montgomery and Buffington, 1997)

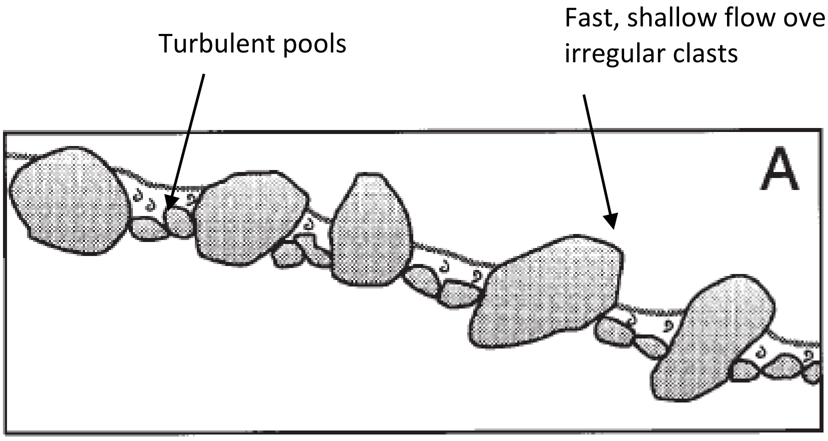

Figure 11.4.5.5. Example cascade long profile (Montgomery and Buffington, 1997)

Characteristics of Step-Pool bed morphology

10.6.8 These channel types form on steep slopes, with energy dissipation through tumbling flow over and around large clasts (cobbles and boulders) (Figure 11.4.5.6). Bed material is a mix of stable coarse casts, and finer material that gets trapped around the coarse material, and mobilised during flood flows (Montgomery and Buffington, 1997). These systems have a high transport capacity relative to sediment supply and will rapidly supply sediment downstream if is available (i.e. supply limited system).

10.6.9 The channel should typically have the characteristics outlined below and in Figures 11.4.5.7, 11.4.5.8 and 11.4.5.9 (Knighton, 1998, and Montgomery and Buffington, 1997):

- Pools and alternating bands of channel-spanning flow obstructions typically occur at a spacing of every 1–4 channel widths;
- Typical gradients of 0.03–0.1 m/m
- Low sinuosity
- Fast water at steps/falls and chutes, slow water at pools.
- Step spacing increasing with decreasing channel bed slope, with $L=0.31s^{-1.19}$ where s=mean slope m/m and L=Step wavelength parallel to mean slope
- Step height is controlled by the largest particle, and pool scour (with approximately 1/3 of the mean step height due to pool scour)
- Pool width approximately 20% greater than steps (Thomas *et al*, 2000)
- Boulders, interlocked with each other and the bed, and arranged in a broad v-shape, with the apex of the weir pointing upstream to prevent bank erosion

Figure 11.4.5.6. Example of a step pool channel (Montgomery and Buffington, 1997)

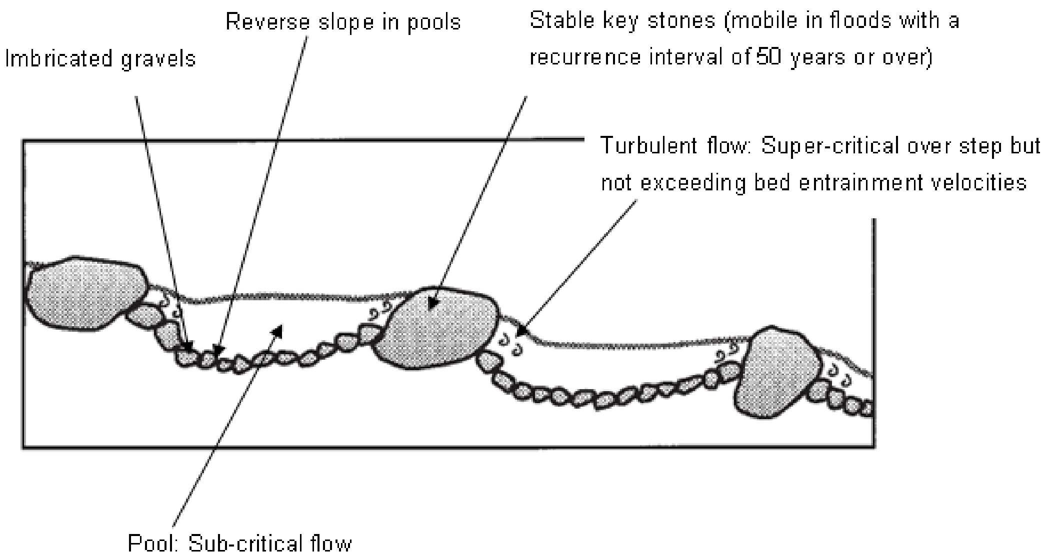

Figure 11.4.5.7 Example long profile of step –pool channel (based on Montgomery and Buffington, 1997)

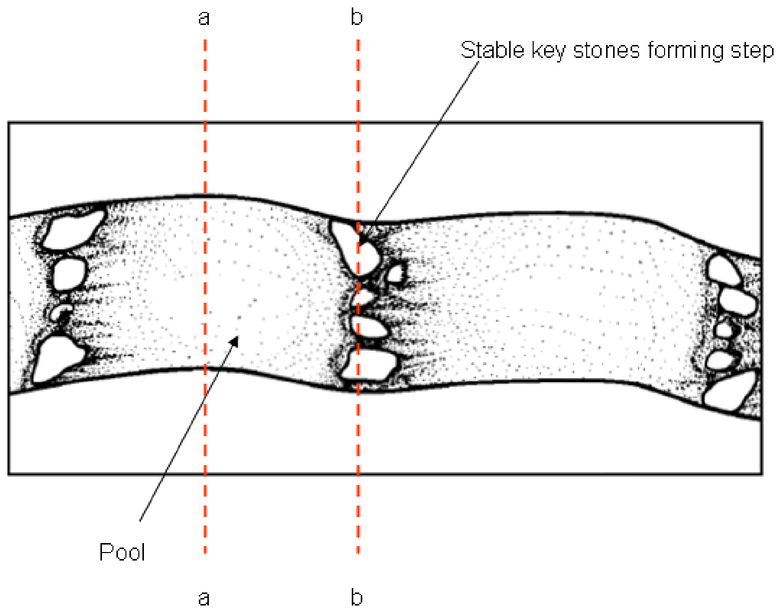

Figure 11.4.5.8 Example planform for a step –pool channel (based on Montgomery and Buffington, 1997)

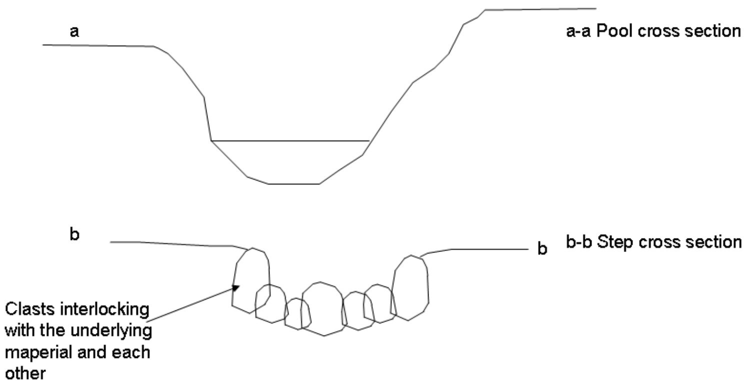

Figure 11.4.5.9 Example cross sections for a step- pool channel

10.6.10 Longitudinal spacing of step and pool sections is important for stability and function of the channel. Step crest wavelength (L) (Figure 11.4.5.10) can be calculated by $L=0.31s^{-1.19}$ where (s=mean slope m/m). The shape and size of the transition between each step and pool also needs to be carefully considered.

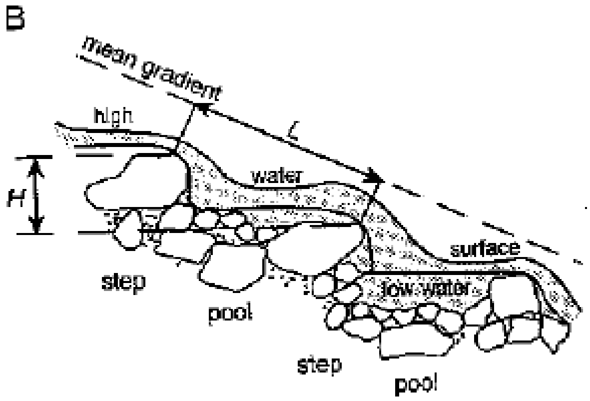

Figure 11.4.5.10. Example positioning of steps and pools (Knighton, 1998)

Characteristics of Plane bed

10.6.11 The channel should typically have the characteristics outlined below and in Figures 11.4.5.11, 11.4.5.12 and 11.4.5.13 (Montgomery and Buffington, 1997):

- Large values of relative roughness (90th percentile grain size to bankfull flow depth)
- Lack of discreet bars and bed forms
- Straight channels
- Moderate to high slopes
- Dominated by cobble and gravel bed

Figure 11.4.5.11. Example of a plane bed channel (Montgomery and Buffington, 1997)

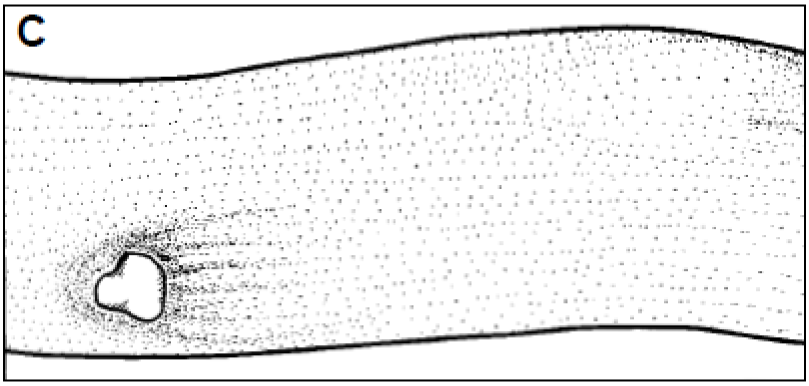

Figure 11.4.5.12. Example of a plane bed channel planfrom (Montgomery and Buffington, 1997)

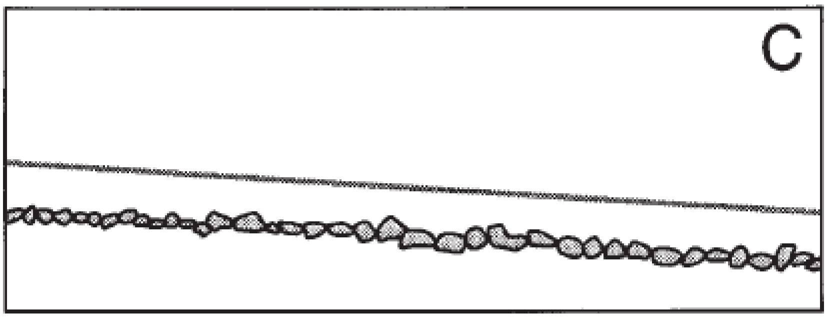

Figure 11.4.5.13. Example of a plane bed channel long profile (Montgomery and Buffington, 1997)

Characteristics of Plane-Riffle bed morphology

10.6.12 Plane - riffle bed channels have characteristics that fall between pool-riffle and plane bed types (SEPA, 2011). Typically, this will include deposition on the inside of bends forming small point bars and poorly defined shallow pools on the outside of bends. These will then be separated by both riffles and plane bed extents, at inflexion locations between the bends (Figures 11.4.5.14, 11.4.5.15 and 11.4.5.16). More detailed characteristics of pools and riffles are outlined in Table 3; however, it should be noted that this information originates form research on pool-riffle channels, not plane- riffle channels, and therefore should only be used with this in mind. Other characteristics will fit with the proposed Type A planform, of width/depth ratios less than 12 and sinuosity between 1 and 1.2 (Table 11.4.5.1).

10.6.13 Plane – riffle bed morphology will require a collection of cross sections. Bends will need greater cross-sectional asymmetry (Figure 11.4.5.16) to create small pools on the outside of bends and bars on the inside; with wider, shallower straighter sections, to form riffles and plane bed units.

10.6.14 Shields (1996) recommends:

- Outer banks of bends should have slopes of 1V [V= vertical]: 2H [H= horizontal] or steeper to cause convergence of high flows;
- Inner banks, where point bars may develop should have bank slopes of 1V: 3H or less;
- Inflexion points are shallower and more symmetrical in shape.

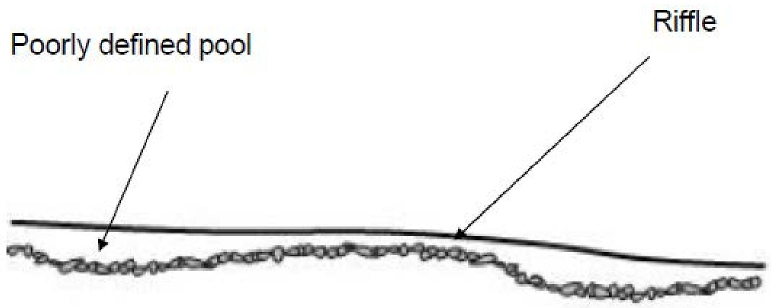

Figure 11.4.14 Example long profile of a plane – riffle channel (SEPA, 2011)

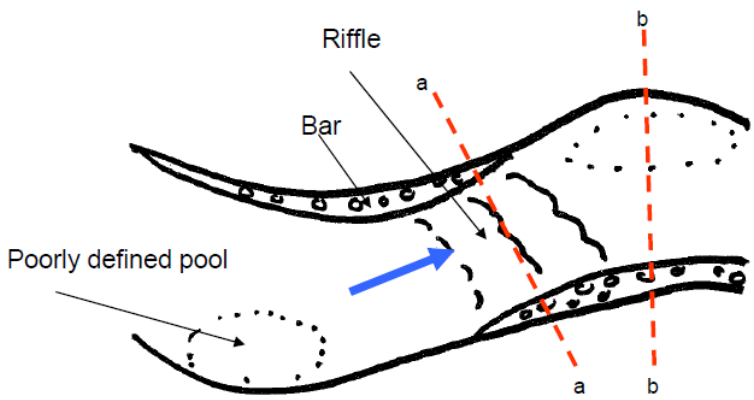

Figure 11.4.5.15 Example planform of a plane – riffle channel

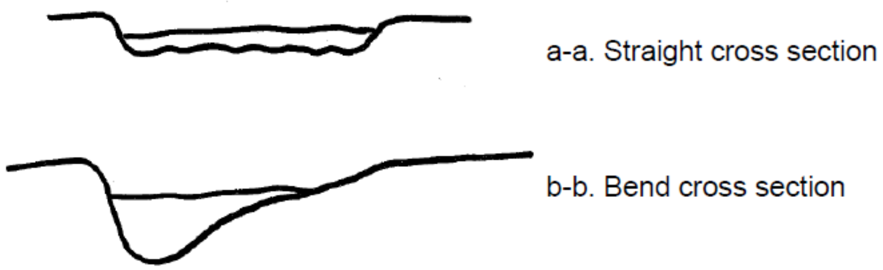

Figure 11.4.5.16 Example cross sections for plane- riffle channels

Table 11.4.5.3 Recommendations for the reinstatement of pools and riffles, focussing on key geomorphic attributes (Thorne et al., 2010; Brookes & Sear, 1996)

Feature	Characteristic	Recommendation
Pool	Size	• Occupy over 50% of the river length • 25% narrower than associated riffles • At least 0.3 m below the mean bed elevation • Maximum scour depths typically don't exceed 4 times the depth in the approach channel upstream
	Shape	• Asymmetrical cross sections • Shallow progressively downstream to the next riffle, with the deepest point within the upstream half of the pool's length
	Location	• Located at bends in the meander planform (around and downstream of a bend apex)
	Sedimentology	• Bed composed of loose and un-compacted mixed gravels (and coarser), overlain by fines during low flows
Riffle	Size	• Collectively occupy 30-40% of river length • 0.3 to 0.5m above mean bed level • 25% wider than associated pools
	Shape	• Near symmetrical cross sections • Variable planform geometries
	Location	• Locally steep, shallow section of the channel profile • Slopes typically 0.005 to 0.200 m/m • At cross over points in the meander planform
	Longitudinal riffle spacing	• 3 to 10 times the bankfull channel width between riffle crests (1 wavelength), but more typically 5 to 7 widths apart. Although some variability in spacing would be natural • Shorter spacing where bed slopes are higher • In straight reaches they are found in alternate channel side locations
	Sedimentology	• Coarse armour, overlying mixed gravel substrate. This may be created by flow winnowing away some fines • Avoid uniform size gradations and over-large substrate • Size gravels according to that in similar undisturbed reaches, or within the floodplain or palaeochannels • High proportion of angular gravels to permit particle interlocking. But avoid excessive imbrication as this limits their ecological benefits • Ideally locally derived substrate
	Riffle stability	• In the absence of coarse sediment supply from upstream material should be static under all flows or replaced periodically

10.6.15 The location and sequencing of these cross sections is important to achieving the required planform and long-profile morphology. In planform, there is a need for the asymmetrical bend cross sections to alternate between the right and left bank side of the channel, with the deeper section always on the outer bank side (OB), and the shallower bank on the inner bank (IB) (Figure 11.4.5.17). These bend sections then join the straight sections via a transitional section, that flairs smoothly between the two which have differing side slope angles (Figure 11.4.5.17). The spacing of the morphological units (cross sections) is also important to create a suitable long profile (Figure 11.4.5.14). The straighter sections (riffles/ planes) should be located at inflexion locations between bends (pools).

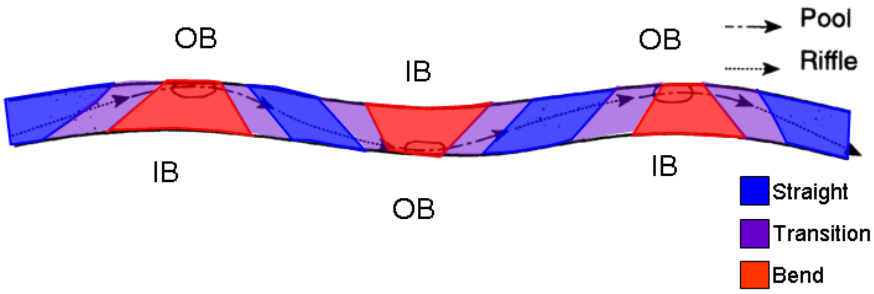

Figure 11.4.5.17 Example locations of plane- riffle cross sections

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