30 July 2020

River Parrett Northmoor to M5 Dredge Profiles

MANAGEMENT SYSTEM: 2020

PARRETT INTERNAL DRAINAGE BOARD

Part of the Somerset Drainage Boards Consortium

CONTENTS

1 INTRODUCTION:

1.1. The purpose of this document is to illustrate the management process which is being undertaken and continues to be developed in order to aid informed decisions on the extent and nature of any dredging activities necessary to the River Parrett channel profiles in such a way as to optimise the flood risk reduction benefits that are being achieved by other dredging works undertaken as part of the Somerset 20 Year Flood Action Plan.

1.2. The work is being delivered as a 'Workstream 1' activity of the Somerset 20 Year Flood Action Plan.

1.3. The drainage and flood risk reduction works discussed in the following pages are envisaged to be implemented by the Parrett Internal Drainage Board operating under delegated powers provided in a Public Sector Cooperation Agreement (PSCA) with the Environment Agency.

1.4. The river channel has a continually evolving profile responding principally to variations in rainfall and tidal conditions, albeit over time this produces a smaller channel. Reference is made throughout the document to monitoring data that recorded the profile present at the time of survey. The data is useful for identifying trends and demonstrating the effect of dredging interventions but it is important to recognise that any works carried out will need to be revised to reflect the actual profile encountered at the time and quantities of sediment dispersed adjusted accordingly.

1.5. The textual content includes samples of collected data and the context in which it has been used. Sources for reports and other documents referenced in the document are included after the appendicies.

2 BACKGROUND:

2.1. During the winter of 2013/14 the Somerset Levels and Moors experienced a severe and prolonged flood. There have also been recent floods in summer 2012 and winter 2012/13. As part of the response to these floods the Somerset Rivers Authority (SRA) was formed. The SRA's purpose is to deliver higher standards of flood protection than would be funded nationally, and to create better flood protection and resilience against further flooding by joint planning and delivery (where possible) by its member authorities. The SRA has produced a Flood Action Plan that covers the next 20 years.

2.2. The Parrett Internal Drainage Board is acting on behalf of, and as a partner member of, Somerset Rivers Authority, with powers delegated by the Environment Agency through Public Sector Cooperation Agreements to maintain flood conveyance by maintaining a consistent cross sectional area of the Parrett, in line with that established by preceding pioneer dredging works implemented by the Environment Agency, in order to retain the flood risk reduction benefits achieved and additional works forming parts of the 20 Year Plan.

2.3. The Somerset Levels and Moors Flood Action Plan includes a programme of dredging to reduce flood risk. These were presented in the October 2016 report by HR Wallingford "Opportunities for further dredging in Somerset" and included five locations for dredging relating to the River Parrett catchment.

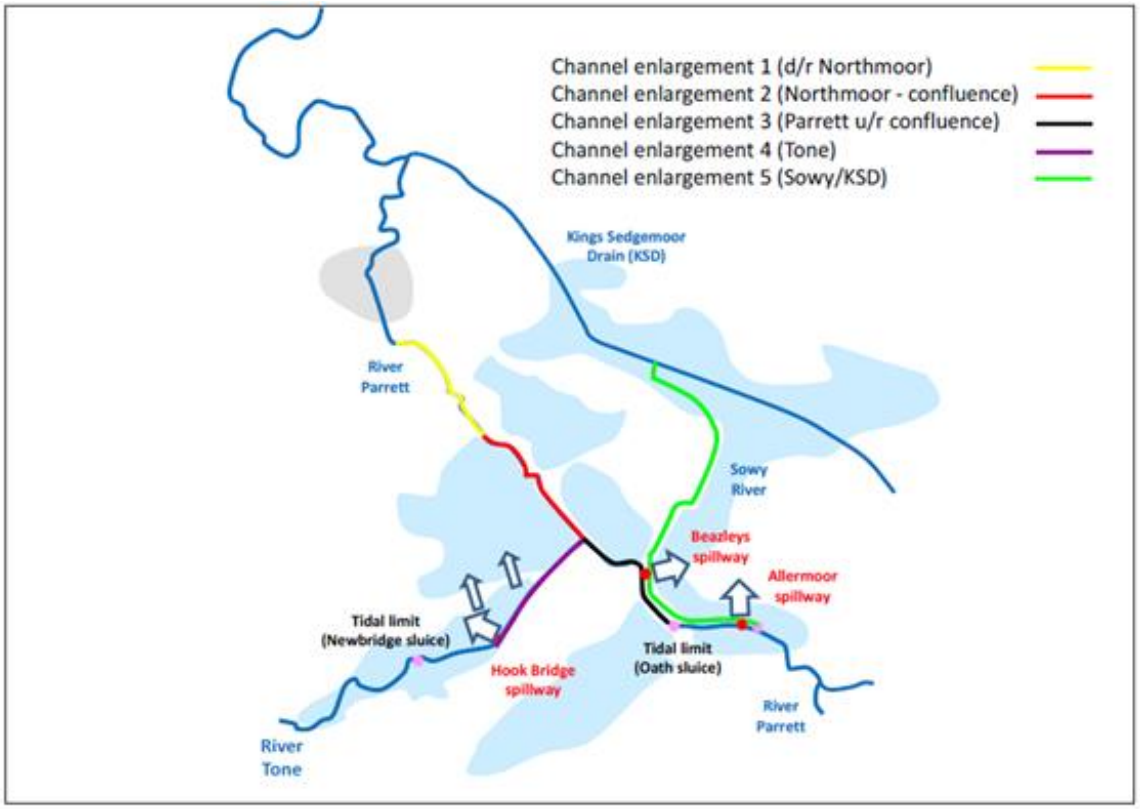


Figure 2: River Parrett Catchment identified dredge reaches

2.4. Three of these reaches have been dredged: Northmoor to confluence, Parrett up-river of confluence and the Tone. The Environment Agency will be undertaking works on the Sowy (River Parrett Relief Chanel) imminently. Channel enlargement of the Parrett downriver from Northmoor, which is the principal subject of this report, is the final reach identified in the HR Wallingford report to be dredged.

2.5. There is also a continuing need to maintain channel capacity on previously dredged parts of the Parrett. Experience to date indicates that Water Injection Dredging (WID) is the most cost effective and environmentally acceptable method currently available. Maintenance dredging is currently undertaken in accordance with 'R. Parrett Water Injection Maintenance Dredging - Environmentally Acceptable Protocol' [Report version 2.0 (08/10/18)]. This Management System proposes continued use WID for maintenance and new dredging on the Northmoor to M5 reach.

2.6. The 'Environmental Permitting (England and Wales) Regulations 2016' consider dredging to be a flood risk activity. In 2016 Hydrodynamic Dredging Trials on the River Parrett were permitted under the regulations in 2016 (permit number EPR/EB3390QC).

3 OBJECTIVE:

To achieve optimum flood risk reduction benefits in the Parrett catchment whilst minimising any potential adverse environmental impact in carrying out the works.

In seeking to achieve this objective it is necessary to ensure that any works carried out are affordable, cost-effective, environmentally acceptable, legally compliant and evidence based.

4 ENVIRONMENTAL ASSESSMENT & SCOPING:

4.1. The following Environmental assessment is extracted from a Technical Memorandum prepared by C2HM Hill Halcrow for the Environment Agency, dated 5 November 2014:

Somerset Levels & Moors appraisal package

Project: Somerset Levels & Moors – Modelling/Appraisal Axe, Brue, Parrett & Tone Dredging Assessment

9. Dredging assessment: River Parrett, North Moor to Bridgwater

Environmental Assessment

There are a number of known and potential local environmental constraints in the vicinity of this reach of the River Parrett. Recognising that there is some potential to extend dredging through Bridgwater, the reach from the M5 to just downstream of the town centre is also considered here.

• There are no international or national nature conservation designations.

• Screech Owl Local Nature Reserve lies on the left bank just upstream of the M5, and comprises of a wetland mosaic in flooded former clay pits.

• Otter and water vole are reported at Screech Owl LNR; otter is expected and water vole may be present in the Parrett here and more widely; upstream of the M5 most of the right bank and intermittent reaches of the left bank comprise Coastal and Floodplain Grazing Marsh priority habitat.

• There are no international cultural heritage assets upstream or downstream of the M5; there is only one listed building (Linden Farmhouse) near the river channel upstream of the M5 but numerous listed buildings in Bridgwater town centre.

• No local cultural heritage assets or known archaeology is reported associated with the channel or immediately adjacent land upstream of the M5; Bridgwater town centre has numerous records.

• No national landscape designations.

• Dredging presents a risk of compromising Water Framework Directive hydromorphology objectives for the Parrett transitional water body and may be constrained by the water body's Freshwater Fishery Protected Area status.

• Upstream of the M5 a small part of the left bank (one field) and a larger extent of the right bank (8 fields) are under Stewardship and most of the rest is within the Somerset Levels and Moors HLS target area.

4.2. Land Drainage Improvement Works EIA Regulations: 'Improvement works', as defined under Regulation 2(1) of the Environmental Impact Assessment (Land Drainage Improvement Works) Regulations (SI 1999 No. 1783) (as amended) (the 'Land Drainage EIA Regulations'), are works which are:

"the subject of a project to deepen, widen, straighten or otherwise improve any existing watercourse or remove or alter mill dams, weirs or other obstructions to watercourses, or raise, widen or otherwise improve any existing drainage work"

As As the maintenance of the dredged profiles of the Parrett and Tone will not increase the cross sectional area of the river channels, it is not considered to be improvement works, under the EIA regulations, there is therefore no requirement to publish an Environmental Statement for the maintenance programme.

4.3. Recent dredging work on the Parrett between Oath and Burrowbridge was subject to Environmental Impact Assessment (EIA), Environmental Statement (ES), Habitats Regulations Assessment (HRA) and Water Framework Directive (WFD), as are imminent works on the River Sowy and King's Sedgemoor Drain by the Environment Agency.

4.4. Mitigations for the effect of these works in upstream catchments will manage impacts of changes in the Special Protection Areas (SPA). In doing so they will also mitigate the effect of increased conveyance of the Parrett between Northmoor and the M5.

4.5. With upstream catchments protected, the scope of EIA required for dredging Northmoor to M5 can reasonably be limited to the dredge extent and direct disturbance during operational activities.

4.6. Planning consent: based on advice given to the Environment Agency by the planning authorities in 2014, this activity is not expected to require planning permission as it does not constitute 'development' as defined by Section 55(1) of the Town and Country Planning Act 1990 (as amended):

> *"development' means the carrying out of building, engineering, mining or other operations in, on, over or under land, or the making of any material change in the use of any buildings or other land."*

4.7. Water Framework Directive and Protected Species: The morphological and ecological impacts of Water Injection Dredging (WID) have been assessed between 2017-2019 (Pledger 2020 and In Press) and a methodology developed for WID that is sensitive to environmental features (EA WID Protocol 2018). The same WID methodology will be used for the Northmoor to M5 Dredge.

4.8. The dredge operation will be undertaken during high tides in January or February, when flow conditions are optimal for WID, to avoid impacts on fish and eel migration. The use of WID has been shown not to damage or kill fish. There is evidence that fish intentionally avoid the dredging operation, with higher numbers of fish found in upstream reaches of the river during dredging. The use of WID allows the operation to be completed quickly, within a few days, which help limit this impact on fish behaviour.

4.9. The operation is programmed to avoid disturbance during environmentally sensitive times of the year for breeding birds, mammals and invertebrates. The dredging method has minimal impact on bank vegetation and marginal habitat features, as WID deliberately focuses on mobilising soft sediments in the centre of the channel.

4.10. Water vole have been found in very low numbers using the tidal Parrett in summer, but not in winter when population density and pressure to use less favourable habitats are lower. Water vole burrows have not been found in this section and any that may exist will be high up the bank to avoid inundation and silt. Therefore, WID is very unlikely to impact water vole.

4.11. The use of WID in the centre of the channel limits the direct impact on marginal habitats. Since WID was been introduced in 2016, the linear extent of reedy-fringe habitat has increased, as it recovers following the 2014 extraction dredging operation that removed large lengths of this important river habitat. Monitoring of marginal habitat recovery following 2014 dredge clearly shows that land management, in particular grazing, is the single most important factor limiting the establishment of a reedy-fringe habitat since 2014. Whereas, WID has almost no impact on the

linear extent of reedy-fringe habitat. As this is the first time dredging will be undertaken in the section, additional monitoring of marginal habitat features will be undertaken to assess changes in the extent and area of reedy-fringe in the dredged section.

4.12. Habitats Regulations Assessment: the potential for the Northmoor the M5 dredge to significantly impact the Somerset Levels and Moors SPA or the Severn Estuary SAC/SPA has been considered. This screening for effects confirms that no significant impact on the SAC/SPAs is likely and therefore a more detailed Appropriate Assessment is not required.

4.13. Severn Estuary SPA/SPA: Monitoring of silt transport and dispersal, downstream of the WID operation, found the distance the silt density cloud travelled downstream was fairly limited. The monitoring showed sediment concentrations were no different to baseline only few kilometres downstream of the WID operation. In part, this reflects the high turbidity gradient of the Estuary. This also suggests dredged silt remains within the upper estuary system and its impact is unnoticeable further downstream in Bridgwater Bay, where silt levels are many time higher than upstream.

4.14. Somerset Levels and Moors SPA: Hydraulic modelling of the dredge shows that the conveyance benefit of the Northmoor to M5 Dredge will occur entirely on Currymoor and there will be very little change for moors upstream of Burrowbridge on the Parrett (see section 5.9 below). The effect of the dredge will be to offset the hydraulic disbenefit to Currymoor of the 2019 Oath to Burrowbridge Dredge on the Parrett. Overall, this represents no change in SPA conditions as consequence of the Northmoor to M5 Dredge. The significant effect of the Oath to Burrowbridge has been assessed and a Mitigation Plan agreed and published. The implementation of the Mitigation Plan, backed up by monitoring and reporting, will ensure there is no detrimental impact on the Somerset Levels and Moors SPA conditions, for all main river dredging operations.

4.15. Marine Licence and Marine Works EIA Regulations: The Marine Management Organisation (MMO) is responsible for marine licensing in English inshore and offshore areas and for Welsh and Northern Ireland offshore areas. The inshore areas include any area which is submerged at mean high water spring tide up to the territorial limit. They also include the waters of every estuary, river or channel where the tide flows at mean high water spring tide. It considers dredging to be a licensable activity where dredging involves the use of any device to move material (whether or not suspended in water) from one part of the sea or sea bed to another part. Dredging techniques include but are not limited to use of trailing-suction hoppers, plough and water injection. However, Article 19 of the 2011 Exempted Activities Order provides an exemption for an activity carried out by, or on behalf of the Environment Agency for maintaining coast protection works, drainage works or flood defence works.

5 DREDGING NEED ASSESSMENT:

5.1. A series of cross-section positions have been established at 50m intervals along the rivers Parrett and Tone. Each position is surveyed periodically to determine the profile of the channel. A theoretical water level for each section, based on the hydraulic gradient during high fluvial flows prior to any overtopping of the spillways, has been adopted as a benchmark against which all cross sectional area calculations are based.

5.2. Comparison of successive surveys highlights changes to the channel profile. The channel profile is influenced by natural processes of scour and accretion, relating to the volume and velocity of flows in the river, and by dredging interventions. Each profile is monitored and assessed both as an

independent entity, in association with adjacent profiles, and in relation to historic river thalweg levels and gradients.

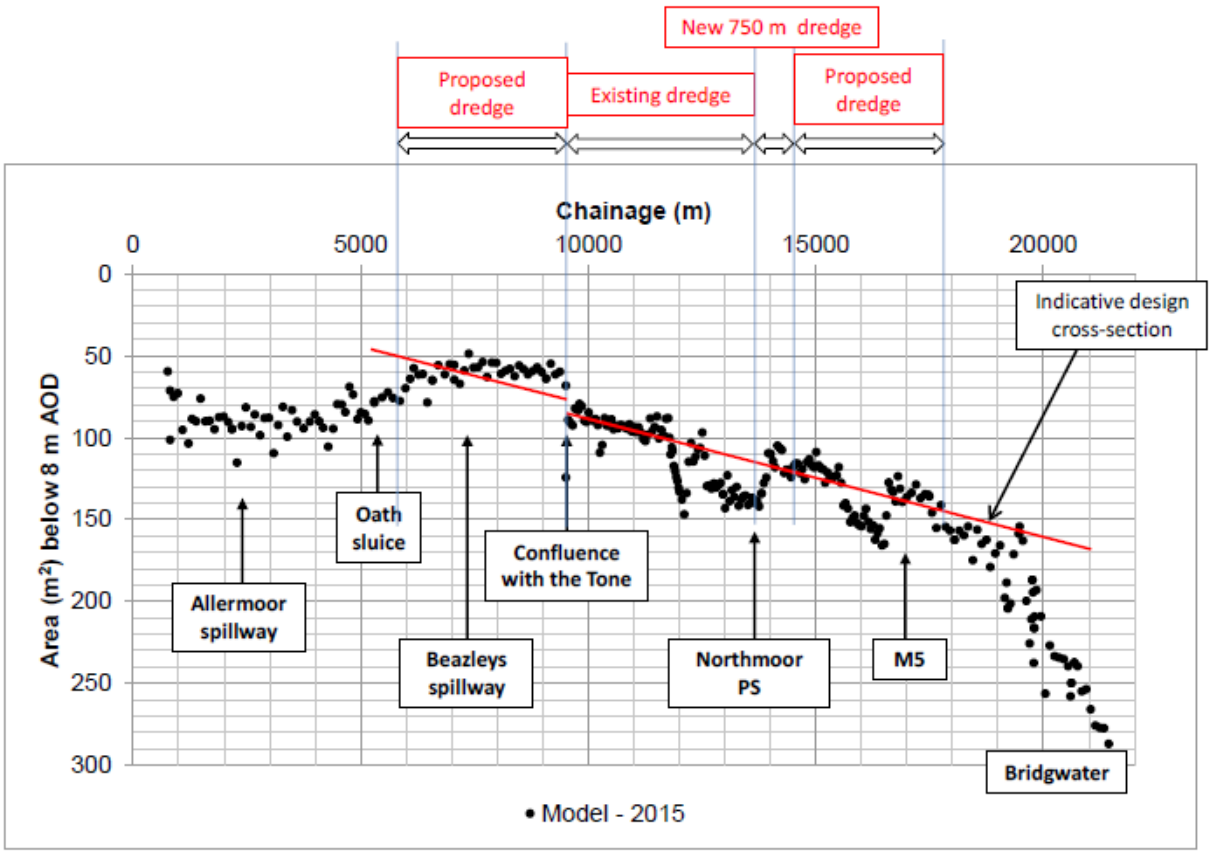
5.3. The average channel cross-sectional area (CSA) following the Environment Agency '750m dredge' undertaken in 2016 has been adopted as the target CSA for the Northmoor to M5 reach.

Section	Chainage	Design WL	CSA @survey
P89	4400	6.43	62.57
P90	4450	6.43	63.44
P91	4500	6.42	62.25
P92	4550	6.42	63.08
P93	4600	6.41	65.97
P94	4650	6.41	64.41
P95	4700	6.40	61.76
P96	4750	6.39	60.20
P97	4800	6.37	62.95
P98	4850	6.36	64.85
P99	4900	6.35	62.10
P100	4950	6.35	64.22
P101	5000	6.34	60.27
P102	5050	6.33	63.40

July 2019 survey values used to establish target cross-sectional area (CSA)

Average value: 62.96 m^2

5.4. This provides a comparable output to the HR Wallingford report whereby channel area is measured below an 8.00m AOD flood bank height



5.5. Continuing downriver with the same hydraulic gradient an assessment has been made of how closely a water injection dredging process could match the Environment Agency 750m cross sectional area:

Parrett	Hydraulic Gradient	0.000162	Target CSA 62.96									
	Thalweg Gradient	0.000317	(Average CSA of EA 750m dredge, July 2019 survey)									
	Channel survey date:	Jun-20										
Section	Chainage	Design WL	CSA @survey	Thalweg (firm bed)	Current depth	Design thalweg at constant gradient	Proposed depth	Shortfall on target CSA	Design dredge v4	Post dredge CSA v4	%age of target CSA	Dredge volume (m^3)
P103	5100	6.32	50.38	1.34	4.98	1.34	4.98	12.58	9.92	60.30	96%	496
P104	5150	6.31	48.34	0.98	5.33	1.32	4.99	14.62	12.29	60.63	96%	615
P105	5200	6.30	49.12	1.42	4.88	1.31	5.00	13.84	14.03	63.15	100%	702
P106	5250	6.30	57.96	1.13	5.17	1.29	5.00	5.00	6.28	64.24	102%	314
P107	5300	6.29	51.71	1.46	4.83	1.28	5.01	11.25	13.25	64.96	103%	662
P108	5350	6.28	51.85	1.15	5.13	1.26	5.02	11.11	8.12	59.97	95%	406
P109	5400	6.27	51.95	1.14	5.13	1.24	5.03	11.01	8.07	60.02	95%	403
P110	5450	6.26	50.47	1.28	4.98	1.23	5.04	12.49	12.07	62.54	99%	603
P111	5500	6.26	52.94	1.27	4.99	1.21	5.04	10.02	7.29	60.23	96%	364
P112	5550	6.25	54.53	1.22	5.03	1.20	5.05	8.43	7.84	62.37	99%	392
P113	5600	6.24	54.00	0.75	5.49	1.18	5.06	8.96	8.26	62.26	99%	413
P114	5650	6.23	53.15	1.46	4.77	1.17	5.07	9.81	9.41	62.56	99%	471
P115	5700	6.22	56.93	1.12	5.10	1.15	5.07	6.03	5.60	62.53	99%	280
P116	5750	6.22	53.99	1.73	4.49	1.13	5.08	8.97	10.47	64.46	102%	524
P117	5800	6.21	55.41	1.13	5.08	1.12	5.09	7.55	7.28	62.69	100%	364
P118	5850	6.20	54.54	1.17	5.03	1.10	5.10	8.42	6.57	61.11	97%	328
P119	5900	6.19	54.02	1.40	4.79	1.09	5.10	8.94	9.43	63.45	101%	471
P120	5950	6.18	48.20	1.07	5.11	1.07	5.11	14.76	12.41	60.61	96%	620
P121	6000	6.17	53.64	1.05	5.12	1.05	5.12	9.32	10.74	64.38	102%	537
P122	6050	6.17	52.57	0.95	5.22	1.04	5.13	10.39	10.74	63.31	101%	537
P123	6100	6.16	55.94	1.76	4.40	1.02	5.14	7.02	10.48	66.42	105%	524
P124	6150	6.15	52.23	1.33	4.82	1.01	5.14	10.73	12.43	64.66	103%	621
P125	6200	6.14	55.74	1.16	4.98	0.99	5.15	7.22	11.12	66.86	106%	556
P126	6250	6.13	56.55	1.09	5.04	0.98	5.16	6.41	10.10	66.65	106%	505
P127	6300	6.13	53.78	0.92	5.21	0.96	5.17	9.18	9.86	63.64	101%	493
P128	6350	6.12	53.58	1.24	4.88	0.94	5.17	9.38	12.02	65.60	104%	601
P129	6400	6.11	55.97	0.90	5.21	0.93	5.18	6.99	11.04	67.01	106%	552
P130	6450	6.10	54.80	0.95	5.15	0.91	5.19	8.16	11.50	66.30	105%	575
P131	6500	6.09	56.35	1.48	4.61	0.90	5.20	6.61	10.63	66.98	106%	531
P132	6550	6.09	58.84	1.10	4.99	0.88	5.21	4.12	7.63	66.47	106%	382
P133	6600	6.08	59.34	0.91	5.17	0.86	5.21	3.62	9.63	68.97	110%	482
P134	6650	6.07	58.15	0.86	5.21	0.85	5.22	4.81	9.27	67.42	107%	464
P135	6700	6.06	61.24	0.85	5.21	0.83	5.23	1.72	6.48	67.72	108%	324
P136	6750	6.05	56.02	1.04	5.01	0.82	5.24	6.94	8.89	64.91	103%	444
P137	6800	6.04	56.08	1.11	4.93	0.80	5.24	6.88	8.76	64.84	103%	438
P138	6850	6.04	58.04	1.24	4.80	0.79	5.25	4.92	10.18	68.22	108%	509
P139	6900	6.03	57.18	1.43	4.60	0.77	5.26	5.78	9.18	66.36	105%	459
P140	6950	6.02	56.53	0.94	5.08	0.75	5.27	6.43	10.25	66.78	106%	513
P141	7000	6.01	56.21	1.45	4.56	0.74	5.27	6.75	9.82	66.03	105%	491
P142	7050	6.00	56.08	1.50	4.50	0.72	5.28	6.88	7.91	63.99	102%	395
P143	7100	6.00	53.70	1.50	4.50	0.71	5.29	9.26	13.92	67.62	107%	696
P144	7150	5.99	59.88	0.82	5.17	0.69	5.30	3.08	8.77	68.65	109%	439
P145	7200	5.98	55.43	0.87	5.11	0.67	5.31	7.53	9.89	65.32	104%	495
P146	7250	5.97	55.06	1.41	4.56	0.66	5.31	7.90	9.95	65.01	103%	497
P147	7300	5.96	58.20	0.73	5.23	0.64	5.32	4.76	9.06	67.26	107%	453
P148	7350	5.96	64.71	0.74	5.22	0.63	5.33	-1.75	0.00	64.71	103%	0
P149	7400	5.95	60.14	0.67	5.28	0.61	5.34	2.82	0.00	60.14	96%	0
P150	7450	5.94	67.52	0.60	5.34	0.60	5.34	-4.56	0.00	67.52	107%	0
											Total	21941

Largest	67.52	1.76	5.49	1.34	5.34	14.03	68.97	110%
Average	55.40	1.14	4.99	0.97	5.16	9.14	64.54	103%
Smallest	48.20	0.60	4.40	0.60	4.98	0.00	59.97	95%

5.6. Analysis on a section by section basis shows that the target CSA could be met to 103% on average, ranging between 95% and 110%.

5.7. Dredging to this design would increase the average gradient of the lowest part of the channel bed (thalweg) from approximately 1:7580 to 1:3175. Increased gradient aids conveyance and silt transport downriver.

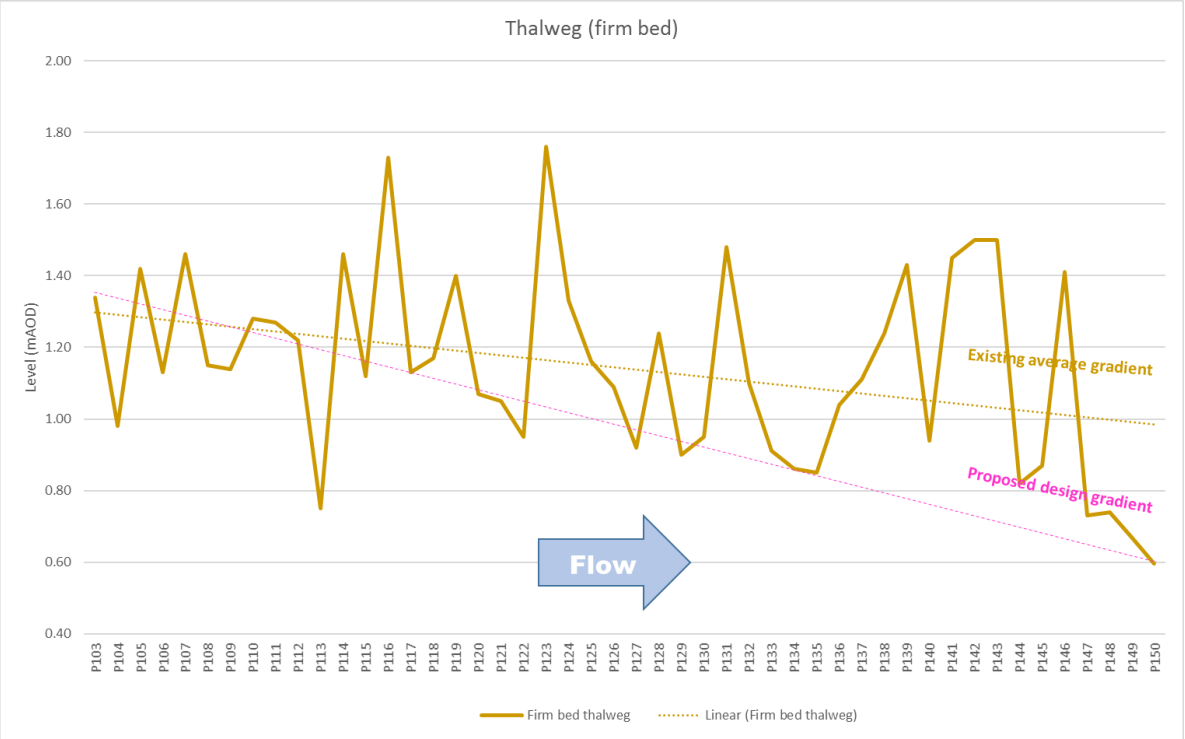


Figure 5.7: Thalweg levels (firm bed)

5.8. Cross sectional change. Application of the design cross-sections gives an average increase in cross-sectional area of 9.14m^2 and involves dispersal of up to 21,941m^3 of silt deposits from the reach.

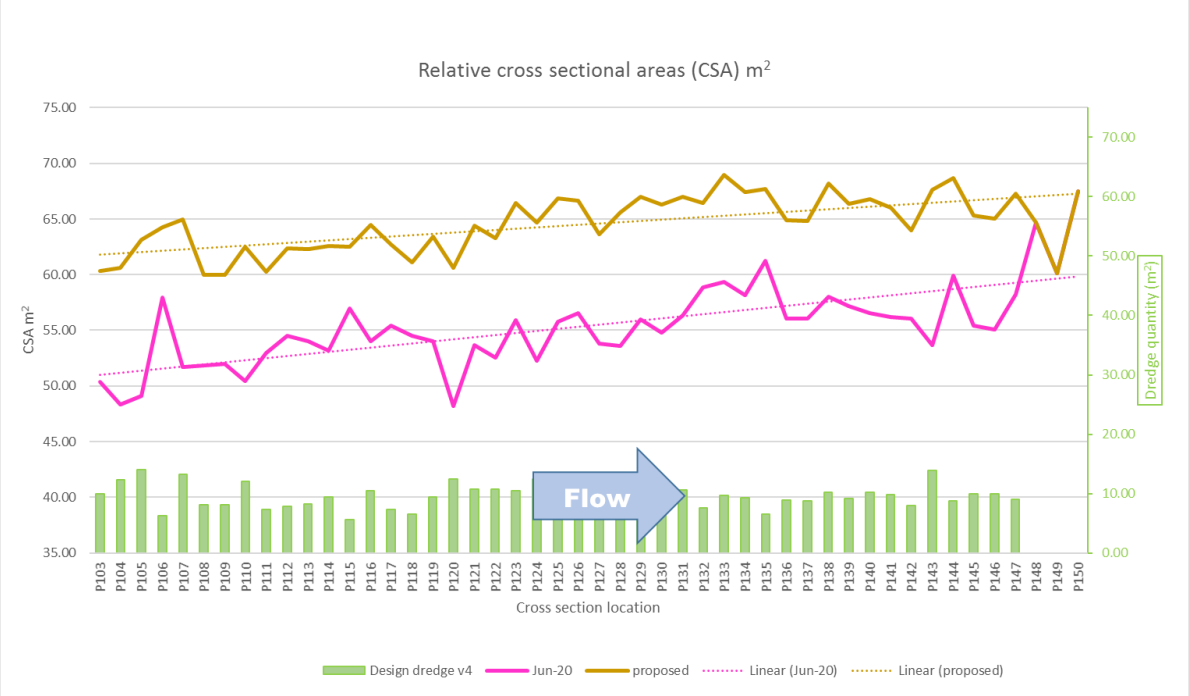


Figure 5.8: Relative cross sectional areas

5.9. An assessment of the potential hydraulic benefits of this design has been made in a Short Technical Report ref. 003/051 by AW Water Engineering which is appended to this document. It identifies the benefits shown in the table below:

	Spring 2012		Winter 2012/13		Winter 2013/14	
Location	Change in peak level	Change in flood duration	Change in peak level	Change in flood duration	Change in peak level	Change in flood duration
Curry Moor	-30mm	-1.4 days	-10mm	-0.7 days	-30mm	-0.5 days
North Moor	0	0	0	0	-40mm	0
Aller Moor	0	0	-10mm	-1.9 days	0	-0.7 days
Kings Sedgemoor	0	0	0	0	-10mm	-0.2 days
Muchelney Level	0	-0.2 days	-10mm	-0.9 days	0	-0.2 days
Huish Level	0	0	-10mm	0	0	-0.9 days

Figure 5.9: Hydraulic benefit

These results show the main beneficiary of any hydraulic benefits will by Curry Moor and its neighbouring moors. There will be minimal benefits on the River Parrett upstream of the Tone confluence.

5.10. The identified benefits are quite modest but this is in part due to the computer modelling assumption that soft silts in the channel are mobilised by river flows early on in a flood event; such that the effective channel cross section is bounded by its firm bed and only increases achieved to that firm bed will feature in the capacity calculations. Whilst an amount of natural scour does occur in these conditions, in practice only the softest silts are mobilised and much of the more consolidated and root-bound material remains in place. On this basis, the modelling under represents the actual hydraulic benefit likely to be achieved by the proposed water injection dredge.

6 THE WATER INJECTION DREDGING PROCESS:

6.1. Water Injection Dredging is a system designed to remove silty material from the river bed. Work is carried out by a dredging vessel from the river channel.

6.2. River water is drawn in to the vessel through grills at the front and pressurised by onboard pumps. It then passes to a jetting bar that is moved over the surface of the river bed while nozzles in the bar inject large volumes of water at low pressure into the sediment layer.

6.3. The density of the sediment layer is lowered until it shows fluid behaviour. The fluidized sediment layer is then transported horizontally in the lower part of the water column away from the dredged areas. The hydrostatic pressure difference, the gradient of the river bed and the tidal and current flows are the main driving forces for this natural horizontal transport.

6.4. In most cases the fluidized sediment will finally re-enter the water column in a high energy environment where it will be mixed with other naturally occurring sediment particles. From there

on the sediment continues its natural route towards its original destination. General practice is to start at the downriver extent of the site to restore bed levels and facilitate mobilisation of the density current.

6.5. The skipper steers the vessel along a pre-planned route designed to optimise dredging effect and achieve design profile . Screens in the wheelhouse display plan position, channel profile and rear facing camera. All on-screen information is updated in 'real time' so careful control is excercised over the locations that silt is mobilised from.

6.6. Water quality monitoring is carried out throughout the dredging works, measuring conductivity, temperature, dissolved oxygen levels and turbidity.

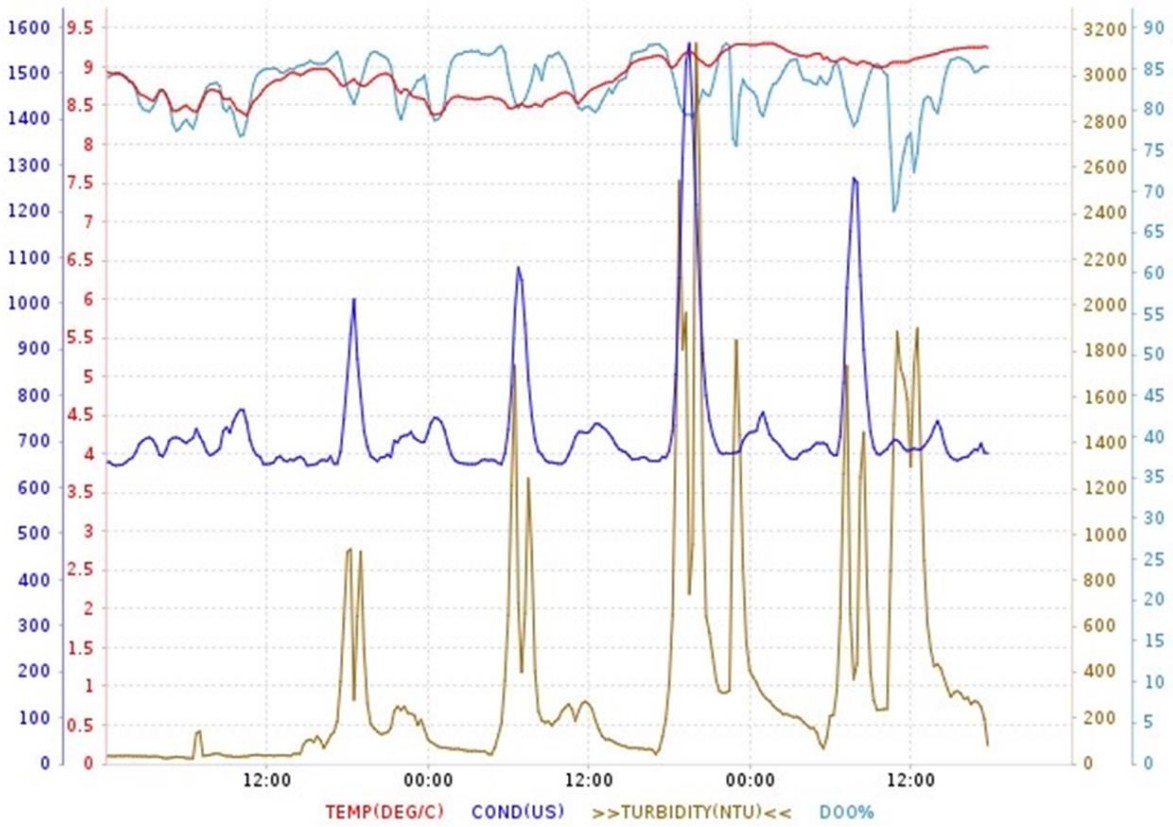


Figure 6: Typical monitoring data

6.7. Temperature and dissolved oxgen are measured to ensure suitable conditions for fish and benthic species are maintained. Water temperature should not exceed 15°c and dissolved oxygen should not be lower than 30% or higher than 120%. It can be noted from figure 6 that conditions remained well within these thresholds for the period shown (and in all subsequent water injection dredging works).

6.8. Turbidity is a measure of how much silt is suspended in the water column and is used to assess the effectiveness of the dredging and progress of the suspended silt downriver. This is discussed thoroughly in the March 2017 report 'Dredging Trials Monitoring Programme November-December 2016' reference AmbSDBC02.

6.9. The Ambios report noted "TSS values varied between 2000 and 10,000 mg l-1, consistent with active suspension of the sediment load, rather than the flow of fluid mud (bed-supported suspensions), the latter occurring at concentrations above about 40,000 mg l-1. This is important, demonstrating that flow from the WID zone into the lower estuary takes place as a normal

suspension rather than a bed-supported 'fluid mud' flow. Consistent with conclusions drawn in previous studies 1 that winter high river discharges erode from the estuary bed during their transit to the sea. Furthermore these data demonstrate convincingly that TSS levels below the dredge zone do not return quickly to natural levels after the cessation of dredging, but only decrease slowly as material disturbed during the dredging continues to be eroded."

6.10. Water injection dredging is known to be effective in mobilising unbound silt in the lower parts of the river channel. It is also capable of mobilising compacted silt from established vegetated berms. Using WID to lower thalweg levels and directly against established berms can induce slumping of vegetated sections of bank to create an increased cross sectional area and the material is dispersed downriver on outgoing tides or a subsequent WID.

6.11. Limiting WID to the lower parts of the channel (which has a 6m wide direct dredging impact) for dredging minimises any environmental impact on the river banks.

7 OPTIONS:

7.1. Having established the extent to which the conveyance capability of the can be improved there are alternative actions to be considered:

Option	Pro's	Con's
1. Do nothing	No direct cost No change to environmental conditions	Reduced level of flood risk protection Potentially huge cost if widespread flooding occurs
2. Dredge using bank and pontoon mounted excavators to remove the accumulated silt and deposit the arisings on banks or incorporate to improve adjacent fields	Well established method of maintaining channel profile Accurate to design profiles	Relatively high cost per m^3 removed Little capacity available for deposition on river banks Removing silt from the channel causes a net depletion of silt from the wider Severn estuary Disturbance of riverside wildlife Disruption to local community Waste management challenges for disposal of arisings from the river
3. Dredge using water injection method	Most cost-effective method used so far of maintaining cross sectional area in the channel No net depletion of silt from the wider Severn estuary Minimal impact on wildlife Minimal disruption to local community Further informs knowledge base for this method and adds to development of the dredging strategy	Less precision in forming channel profile Does not directly displace silt from the whole channel profile – silt on higher sections of the channel are not accessible by this method Only suitable for operation during outgoing flows – tide limited for operation of the equipment

7.2. Option 3 is the preferred option as it meets the principal objective identified in item 3 above.

8 PROPOSAL:

In order to restore the cross sectional area of the river and retain its conveyance capability it is necessary to carry out dredging of the channel over the length of river Parrett between Northmoor and the M5 at the locations where current cross-sectional area is below the design values. This relates to sections P103 to P147 inclusive.

8.1. Water injection dredge a 6m wide course to a depth that would achieve the design thalweg average gradient on the 2.2km reach downriver of Burrowbridge. The number of passes required to achieve target depth will vary according to the silt load. Based on the projected silt profiles for autumn 2020, this would involve the dispersal of around 22,000m^3.

8.2. The equipment used previously requires a tide level above 4.5m to operate. Productive time is only assured on predicted tidal events. However, fluvial influence has consistently extended Dredging needs to be timed to make best use of the prevailing tide and fluvial flows and minimise the impact on wildlife. Spring tides in January and February have the greatest range between high and low water levels and have the lowest environmental impact.

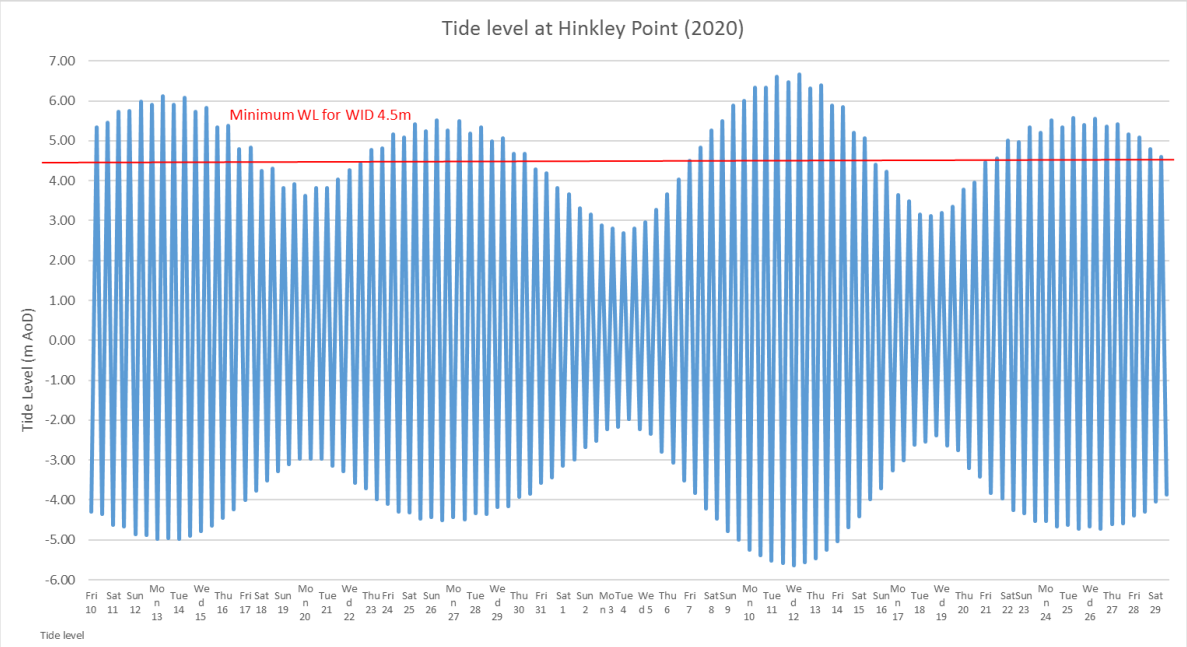


Figure 8.2 Tide Levels Jan/Feb 2020 (Hinkley Point)

8.3. The decision to dredge on a particular set of tides should be deferred until as late as possible so that fluvial conditions can be taken into account. High fluvial flow and strong ebb currents provide the optimal conditions for silt dispersal and maximise productive dredging time.

8.4. Conceptual dredging campaign schedule based on 2020 tides pending publication of 2021 data.

Activity	Date	Comment
Establish site compound at WZPS	Thursday 23 January	* These dates are bases on water levels of predicted tides only and represent the longest duration for the
Establish in-river water quality monitoring	Friday 24 January	
Mobilise dredger at Dunball Wharf	Saturday 25 January	
Move dredger to site at WZPS	Saturday 25 january	

Pre-dredge checks & setup	Sunday 26 January	works. Prevailing fluvial conditions may well contribute to higher river levels that allow dredging to continue and complete earlier.
Commence dredging	Sunday 26 January	
Suspend dredging (if river levels too low)	Thursday 30 January*	
Resume dredging (when water levels permit)	Friday 7 February*	
Complete dredging	Friday 14 February*	
Return dredger to Dunball	Saturday 15 February*	
Remove in-river water quality monitoring	Saturday 15 February*	
De-mobilise dredger at Dunball Wharf	Saturday 15 February*	
Reinstate site compound at WZPS	Tuesday 18 February*	

(This will be replaced by the contractor's programme post-award)

Mobilisation and demobilisation of the dredger is constrained to weekends due to port/wharf activity.

9 MONITORING ARRANGEMENTS:

9.1. Continuous water quality monitoring will be carried out to record temperature, dissolved oxygen and turbidity at a point approximately 500m below the downstream extent of the dredge. The equipment will be moored in the river and data transferred at 15minute intervals to a data logger linked to a telemetry system for the period of at least one tide cycle before to one tide cycle after dredging operations. The equipment is configured to alert key personnel by text message in the event of any thresholds being exceeded. Threshold values are: temperature exceeding 15°C and dissolved oxygen outside the range 30% to 120%.

9.2. Pre and post dredge photographs/video have been taken from the river, looking at both banks, which demonstrates that there was no obvious deterioration of bankside habitat as a result of the dredging. These will be repeated for future works.

9.3. A series of markers have been established along the river to provide an easy visual indication of changes to silt level. These are monitored periodically through the year and are useful for recognising silt accumulation in higher berms.

9.4. The linear extent and area of marginal reedy-fringe habitat will be monitored using aerial photography taken before and after dredging operations. Post dredge monitoring of bankside habitat will continue for 3 years after the completion of the dredge operation to assess recovery and continuing change in habitat extent.

9.5. Photographic monitoring was also carried out on the Burnham on Sea beach over eight low spring tides between July and December 2017 in an effort to recognise natural trends in silt/mud deposits on the beach. These showed that conditions varied widely through the period, such that displaced silt from WID activities would be totally indiscernible against natural silt movement by other causes. This monitoring did not prove sufficiently informative to warrant continuing.

9.6. Topographic sections at 50m intervals along the pioneer dredged reach have been taken during spring and autumn since 2015. These provide a comprehensive record of changes to the channel profile, showing both natural scour and deposition cycles as well as the effect of dredging interventions. These will be continued while funding permits.

9.7. Bathymetric surveys have also been carried out between Burrowbridge and the site of the proposed Parrett Tidal Barrage. There have yet to be sufficient repeat surveys to identify trends of silt movement but, importantly, the bathymetry has not indicated any obvious settling out of silt mobilised by water injection dredging. Highly turbid conditions present technological challenges to bathymetric survey (even in the absence of WID) which our supplier is working hard to overcome so that this remains a viable monitoring resource.

9.8. All staff and operatives engaged in the works exercise vigilance in spotting dead or distressed fish in the vicinity of the works and downstream. This is supplemented by targeted monitoring at key downstream locations. All reasonable endeavours will be made to recover any such fish so that likely causes of their morbidity can be investigated.

9.9. The 2017 WID Trial involved collaboration with an expert team from Loughborough University, led by Dr Andrew Pledger, to monitor the effect of WID on fish and benthic species in the river and further investigations in 2018. This is being reported separately but, in summary, his report endorses that WID activities have not caused fish mortality or unacceptable changes in fish behaviour.

10 NEXT STEPS

- Seek Regulator Approval for the proposed works
- Establish Public Sector Cooperation Agreement between the Environment Agency and Parrett Internal Drainage Board
- Award works to the Contractor
- The contractor's programme will be disseminated to interested parties ahead of works commencing
- Monitor outcomes of the works

APPENDIX 1: FLOOD RISK ACTIVITY RISK ASSESSMENT

River Parrett: Northmoor to M5 Dredging

Flood Risk Activity Risk Assessment

Risk		Source	Mitigation applied	Severity (S)		Probability (P_r)		Risk factor	Risk Rating	Receptor: homes, factories, businesses, schools, hospitals and other public buildings that might be at	Receptor: roads, footpaths, railways or other infrastructure like electricity substations	Receptor: flood defence structures, pumping stations and gauge weirs	Receptor: drain and sewer systems that could become blocked by your work	Receptor: protected environmental sites and species	Receptor: water resources including groundwater and public water supply	Receptor: water bodies including ponds, streams, rivers and lakes
				High	5	Likely	3		10< High							
				Med	3	Possible	2	=(S x P_r)	4-9 Moderate							
				Low	1	Unlikely	1		<4 Low							
				None	0	None	0		0 None							
1 Creating or worsening flood risk or impeding drainage																
Could work permanently or temporarily increase flood risk as a result of:	1.1	impeding the flow of the river	Floating plant to be deployed on the river has low displacement relative to river channel cross sectional capacity	Low	1	Likely	3	3	Low			Low				
	1.2	blocking or narrowing a river channel or flood plain	Displaced silt may re-accrete downriver. Extensive monitoring proposed to quantify and assess impact	Low	1	Unlikely	1	1	Low			Low				
	1.3	storing excavated materials in a flood plain	No excavated materials to be removed from river	None	0	None	0	0	None			None				
	1.4	doing work to a flood defence that will temporarily render it ineffective	Removal of silt accumulations to improve flood conveyance. Monitoring in contract. Possible impact on stability of bank considered below.	High	5	Unlikely	1	5	Moderate			Moderate				
	1.5	blocking drainage routes or pipes	Mobilised silt unlikely to cause a blockage. Known outfall locations identified on works plans and sections.	Med	3	Unlikely	1	3	Low				Low			
	1.6	making surfaces impermeable	No works proposed outside river channel	Low	1	None	0	0	None					None	None	
	1.7	creating overland surface water runoff that affects another property	Works designed to keep flows within channel	Low	1	None	0	0	None	None	None		None	None	None	None
2 Disturbing or undermining the stability of a bank									None							
This could be caused by:	2.1	putting a structure through the bank or on the bank	Access gangway at compound to be secured by attaching to short driven piles from the pioneer dredging campaign	Low	1	Unlikely	1	1	Low			Low				
	2.2	cutting into the bank	Silt removal is to restore EA design channel profile. Stone revetment and rock armouring to be retained in place. Monitoring,tolerances and contractural disincentives set to minimise excessive silt removal.	med	3	possible	2	6	Moderate			Moderate				
	2.3	placing heavy machinery or equipment on the bank	No heavy machinery is required to be deployed on the bank	None	0	None	0	0	None			None				
	2.4	driving machinery, riding animals, or allowing them to graze on the bank	Bank access is not required other than for pedestrian activity associated with monitoring of the works	Low	1	Likely	3	3	Low			Low				
	2.5	excavating into the bank for planting or installing structures	No excavating for structures proposed. However, piling operations may be considered as emergency response in the event of loss of bank stability.	High	5	Unlikely	1	5	Moderate			Moderate				
3 Damaging structural integrity or performance								0	None							
Is there a risk that work could damage or undermine flood defence structures, river control works, land drainage works, sea defences or remote defences. This could be caused by:	3.1	an outfall or temporarily redirected flow causing erosion or scour	The proposed works do not create any new outfalls. Removal of accumulations or berms of silt will alter flow characteristics in the river but changes are expected to improve flow. Extensive monitoring will be carried out to identify the location and extent of any change	Med	3	Likely	3	9	Moderate			Moderate	Moderate			
	3.2	drilling through a defence	There are no works proposed to pass through river defences.	none	0	none	0	0	None			None				
	3.3	the weight of machinery on a defence causing damage	No works are proposed to be carried out from the river banks. Works are confined to the river channel. Equipment is expected to be loaded onto the river by crane over flood defences at Westonzoyland pumping Station compound or brought upriver following a slipway launch. (Outline Method Statement	Med	3	Unlikely	1	3	Low			Low				
4 Damaging habitats and species								0	None							
There is a risk that your work could physically damage habitats and species or you could create changes in the natural environment that would result in the loss of habitats and species. Your works could affect fish movement or mortality or could damage fish spawning grounds. It could also affect the ability of mammals to migrate. Damage could be caused by:	4.1	sediment mobilisation causing damage to fish spawning grounds and other habitats, or increasing flood risk downstream	This potential issue is addressed in the Environmental Action Plan	High	5	Unlikely	1	5	Moderate					Moderate		
	4.2	deliberate or accidental discharge of polluting materials such as oil, silt, dust, litter, and construction debris	Chemical analysis of silt accretions in the river does not indicate significant polution levels (see Testing Certificates)	High	5	Unlikely	1	5	Moderate					Moderate	Moderate	Moderate
	4.3		Controls in place for refuelling and waste management in the Outline Method Statement. Biodegradable hydraulic fluids mandatory for use in equipment.	Med	3	Possible	2	6	Moderate					Moderate	Moderate	Moderate
	4.4	spreading non native invasive species during works or by moving contaminated machinery and personal equipment (boots and hand tools) to a new site	Contractor required to ensure all dredging equipment, including boats, are not contaminated prior to use and provide biosecurity measures, such as machinery cleaning , on site.	Med	3	Possible	2	6	Moderate					Moderate		Moderate
	4.5	changes to habitats by reducing the size of or breaking the continuity of the green corridor provided by watercourses	Works are confined to the river channel below high water level. No trees or hedgerows should be damaged or removed as part of the works.	med	3	Unlikely	1	3	Low					Low		
	4.6	noise, vibration or light affecting species either during construction works or from the permanent installation of works	equipment deployed is mobile and will generate similar noise and vibration levels as those of agricultural equipment typically in routine use in the locality.	Low	1	Likely	3	3	Low					Low		

12 APPENDIX 2: DESIGN SECTIONS:

The PDF file containing Design Cross Sections' is available via the following link:

https://somersetdrainageboards.gov.uk/media/Design-cross-sections.pdf

13 REFERENCED REPORTS:

- Somerset 20 Year Flood Action Plan

https://somersetnewsroom.com/flood-action-plan/

- Opportunities for further dredging in Somerset — HR Wallingford — October 2016

https://somersetdrainageboards.gov.uk/media/HR-Wallingford-opportunities-for-dredging.pdf

- R. Parrett Water Injection Maintenance Dredging - Environmentally Acceptable Protocol — Environment Agency — 08 October 2018

https://somersetdrainageboards.gov.uk/media/Parrett-WID-Maintenance-Protocol.pdf

- Technical Memorandum — C2HM Hill Halcrow — 5 November 2014

https://somersetdrainageboards.gov.uk/media/CH2MHILL-Halcrow-SLM_TechMemo_Modelling_DredgingAssessment.pdf

- Environmental Impact Assessment (EIA), Environmental Statement (ES), Habitats Regulations Assessment (HRA) and Water Framework Directive (WFD)

https://www.somersetriversauthority.org.uk/final-public-consultation-begins-on-river-parrett-dredging-proposals/

- Short Technical Report ref. 003/051 — AW Water Engineering

https://somersetdrainageboards.gov.uk/media/Northmoor-to-M5-hydraulic-assessment.pdf

- Dredging Trials Monitoring Programme November-December 2016 [reference AmbSDBC02] — Dr R Nunny, Ambios Ltd — March 2017

https://somersetdrainageboards.gov.uk/media/Ambios-Dredging-Trials-Monitoring-Report.pdf

14 OTHER REFERENCED DOCUMENTS:

UAV Vegetation survey locations plan	https://somersetdrainageboards.gov.uk/media/UAV-vegetation-survey-locations.pdf
Vegetation survey – sections P118 to P127 (Sam Gamlins)	https://somersetdrainageboards.gov.uk/media/Vegetation-survey-area-1.pdf
Vegetation survey – sections P79 to P88 (Northmoor PS)	https://somersetdrainageboards.gov.uk/media/Vegetation-survey-area-2.pdf
Vegetation survey – sections P46 to P56 (Derelict Cottage)	https://somersetdrainageboards.gov.uk/media/Vegetation-survey-area-3.pdf
Vegetation survey – sections P12 to P22 (Saltmoor PS)	https://somersetdrainageboards.gov.uk/media/Vegetation-survey-area-4.pdf