

TECHNICAL NOTE

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Subject

2020s0819
Walmersley Old Road, Bury
Barratt Homes
September 2021 [Rev 4]
M Hemsworth
R Thrower
Geomorphology Appraisal

1 Purpose of this document

This document provides geomorphology comments and recommendations based on design work and hydraulic modelling outputs produced and provided by CEC who are acting as designers for Barratt Homes.

JBA Consulting's input is limited to geomorphological advice and no JBA engineering or hydraulic modelling work has been undertaken as part of this technical note.

2 Appraisal of CEC Modelled Velocity Downstream of the Control Structure in Reach 1

Overview	The following documents have been used: 6155-522 Section View PLB352 - PLB427.pdf High energy flows emanate from a flow control orifice at the upstream extent of the site during high order events. CEC provided a long-section through the flow control structure, and proposed Reach 1 features with modelled velocity information and issued these to JBA for comment.
Initial Geomorphology Observation	• Water will pass through an orifice flow control into a rocky section of channel followed by a step pool reach. • Velocities within the initial rocky section (model cross section PLB352) range between 1.01m/s (2yr flood) to 1.87 m/s (1000yr flood) • Shear stresses within the initial rocky section (model cross section PLB352) range between 33.9Pa and 96.2Pa. This equates to coarse gravel being entrained in a 2yr (50% Annual Exceedance Probability (AEP)) extreme flood event and cobbles being entrained in a 1000yr (0.1% AEP) extreme flood event. • Velocities within the step pool reach downstream of the orifice exit (model cross sections PLB387 and PLB427) range between 1.06m/s and 1.91m/s for the suite of flood events modelled by CEC. • Shear stresses within the step pool reach downstream of the orifice exit (model cross sections PLB387 and PLB427) range between 44.5Pa and 114.6Pa. This equates to coarse gravel being entrained in a 2yr AEP extreme flood event and boulders being entrained in a 100yr AEP extreme flood event. • The hydraulic results indicate that the channel will be energetic and capable of erosion. A robust design solution is required to prevent unintended lateral erosion and bed incision
May 2021 Design Appraisal	The current modelling used to inform the design is based on coarse resolution flood modelling (i.e. modelled cross sections are widely spaced). For increased confidence a higher resolution model (1D or 2D) is recommended to be developed in order to define velocity and shear stress differences at a local scale and improve confidence in the design.

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	Action: Further hydraulic modelling recommended.
July 2021 Design Appraisal	A review of modelling undertaken by CEC indicates that whilst a low flow channel has been maintained through the storage area, sediment deposition is still likely to occur. This will need long term management via a management and monitoring plan. Action: Management and monitoring plan to be developed

3 Review and Provision of Comment with Regards to Standard Channel Detail Drawing Provided by CEC.

Overview	The following documents have been used: 6155-519 (B) Proposed Watercourse Geomorphology.pdf CEC modified their design to include typical summer low flow water levels and also extended the gravel areas and notched riffles.
May 2021 Design Appraisal	- Cobble and boulder sizes need specifying for the contractor - Detail C appears narrow which could lead to excessive energy Example drawings from another scheme are shown below – this is a different context; however, it provides useful information for design development. A key aspect of the design will be to ensure that the channel isn't too narrow – if it is too narrow energy will be concentrated and instability may occur.  Action: Further design detail required
June 2021 Design Appraisal	Channel widths and in channel feature designs amended by CEC. CEC also noted that the channel side slopes were at their maximum steepness and this limits the potential to widen the channel further. For the purposes of the design it is noted that the channel width does vary where space allows. Action: Further hydraulic modelling and design development required of in-channel features such as step pools and riffles
July 2021	A further review was undertaken to assess the potential buffer to allow for local change within the pool and riffle section of the proposed channel. The following extract from the design indicates that the channel width at

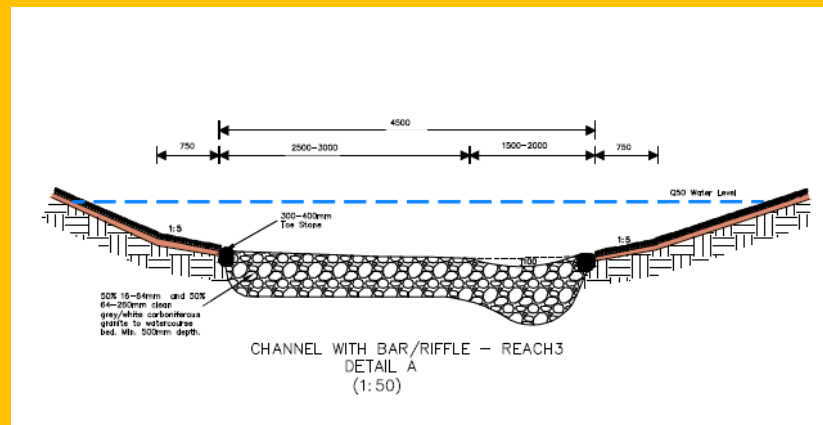
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the base of the slope is typically ~4.5m wide, with a low flow notch indicated in the design. It is hope this will allow for localised adjustments to be made. This should be clearly defined in a monitoring and management plan to ensure natural adjustment is allowed to take place.



Action: Amend plans to identify areas within the channel where natural adjustment is acceptable and provide a link on the drawings to the monitoring and management plan.

4 Provision of Comment with Respect to Sediment Mobilisation within the Storage Area and the Potential for Sediment Replenishment Downstream based on Hydraulics Provided by CEC.

Overview

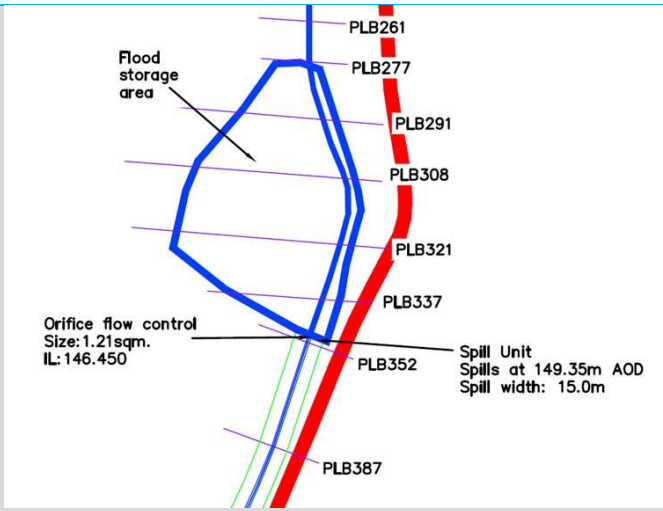
The following documents have been used:
6155-516(B) Flood Storage Area General Arrangement.pdf
6155-507-02(D) Proposed Cross-sections.pdf

Cross section Reference	Parameter	Return Event								
		1:2yr	1:10yr	1:30yr	1:50yr	1:75yr	1:100yr	1:100yr +35%	1:100yr +70%	1:1000 yr
PLB291	Peak Water Level (mAOD)	147.227	147.466	147.600	147.819	148.023	148.153	148.854	149.462	149.499
	Peak Water Depth (m)	0.527	0.766	0.900	1.119	1.323	1.453	2.154	2.762	2.799
	Peak Velocity (m/s)	0.184	0.193	0.188	0.189	0.192	0.184	0.186	0.188	0.193
PLB308	Peak Water Level (mAOD)	147.227	147.466	147.600	147.820	148.023	148.154	148.854	149.462	149.499
	Peak Water Depth (m)	0.527	0.766	0.900	1.120	1.323	1.454	2.154	2.762	2.799
	Peak Velocity (m/s)	0.094	0.095	0.095	0.095	0.095	0.092	0.093	0.093	0.098
PLB321	Peak Water Level (mAOD)	147.226	147.465	147.600	147.820	148.023	148.154	148.854	149.462	149.499
	Peak Water Depth (m)	0.526	0.765	0.900	1.120	1.323	1.454	2.154	2.762	2.799
	Peak Velocity (m/s)	0.081	0.083	0.082	0.081	0.081	0.08	0.08	0.082	0.084
PLB337	Peak Water Level (mAOD)	147.223	147.463	147.597	147.818	148.022	148.152	148.853	149.461	149.498
	Peak Water Depth (m)	0.523	0.763	0.897	1.118	1.322	1.452	2.154	2.761	2.798
	Peak Velocity (m/s)	0.444	0.447	0.446	0.446	0.445	0.206	0.206	0.206	0.206

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Initial Geomorphology Observation	• Velocities in the storage area range between 0.081 - 0.4m/s in all events between 2-yr flood event and the 1000-yr flood event. • 0.08m/s: This indicates sand will be transported but larger sediment will not be transported or entrained. • 0.4m/s: This indicates sand and some small gravels will be entrained and transported but larger sediment will not be mobilised. • Analysis of velocity alone does have limitations - since erosion is driven more by near bed shear stress than velocity. • The results indicate the storage area will be a depositional zone, assuming sediment is transported into the reach from upstream. However, the results are coarse is resolution and do not represent the detailed functioning of the storage area (i.e. local flow dynamics aren't represented - a more detailed 2D modelling approach would typically be preferred).	
May 2021 Design Appraisal	Consultation may be required with the Environment Agency regarding sediment depletion and future maintenance and management requirements. A more detailed representation in a hydraulic model of the storage area would allow local flow dynamics to be assessed and options could be tested - i.e. installation of a low flow channel through the storage area etc, which may have greater benefits in terms of river system functioning. Action: Further hydraulic modelling required	
July 2021 Design Appraisal	A review of modelling undertaken by CEC indicates that whilst a low flow channel has been maintained through the storage area, sediment deposition is still likely to occur. This will need long term management via a management and monitoring plan. Action: Management and monitoring plan to be developed	

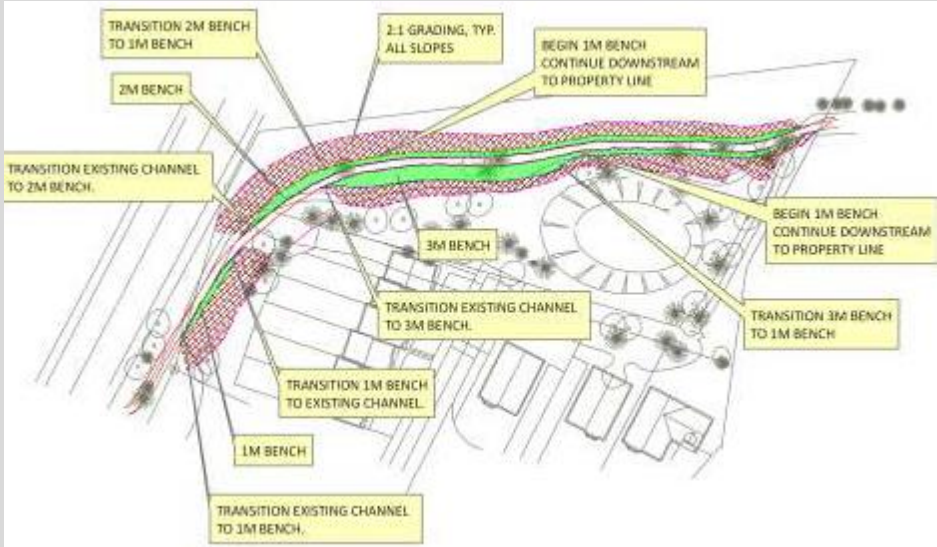
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5 Review of Model Results Provided by CEC and Consideration of Boulder Sizes and Guidance to Allow an Updated Model to be Created which will Represent the Step Pool Features in more detail.

Overview	The existing model results indicate coarse sediment (up to boulder size) could be moved during a flood event. This introduces risk to the project and could lead to channel de-stabilisation during a flood event. Wider 'bench' areas could be introduced to try and reduce in-channel energy. Similar to the example below:  Model results suggest that sediment ~300mm can be entrained. This acts as a strong indicator that morphological instability may occur which may lead to the erosion of gravels and finer sediment. A varied range of sizes is recommended - as shown in the indicative drawing above. This should be tested in a detailed model (1D or 2D) to inform the design and for greater confidence. Key sediment types in which sizes need to be defined in the CEC design include (the below are only indicative and need to be informed by further detailed hydraulic modelling): - Central key stone - largest size - 500mm - Step boulders - downward facing side - 100mm to 400mm - Step particles - upstream face - 200 - 300mm - Pool cobble grade - 100 - 150mm - Bank toe stone - 300-400mm
May 2021 Design Appraisal	Next steps modelling - more detailed modelling will give greater design confidence. This could be 1D or 2D modelling. Typically, a more detailed model would allow an assessment to be made of the velocities within each pool and passing over each step. This would allow more accurate

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	velocities and shear stresses to be assessed in order to aid the sizing of in channel features, including sediment sizes. Action: more detailed modelling and design development required.														
June 2021 Design Appraisal	Advice provided to CEC with regards to improving the detail and representation of Step Pool features in their hydraulic model – based on 400mm step drops. CEC noted that the option of including 'bench' areas into their design had been considered, however, the channel width is constrained by the side slope therefore this option could not be integrated. Action: undertake updated hydraulic modelling based on updated step pool design														
July 2021 Design Appraisal	Following the completion of further hydraulic modelling CEC provided updated model results to JBA to review. Model results were used by CEC to assess channel stability and to define the step pool stone sizes. Updated model results provided by CEC are shown in Appendix A The model results indicate greater stability than originally noted. A review of the suggested step pool sediment sizes was also undertaken, based on the table below: <table><tr><td>Stone</td><td>400mm Step</td></tr><tr><td>Central key stone</td><td>600mm to 700mm</td></tr><tr><td>Step boulders</td><td>500mm-600</td></tr><tr><td>Step particles</td><td>400mm-500mm</td></tr><tr><td>Pool cobble grade</td><td>100 – 150mm</td></tr><tr><td>Bank toe stone</td><td>300 – 400mm</td></tr><tr><td>Bank edge gravels (in front of bank toe stones)</td><td>20 – 100mm</td></tr></table> This assumes sediment is sized to allow for it to be keyed into the bed adequately – assuming 200-300mm bed embedment. It is noted following discussions with CEC that the side slopes limit a varied spacing between step pools – where possible, some differentiation in spacing would be preferable, however, if the spacing is uniform it is anticipated that there will be little impact on morphological processes. Action: update plans to identify where (if possible) step pool spacing can be varied (even if only slightly).	Stone	400mm Step	Central key stone	600mm to 700mm	Step boulders	500mm-600	Step particles	400mm-500mm	Pool cobble grade	100 – 150mm	Bank toe stone	300 – 400mm	Bank edge gravels (in front of bank toe stones)	20 – 100mm
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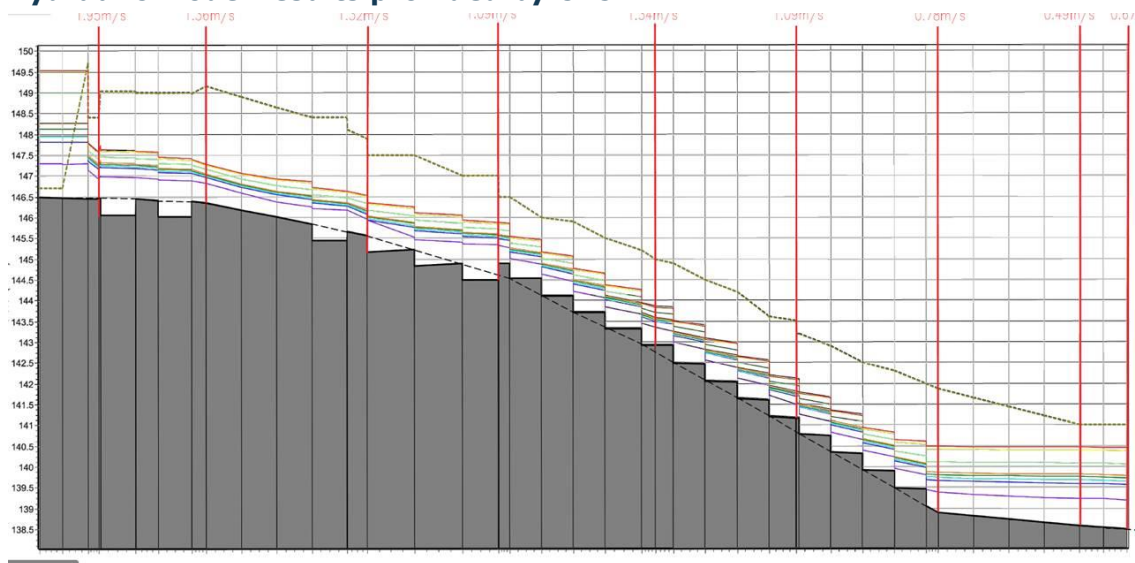
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A Appendix

A.1 Hydraulic model results provided by CEC



Updated Watercourse Parameters Table

Cross section Reference	Parameter	Return Event								
		1:2yr	1:10yr	1:30yr	1:50yr	1:75yr	1:100yr	1:100yr + 35%	1:100yr + 70%	1:1000yr
PLB352	Mannings n value:	0.09								
	Peak Water Level (mAOD)	146.926	147.073	147.152	147.197	147.241	147.274	147.405	147.549	147.581
	Peak Water Depth (m)	0.476	0.623	0.702	0.747	0.791	0.824	0.955	1.099	1.131
	Wetted Perimeter (m)	3.866	4.621	5.026	5.258	5.484	5.653	6.326	7.064	7.229
	Wetted	1.001	1.576	1.928	2.140	2.358	2.528	3.251	4.140	4.351

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	Area (m ²)									
	Peak Velocity (m/s)	1.43	1.59	1.67	1.71	1.74	1.77	1.85	1.94	1.95
PLB387	Mannings n value: 0.09									
	Peak Water Level (mAOD)	146.82 3	146.90 9	146.96 8	146.99 8	147.02 8	147.05 1	147.15 5	147.25 5	147.28 0
	Peak Water Depth (m)	0.473	0.559	0.618	0.648	0.678	0.701	0.805	0.905	0.930
	Wetted Perimeter (m)	5.959	6.417	6.732	6.891	7.051	7.174	7.728	8.26	8.394
	Wetted Area (m ²)	1.832	2.353	2.732	2.931	3.135	3.294	4.047	4.82	5.018
	Peak Velocity (m/s)	0.79	0.93	1.00	1.05	1.09	1.11	1.22	1.34	1.36
PLB427	Mannings n value: 0.09									
	Peak Water Level (mAOD)	145.96 7	146.01 1	146.08 5	146.12 5	146.16 4	146.19 2	146.32 6	146.49 7	146.53 7
	Peak Water Depth (m)	0.397	0.441	0.515	0.555	0.594	0.622	0.756	0.927	0.967
	Wetted Perimeter (m)	5.59	5.841	6.262	6.49	6.712	6.872	7.635	8.614	8.837
	Wetted Area (m ²)	1.404	1.651	2.094	2.344	2.596	2.782	3.725	5.075	5.411
	Peak Velocity (m/s)	1.33	1.33	1.33	1.32	1.32	1.33	1.33	1.33	1.32
PLB468	Mannings n value: 0.09									
	Peak Water Level (mAOD)	145.00 9	145.10 3	145.16 7	145.20 4	145.23 6	145.25 9	145.37 9	145.51 2	145.54 4

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	Peak Water Depth (m)	0.479	0.573	0.637	0.674	0.706	0.729	0.849	0.982	1.014
	Wetted Perimeter (m)	5.965	6.458	6.794	6.989	7.157	7.278	7.908	8.606	8.774
	Wetted Area (m ²)	1.857	2.428	2.842	3.093	3.313	3.474	4.353	5.415	5.682
	Peak Velocity (m/s)	0.75	0.89	0.97	1.00	1.02	1.04	1.09	1.09	1.09
PLB508	Mannings n value: 0.09									
	Peak Water Level (mAOD)	143.357	143.441	143.498	143.532	143.564	143.588	143.703	143.834	143.866
	Peak Water Depth (m)	0.427	0.511	0.568	0.602	0.634	0.658	0.773	0.904	0.936
	Wetted Perimeter (m)	6.700	7.151	7.458	7.641	7.813	7.942	8.56	9.265	9.437
	Wetted Area (m ²)	2.669	3.235	3.639	3.888	4.127	4.31	5.227	6.351	6.638
	Peak Velocity (m/s)	0.92	1.08	1.12	1.19	1.21	1.23	1.30	1.33	1.34
PLB548	Mannings n value: 0.09									
	Peak Water Level (mAOD)	141.499	141.609	141.690	141.734	141.775	141.804	141.944	142.095	142.131
	Peak Water Depth (m)	0.319	0.429	0.51	0.554	0.595	0.624	0.764	0.915	0.951
	Wetted Perimeter (m)	5.199	6.118	6.796	7.164	7.506	7.749	8.919	10.182	10.483
	Wetted Area (m ²)	0.996	1.611	2.127	2.43	2.726	2.944	4.09	5.506	5.87
	Peak Velocity (m/s)	1.08	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09

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PLB588	Mannings n value: 0.05									
	Peak Water Level (mAOD)	139.38 8	139.53 5	139.65 9	139.73 2	139.80 4	139.85 8	140.11 6	140.41 4	140.48 5
	Peak Water Depth (m)	0.488	0.635	0.759	0.832	0.904	0.958	1.216	1.514	1.585
	Wetted Perimeter (m)	6.236	7.163	7.944	8.405	8.858	9.199	10.825	12.704	13.151
	Wetted Area (m ²)	1.948	2.913	3.828	4.41	5.015	5.489	7.995	11.384	12.27
	Peak Velocity (m/s)	0.75	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
PLB628	Mannings n value: 0.05									
	Peak Water Level (mAOD)	139.23 6	139.44 2	139.59 3	139.67 6	139.75 5	139.81 4	140.08 6	140.39 3	140.46 6
	Peak Water Depth (m)	0.656	0.862	1.013	1.096	1.175	1.234	1.506	1.813	1.886
	Wetted Perimeter (m)	5.493	6.534	7.297	7.717	8.116	8.414	9.789	11.341	11.71
	Wetted Area (m ²)	2.261	3.437	4.424	5.011	5.599	6.057	8.377	11.406	12.19
	Peak Velocity (m/s)	0.50	0.49	0.50	0.50	0.50	0.50	0.49	0.50	0.49
PLB641	Mannings n value: 0.05									
	Peak Water Level (mAOD)	139.19 5	139.40 9	139.56 4	139.64 9	139.73 1	139.79 0	140.06 6	140.37 7	140.45 1
	Peak Water Depth (m)	0.695	0.909	1.064	1.149	1.231	1.290	1.566	1.877	11.951
	Wetted Perimeter	5.083	6.137	6.901	7.32	7.725	8.015	9.136	10.909	11.274

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	(m)									
	Wetted Area (m ²)	2.239	3.366	4.31	4.875	5.45	5.882	8.113	11.038	1.798
	Peak Velocity (m/s)	0.66	0.66	0.66	0.67	0.67	0.67	0.67	0.67	0.67