

TECHNICAL NOTE

Job Name: Dunsbury Hill Farm
Job No: 30142
Note No: TN002
Date: 12.06.2015
Prepared By: Alex Wray
Subject: Flood level comparison between Atkins and PBA proposals

Item	Subject
1.	Introduction This technical note has been prepared to support the flood defence consent application for the proposed restoration works of a 125m length of the Hermitage Stream at the Dunsbury Hill Farm development site, north of Havant. The proposals comprise: - Increasing the length of a 100m section of the existing concrete lined channel to 125m due to the diversion beneath the bridge and the increased sinuosity; - Changing the average gradient in this section from 1:136 to 1:164; - Addition of a new road bridge with a soffit varying between 19.79 – 19.55mAOD compared to 20.47mAOD in the Atkins options model; - Bringing 86m of the 125m total length out the concrete lined channel and the introduction of more natural battered banks to existing ground level. The technical note summarises the impact of the proposed scheme on the local flood levels. The note also reviews likely flow velocities in relation to in-channel enhancements and considers bank protection requirements against scour. As no baseline model has been made available, the Infoworks RS model of the Atkins proposals will serve as the baseline for the PBA analysis. This Infoworks RS model was converted to ISIS and a comparison made to the most recent proposals.
2.	Description of initial Atkins model The original FRA undertaken by Atkins dated 02.09.2011 compared the baseline existing situation with their outline design situation. The baseline flood outlines for the Hermitage Stream were derived from an Infoworks RS modelling study completed in 2006. It was determined that the site was at low risk of flooding in the baseline and that development would be acceptable in line with the guidance of PPS25. From the Atkins FRA, the following changes were made to the baseline model to test the post-development flood risk: <i>“The existing model was truncated to include only the reach of the Hermitage Stream from upstream of the A3 to Leigh Park. The section proposed for restoration was identified and the original 7 channel cross sections and 3 structures removed. The latter represented a series of small timber weirs originally designed to act as velocity breaks. The weirs are currently ineffective because of sediment accretion and will be removed and not replaced through the restored reach. Three new indicative channel cross sections representing the outline proposed shape of the restored channel were added into the model. The reach length was increased by approximately 10% to 100m to reflect the increased sinuosity of the new</i>

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	<i>channel. The channel Mannings value was kept at 0.03 and the bank Mannings value at 0.09. No change was made because the existing Mannings value is considered high for a concrete channel and more appropriate for a vegetated channel. The high Mannings means that the existing modelled water levels are likely to be a conservative estimate of the actual water levels in the Hermitage Stream. The new bridge crossing over the Hermitage Stream was modelled as an USBPR Bridge Unit with a soffit / spring height of 20.47m AOD, as taken from drawing 2 in Appendix A."</i> The model showed that the changes made to the Hermitage Stream resulted in no change in flood risk to the residential area of Leigh Park or areas upstream of the A3. There was, however an increase in water levels immediately upstream of the start of the restored reach, by a maximum of 60mm in the 1% AP flood event.
3.	Changes to the Atkins model A number of amendments have been made to the initial outline design proposals put forward by Atkins due to the site constraints identified as part of the design development process. The constraints include: • The toe of the existing A3 embankment upstream of the new road bridge; • The existing woodland on the left bank upstream of the new road bridge and downstream of the existing incoming ditch at the downstream end of the new channel section; • The alignment of an existing 1025mm diameter foul sewer. As well as these constraints, the Environment Agency made a number of recommendations in their letter dated 3rd March 2015 which have been incorporated into the design: • Remove the 90° bends upstream and downstream of the new road bridge and make these transitions smoother. • Introduce new in-channel ecological features and utilise a natural bed and profile downstream of the bridge. • Endeavour to reduce the amount of bank protection required throughout the new reach downstream of the bridge and naturalise the bank as much as possible upstream of the bridge.
4.	Manning's assumptions Atkins used a Manning's n value of 0.03 for the channel and 0.09 for the banks and commented that there was no change between their existing baseline model and their option model as these values are considered representative of a vegetated system. To ensure a reasonable comparison, the PBA model has assumed the same Manning's n values for channel and bank. A sensitivity test was also undertaken using a channel Manning's n value of 0.045 (50% increase) to determine what affect this change has on the flood levels.

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5. Modelled flood level comparison

The tables below show the change in 1% annual probability (AP) and 1% AP with allowance for climate change flood levels at 3 locations along the channel, comparing the current proposals with the original Atkins proposals.

Table 5.1: - Comparison of Hydraulic Model Water Level Results – 1% AP

Cross Section	Location	1% AP Water Level (mAOD)			Change in Water level (mm)	Manning's n +50% water level test (mAOD)	Change in Water level (mm)
		Baseline	Original Atkins Proposals	Updated 2015 Proposals			
Super A0A0A	Section 35m upstream of new road bridge	17.91	17.92	17.65	-270	17.88	-4
Super A0A0B	Section at upstream face of new road bridge	-	17.64	17.41	-230	17.64	-0
Super A0A0C	Section downstream of backwater but upstream of incoming ditch	17.05	17.04	17.03	-10	17.09	+50

Table 5.2: - Comparison of Hydraulic Model Water Level Results – 1% AP plus climate change

Cross Section	Location	1% + CC AP Water Level (mAOD)			Change in Water level (mm)	Manning's n +50% water level test (mAOD)	Change in Water level (mm)
		Baseline	Original Atkins Proposals	Updated 2015 Proposals			
Super A0A0A	Section 35m upstream of new road bridge	-	18.08	17.82	-260	18.09	+10
Super A0A0B	Section at upstream face of new road bridge	-	17.79	17.55	-240	17.82	+30
Super A0A0C	Section downstream of backwater but upstream of incoming ditch	-	17.16	17.14	-20	17.22	+60

The results summarised above show that there is an overall drop in modelled flood levels between the Atkins outline design and the PBA developed design when maintaining the same assumptions for Manning's n between the two schemes.

Increasing the channel Manning's n value to 0.045 from 0.03 causes a small but limited increase in flood levels when compared to the Atkins proposals for both the 1% and 1% AP plus climate change events as shown in Tables 5.1 and 5.2. Although the water levels increase, the Stream still remains in bank during these extreme flood flows.

For the 1% AP flood event the increase in water level with the increase in Manning's n is recorded at the node SuperA0A0C (see Table 5.1). This node is located immediately downstream of the incoming ditch, south of the backwater feature. The water level does not increase downstream of this node.

Once an allowance for climate change has been applied to the 1% AP flood event the water level changes are shown to increase between nodes SuperA0A0A (35m upstream of the bridge) and SuperA0A0C (see Table 5.2). The model results further upstream and downstream of these nodes showed no change to the water levels and therefore this rise in water levels is retained within the realigned Hermitage Stream.

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	The hydraulic modelling results highlight how sensitive the water level is to a change in Manning's n which in turn could increase water levels. This highlights the importance of regular maintenance within the channel to ensure that the channel conveyance and water levels are retained at the design level.																																																																												
6.	Scour Protection Design The proposed scheme required an assessment for the potential risks of scour. For the purpose of the design, the critical velocity was extracted from the Atkins model which has been updated by PBA to suit the 2015 proposals. Table 6.1: - Comparison of Hydraulic Model Velocity Results – 1% AP <table> <tr> <th rowspan="2">Cross Section</th><th rowspan="2">Location</th><th colspan="3">1% AP Velocity (m/s)</th><th rowspan="2">Change in Velocity (m/s)</th><th rowspan="2">Manning's n +50% velocity test (m/s)</th><th rowspan="2">Change in Velocity (m/s)</th></tr> <tr> <th>Baseline</th><th>Original Atkins Proposals</th><th>Updated 2015 Proposals</th></tr> <tr> <td>Super A0A0A</td><td>Section 35m upstream of new road bridge</td><td>-</td><td>1.48</td><td>1.63</td><td>+0.15</td><td>1.31</td><td>-0.17</td></tr> <tr> <td>Super A0A0B</td><td>Section at upstream face of new road bridge</td><td>-</td><td>2.55</td><td>1.98</td><td>-0.57</td><td>1.53</td><td>-1.02</td></tr> <tr> <td>Super A0A0C</td><td>Section downstream of backwater but upstream of incoming ditch</td><td>-</td><td>1.30</td><td>1.55</td><td>+0.25</td><td>1.43</td><td>+0.13</td></tr> </table> Table 6.2: - Comparison of Hydraulic Model Velocity Results – 1% AP plus climate change <table> <tr> <th rowspan="2">Cross Section</th><th rowspan="2">Location</th><th colspan="3">1% + CC AP Velocity (m/s)</th><th rowspan="2">Change in Velocity (m/s)</th><th rowspan="2">Manning's n +50% velocity test (m/s)</th><th rowspan="2">Change in Velocity (m/s)</th></tr> <tr> <th>Baseline</th><th>Original Atkins Proposals</th><th>Updated 2015 Proposals</th></tr> <tr> <td>Super A0A0A</td><td>Section 35m upstream of new road bridge</td><td>-</td><td>1.63</td><td>1.80</td><td>+0.17</td><td>1.46</td><td>-0.17</td></tr> <tr> <td>Super A0A0B</td><td>Section at upstream face of new road bridge</td><td>-</td><td>2.75</td><td>2.18</td><td>-0.57</td><td>1.67</td><td>-1.08</td></tr> <tr> <td>Super A0A0C</td><td>Section downstream of backwater but upstream of incoming ditch</td><td>-</td><td>1.47</td><td>1.76</td><td>-0.29</td><td>1.61</td><td>+0.14</td></tr> </table> The peak velocity (2.18m/s) appears at node ref Super A0A0B during the 1% + CC AP event. The location of this node is upstream of the proposed bridge, with the channel confined by the proposed concrete channel at this point. It is assumed that a similar velocity will be experienced beneath the bridge and immediately downstream of the bridge, prior to the river cross-section widening and therefore the velocity decreasing. The design of the scour protection is in accordance with CIRIA C742 Manual for scour at bridges and other hydraulic structures, 2nd edition dated 2015. The velocities quoted in Tables 6.1 and 6.2 are an average velocity for that particular cross-section. Hence, the design procedure includes calculations to modify the velocity extracted from the model to account for the increase in turbulence immediately downstream of the bridge and the increase in velocity on the outside of the bend. Design velocity downstream of bridge = 4.8m/s							Cross Section	Location	1% AP Velocity (m/s)			Change in Velocity (m/s)	Manning's n +50% velocity test (m/s)	Change in Velocity (m/s)	Baseline	Original Atkins Proposals	Updated 2015 Proposals	Super A0A0A	Section 35m upstream of new road bridge	-	1.48	1.63	+0.15	1.31	-0.17	Super A0A0B	Section at upstream face of new road bridge	-	2.55	1.98	-0.57	1.53	-1.02	Super A0A0C	Section downstream of backwater but upstream of incoming ditch	-	1.30	1.55	+0.25	1.43	+0.13	Cross Section	Location	1% + CC AP Velocity (m/s)			Change in Velocity (m/s)	Manning's n +50% velocity test (m/s)	Change in Velocity (m/s)	Baseline	Original Atkins Proposals	Updated 2015 Proposals	Super A0A0A	Section 35m upstream of new road bridge	-	1.63	1.80	+0.17	1.46	-0.17	Super A0A0B	Section at upstream face of new road bridge	-	2.75	2.18	-0.57	1.67	-1.08	Super A0A0C	Section downstream of backwater but upstream of incoming ditch	-	1.47	1.76	-0.29	1.61	+0.14
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	Design velocity on outside of bend (left bank) downstream of the bridge = 2.4m/s Table 6.9 from the CIRIA guidance suggests that a 300mm thick reno mattress with 100-150mm (D50 125mm) stone size would be suitable immediately downstream of the bridge and left bank, based on peak velocity and duration of flood event. The reno mattresses, which will be lined with a suitable geotextile to prevent scour of the bed material beneath the mattresses, will be installed for an extent of 8m downstream of the bridge. The extent of the protection has been determined by considering the transition in velocity from high values beneath the bridge to the decreased values downstream, where the channel profile increases. This section of reno mattress will transition into the proposed scour protection for the bank and the designed bed profile of the riffles and pools. Following discussions with Maccaferri Ltd, they suggested the use of MacMat-R along the extent of the left bank. This is a reinforced geotextile which would be topsoiled and seeded to provide a natural bank profile. Similar, approved scour protection would also be acceptable at this location as long as it meets the requirements of "CIRIA Report 116 Design of Reinforced Grass Waterways" Figure 9, representing limiting values for erosion resistance of plain and reinforced grass.
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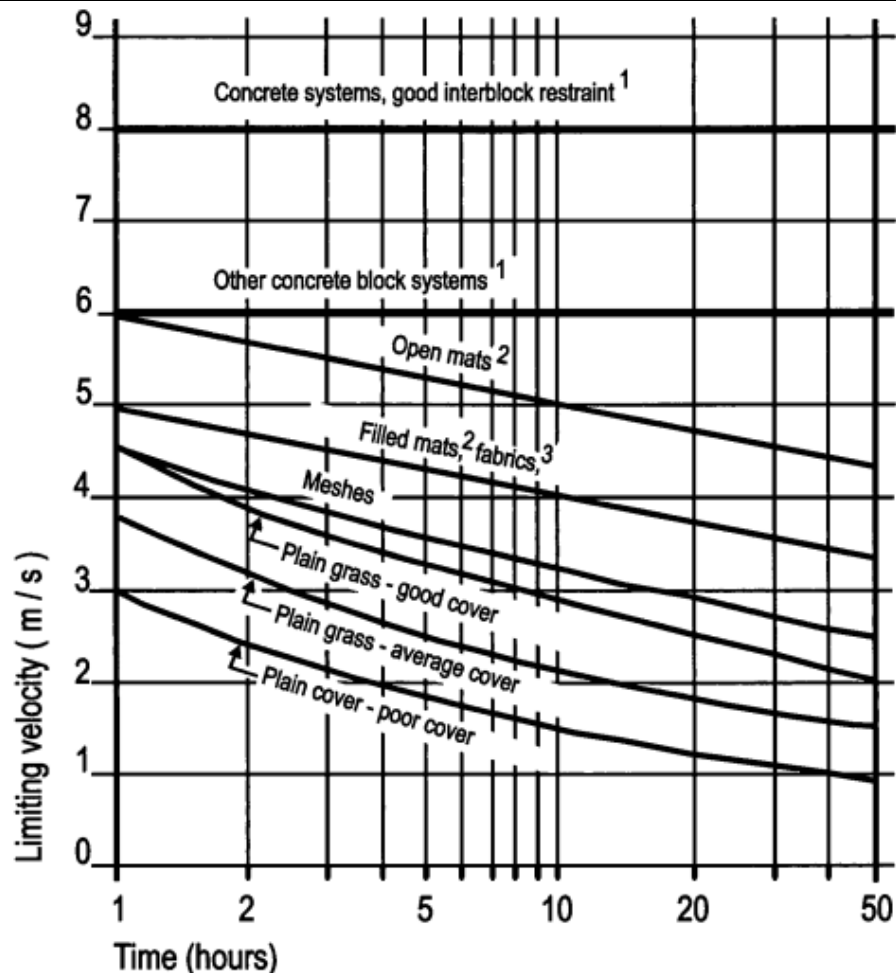


Figure 9 Recommended limiting values for erosion resistance of plain and reinforced grass

- Notes:
1. Minimum superficial mass 135 kg/m², see Section 4.3.3 for other criteria.
 2. Minimum nominal thickness 20 mm.
 3. Installed within 20 mm of soil surface, or in conjunction with a surface mesh.
 4. See Section 4.3.2 for other criteria for geotextile reinforcement.
 5. These graphs should only be used for erosion resistance to unidirectional flow. Values are based on available experience and information at date of this report.
 6. All reinforced grass values assume well-established, good grass cover.
 7. Other criteria (such as short-term protection, ease of installation and management, susceptibility to vandalism, etc) must be considered in choice of reinforcement.

A concrete wing wall has also been designed to provide protection to the right bank from scour immediately upstream of the bridge. The wing wall funnels water downstream, through the bridge and away from the bridge abutments and foundations.

7. Conclusion

- 7.1** This technical note explains the impact of the proposed restoration scheme on the hydraulics of the Hermitage Stream and how this has developed since the Atkins proposals and hydraulic model (2011) were developed.
- 7.2** In terms of flood risk, there is a modelled reduction in flood levels, when compared with the original Atkins scheme for the 1% AP and 1% AP plus climate change flood events. When the Manning's n is increased by 50% there is a slight increase in flood levels (+60mm) at the downstream end. However, this increase is limited and does not extend beyond the modelled nodes, upstream or downstream of the scheme's reach.
- 7.3** The model results have emphasised the importance of regular maintenance within the

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7.4	Hermitage Stream channel to ensure the roughness (Manning's n) of the channel does not increase and lead to elevated water levels. This note also explains how the scour protection for the channel has been designed, with the use of the hydraulic modelling results, and in accordance with CIRIA C742. Allowance has been made for: i. A concrete wing wall upstream of the bridge to funnel flood flows through the bridge ii. Reno mattress downstream of the bridge; and iii. Erosion control on the left bank, downstream of the bridge
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DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
30142/4001/TN001	-	12.06.15	AEW	RMF	NKA	

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