

28 November 2018

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FAO: Paul Harvey

Ref: 1849

**Re: Land adjacent 15 Billet Avenue, Waterlooville PO7 7SZ
Assessment of Fluvial Flood Risk APP/18/00109 and HA/2018/120240/03-L01**

Dear Sirs

We understand that an FRA (31-10-2018) by Messrs Hamill Davies Ltd has been produced in support of planning application APP/18/00109 to Havant BC for the development of 4 dwellings on the above site. We further understand that the Hermitage Stream is culverted beneath the site in a North to South direction and that you have been granted a Flood Risk Activity Permit (FRAP) on 29-1-2018 for replacement of the existing 1.2m DN culvert which is currently in poor condition. The Environment Agency are objecting (19-11-2018) to the current planning application for the proposed dwellings on the basis that the FRA fails to assess the fluvial flood risk from Hermitage Stream.

In the following paragraphs we set out the assessment of the fluvial flood risk to the site which draws upon various information sources:

1. Existing site topographic survey (16-2654-900-P2)
2. 2012 EA CCTV condition report NFCDD: 07128S5300303L02- this site and No 17. Billet Ave
3. Long section of replacement culvert (16-2654-2111-P3)- culvert within the site- from consented FRAP
4. CGB Designs drawing June 1997 of culvert to 17 Billet Avenue (held by Havant BC)
5. GB Designs drawing 13-BILL-03 of external steps and patio to 17 Billet Ave (held by Havant BC)
6. EA JFLOW (2016) flood outline plan and levels (output contained in FRA 31-10-2018)
7. Flood Flow rates from JFLOW (2016) dataset at upstream entry point to the culvert
8. Liaison with Steve Mountain LPA Drainage Engineer for Havant BC
9. 16-254-2152-P1 culvert works sequence drawing- from consented FRA

The existing culvert under the site (hereafter referred to as the site section) and the culvert extension under the grounds to 17 Billet Avenue (hereafter referred to as the downstream section) are 1.2m DN. From (3) the site section of the culvert falls from 36.64 mAOD IL at Ch0 to 36.25 mAOD IL at Ch 77.40 (ie gradient 1:198) From (2) the aggregate length of the total culvert is 110.4m so the length of the downstream section Ch 77.4-Ch110.4 is 33.0m and from (4) the fall along this length is (6.62m LD to 5.57m LD) 1.05m (ie gradient 1:31.4).

Without surcharge and for the present ignoring entry and exit head losses the culvert capacity would be limited by the capacity of the site section to 3.0 m³/sec.

Allowing for sufficient surcharge of the site section to reach the no surcharge capacity of the downstream section, again at present ignoring entry and exit losses the culvert capacity would be limited to 7.6 m³/sec and would require a head level of 38.72 + 1.2 = 39.92m AOD. This is below the upstream Ground Level (GL) over the culvert of some 40.3m AOD. Head losses must therefore be considered.

For 7.6 m³/sec throughput flow velocity would be 6.69 m/sec and associated entry loss would be $0.5 \times v^2/2g$ and exit loss $1.0 \times v^2/2g$ ie total losses would be 3.42m. It is therefore apparent a secondary flow path would develop overland above the culvert before the unsurcharged capacity of the downstream section could be mobilised. Considering head losses for the site section at no surcharge condition: velocity 2.65 m/sec has an associated head loss of 0.53m. ie The full site section capacity can be mobilised but not the full downstream section capacity. There will therefore be a critical surcharge value at which an intermediate flow capacity can be achieved when the upstream head reaches the upstream ground level. Beyond this flow rate additional flow would be accommodated partly within the culvert and partly over land above the culvert. The table below examines the effect of increasing flow rates on the surcharge head required:

Flow Rate (m ³ /sec)	Velocity (m/sec)	Basic head 36.64+1.20	Head losses (m)	Head level req'd (mAOD)	Notes
3.0	2.65	37.84 mAOD	0.54	38.38	within culvert
3.25	2.87	37.84 + 0.07	0.63	38.54	within culvert
3.50	3.09	37.84 + 0.14	0.73	38.71	within culvert
3.75	3.32	37.84 + 0.22	0.84	38.90	within culvert
4.0	3.53	37.84 + 0.30	0.95	39.09	within culvert
4.25	3.75	37.84 + 0.39	1.08	39.31	within culvert
4.50	3.99	37.84 + 0.49	1.22	39.55	within culvert
4.75	4.21	37.84 + 0.59	1.36	39.79	within culvert
5.0	4.42	37.84 + 0.69	1.49	40.02	within culvert
5.1	4.50	37.84 + 0.73	1.55	40.12	within culvert
5.2	4.60	37.84 + 0.78	1.62	40.24	At GL

The limiting flow rate is 5.2 m³/sec. Above this flow rate a secondary path would start to develop over land.

This capacity can be considered in the context of the flood flow rates in Hermitage Stream from the JBA analysis (7). Model point ID 609 is located immediately upstream of the culvert. The modelled flood flows for this are:

Q ₃₀	1.82 m ³ /sec	
Q ₁₀₀	2.45 m ³ /sec	(FZ2)
Q ₁₀₀₀	4.47 m ³ /sec	(FZ1)

In their planning response of 19-11-2018 the EA have stated that in the case of this site they require the Central Allowance climate change figure of +35% increase in fluvial flows. The modelled +35%CC flow is:

Q _{100 + 35%CC}	3.30 m ³ /sec	(2118 _{AD} FZ2)
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With reference to the flow rate versus head level table above, in all cases (Q₁₀₀ Q_{100 + 35%CC} & Q₁₀₀₀) flows can be accommodated within the culvert and would not develop any overland flow above the culvert. The JBA modelling is not based on site specific data and JBA acknowledge that the use of LIDAR terrain in the JFLOW model may not give an accurate indication of flood levels in some circumstances. We consider the JFLOW plan used for the Hamill Davies FRA does not accurately represent flood development on this site, and the flood development is more accurately represented by our own site specific modelling for the flow rates determined by JBA.

Consideration has been given to the potential for blockage. From liaison with Steve Mountain (Havant BC Drainage Engineer). Hermitage Stream rises in the Queens Enclosure a few hundred metres north of the site. The surface water sewer/drain discharge into the stream at that point is only some 375mm DN. At the southern edge of the Enclosure the stream passes through approximately 120m length of 1.05m DN culvert beneath Highfield Avenue, then reverts to a short length(50m) of open channel before reaching the site

culvert. In practice the Highfield Avenue culvert will act as a screen to the site culvert and any debris passing through the 1.05m DN Highfield Avenue culvert would inherently be able to pass through the 1.2m DN site culvert.

Notwithstanding this then for a hypothetical 50% blockage to flow rate and with reference to the flow versus head level table above 2.6m³/sec would be passed before any overland flow were to occur. The hypothetical shortfall on Q_{100+35%CC} flow of 3.3 m³/sec would therefore be some 0.7 m³/sec. The overland flow capacity across the rear gardens can then be considered. From (1) the GL falls from some 40.3m to some 39.7m AOD over the 77m length across the site ie gradient of 0.0078. The proposed landscape plan Martin Ralph Architects drawing 16A-071-010 rev L indicates there will be some 15m between the rear wall of the proposed dwellings and the retained trees and landscape/back of gardens to the east and some 11.5m between the proposed timber decking and the retained trees and landscape to the East. A simple Manning channel calculation using a Manning n value of 0.1, similar to that for a heavy/dense stand of trees would give the following capacities:

Depth	bed width(P)	Area(m ²)	Gradient	n value	Flow (m ³ /sec)	m/sec
0.1m	10m	1.0	0.0078	0.1	0.2	0.2
0.2	10	2.0	0.0078	0.1	0.6	0.3
0.25	10	2.5	0.0078	0.1	0.9	0.35

It is therefore apparent that in the unlikely event that a 50% flow rate blockage were to occur, development of a flow depth of 0.2m across a 10m width of the proposed gardens would accommodate the overland flow component, minded that the increase in depth approaching the culvert would also yield a further increase in flow through the culvert due to the increased head.

In the event of such an overland flow, flood levels would be 40.5m AOD at the upstream end of the site and 39.9m AOD at the downstream end. The applicant has proposed the following FFLs on Martin Ralph Architects drawings 16A-071-012E and -013F:

Upstream plot (section DD) proposed	FFL 41.10m AOD	ie 0.6m freeboard
Section CC	FFL 40.93m AOD	
Section BB	FFL 40.87m AOD	
Downstream plot (section AA) proposed	FFL 40.73m AOD	ie 0.83m freeboard

The freeboards provided are considered adequate.

In summary:

- With no blockage the culvert has the capacity to accommodate the design flow and no overland flow would occur.
- In the unlikely event of 50% flow blockage to the culvert the existing site levels would provide at least 0.6m freeboard between design flood levels in the rear gardens and proposed plot FFLs.

The grounds to 17 Billet Avenue are significantly lower than the site GLs. Havant BC record information indicates a GL of well below 38m AOD at No 17, so overland flows which may occur in the site would free drain over the grounds to No 17 without any backwater effects upon the site.

There is scope to manipulate the finished GLs in the rear gardens. The construction phasing drawing (9) for the consented FRAP culvert replacement works indicates an excavation width of some 9.5m width at GL. When the ground, which would form the gardens, is reinstated it is possible that this could be done to a lower level. This is however not considered to be necessary given the FFL currently proposed. It should be noted that should this be proposed it would be necessary to maintain an upstand to the upstream headwall of the new culvert to the same level as the existing GL. In this way overland flow would not commence at an earlier flood stage, as this would otherwise lead to an earlier onset of overland flood flow to the garden of No 17. Installation of a wall would maintain the time/stage of onset. It would not change any flow rate across the grounds to No 17 once mobilised.

We consider that if considered necessary by the EA, the final rear garden GLs can be secured by appropriate condition with the LPA. These finished GLs will form part of the subsequent FRAP-2 application for the residential construction so would be subject to the review and agreement of the EA anyway. Similarly it may be appropriate to condition the form of fencing or boundary treatment detail between the properties. A hedge or hit and miss fencing etc may be required by the EA and could also be secured by condition.

A site reconnaissance visit was made on 27 November 2018 with Kim Smith of the Environment Agency. The likelihood of potential blockage was discussed, and it was concluded that a 50% blockage scenario was considered unlikely. We would therefore conclude that overland flow above the culvert will not occur for the design flow $Q_{100+35\%CC}$ or for Q_{1000} and that the site including dwelling curtilages and access will remain dry and safe. The proposed development is therefore considered to comply with the flood risk requirements of the NPPF.

The assessment of fluvial flood risk contained in this letter should be considered as a supplemental addendum to the Hamill Davies FRA and supersedes the fluvial flood risk component of the Hamill Davies FRA.

Yours sincerely

Aqua Callidus Consulting Ltd

Andy Traves

Enc Base culvert capacities (no surcharge and ignoring entry/exit losses)

Site Ref	Billet Avenue				
Catchment Element	1200 DN SW culvert upstream no entry/exit losses				
PIPE SIZING	defaults				
Fluid density	999.1	kg/m ³		999.1	
Kinematic viscosity	1.141	m ² s ⁻¹ ×10 ⁶		1.141	
Colebrook White factor	1.000			1.000	Look up value in HR tables
Roughness K _s (SW/FW)	0.6/1.5	mm		0.60	

			(m)	(m)	(m)	(m)	L/sec		(mm)	L/sec	m/sec
Run ID	From	To	IL _{start}	drop	IL _{start}	Length	Q _{req}	Fall _{1 in}	DN	Q _{avail}	V _{flow}
1	Ch0	Ch77.4	36.640	0.000	36.250	77.4		198.5	1200	2998.07	2.65
2								#####		#DIV/O!	#####
3								#####		#DIV/O!	#####
4								#####		#DIV/O!	#####
5								#####		#DIV/O!	#####
6								#####		#DIV/O!	#####
7								#####		#DIV/O!	#####
8								#####		#DIV/O!	#####
9								#####		#DIV/O!	#####
10								#####		#DIV/O!	#####
11								#####		#DIV/O!	#####
12								#####		#DIV/O!	#####
13								#####		#DIV/O!	#####
14								#####		#DIV/O!	#####

Site Ref	Billet Avenue				
Catchment Element	1200 DN SW culvert D/S section next door				
PIPE SIZING	defaults				
Fluid density	999.1	kg/m ³		999.1	
Kinematic viscosity	1.141	m ² s ⁻¹ ×10 ⁶		1.141	
Colebrook White factor	1.000			1.000	Look up value in HR tables
Roughness K _s (SW/FW)	0.6/1.5	mm		0.60	

			(m)	(m)	(m)	(m)	L/sec		(mm)	L/sec	m/sec
Run ID	From	To	IL _{start}	drop	IL _{start}	Length	Q _{req}	Fall _{1 in}	DN	Q _{avail}	V _{flow}
1	Ch79.0	Ch110.4	6.620	0.000	5.570	31.4		29.9	1200	7749.91	6.85
2								#####		#DIV/O!	#####
3								#####		#DIV/O!	#####
4								#####		#DIV/O!	#####
5								#####		#DIV/O!	#####
6								#####		#DIV/O!	#####
7								#####		#DIV/O!	#####
8								#####		#DIV/O!	#####
9								#####		#DIV/O!	#####
10								#####		#DIV/O!	#####
11								#####		#DIV/O!	#####
12								#####		#DIV/O!	#####
13								#####		#DIV/O!	#####
14								#####		#DIV/O!	#####