SECTION 78 OF THE TOWN AND COUNTRY PLANNING ACT 1990 (AS AMENDED)

INQUIRY INTO THE APPEAL BY CASTLEFIELD INTERNATIONAL LIMITED AGAINST REFUSAL OF RESERVED MATTERS APPLICATION BY SOUTH CAMBRIDGESHIRE DISTRICT COUNCIL AT LAND AT TEVERSHAM ROAD, FULBOURN

PROOF OF EVIDENCE OF DR ELIZABETH SOILLEUX MA MB BChir PhD FRCPath PGDipMedEd

On behalf of

SAVE FULBOURN FIELDS AND FULBOURN FORUM

RULE 6 PARTY

Planning Appeal Ref: APP/W0530/W/22/3291523
Planning Application Ref: S/3290/19/RM

TOWN AND COUNTRY PLANNING

(INQUIRIES PROCEDURE) (ENGLAND) RULES 2000

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Proof of Evidence

Section 1 Introduction

The writer

1 My name is Dr Elizabeth Soilleux and I am a local resident in Fulbourn and live at [redacted], a property adjacent to the proposed development site known as "land east of Teversham Road". Professionally, I am a Cambridge and Oxford trained university academic and consultant pathologist. I hold an MA (first class, natural sciences), MB BChir (clinical medical degree, passed with distinction), PhD in Biological Sciences, and Postgraduate Diploma in Medical Education, from the University of Cambridge. I undertook postgraduate training (leading to the award of Fellowship of the Royal College of Pathologists) in Cambridge and Oxford. I currently work for the University of Cambridge, undertaking teaching, research and clinical work. In particular, my research group undertakes computational and mathematical modelling in bioinformatics (DNA and RNA sequencing) and complex biopsy image analysis. As part of my work I am required to have a clear understanding of the principles of data modelling and the importance of using complete and accurate data, appropriate methodology and situation-appropriate assumptions. I completed the Cardiff University Bond Solon Expert Witness Certificate in Civil Law in 2011 and I undertake expert witness work in Coronial, Civil and, rarely, Criminal Law settings.

2 I accept that I am not a drainage and flood risk expert and this evidence is not provided on that basis[1] [2] but I have spent many hours reviewing the information related to drainage and flood risk provided alongside the reserved matters application (ref: S/3290/19/RM) and

[1] Please refer to the evidence of Alex Bennett, submitted separately on behalf of Rule 6 Status Party
[2] Please refer to the commentary by Professor Roger Falconer and Dr Dongfang Liang, Appendix F

subsequent plan iterations and amendments. As a local resident I am also able to relay the significant emotional impact and stress which results from the uncertainty relating to potential flooding of existing properties, as a result of the proposed adjoining development.

Section 2 Executive Summary

3 A Reserved Matters application was submitted in September 2019 and then multiply amended (despite being out-of-time). Ultimately, this Reserved Matters application was rejected unanimously by the SCDC Planning Committee on 13th October 2021 on five grounds, one of which was a lack of information to assure the Planning Committee that flood risk could be mitigated.

4 There were 9 iterations of the surface water and drainage management plans prior to the 13th October 2021 Planning Committee, culminating in version P09 (April 2021), with one further amendment to the strategy in July 2021. Changes were made, either because guidance (e.g., the SUDS Manual[3]) was not met, or because it was acknowledged that proposed or existing (surrounding) properties were put at increased risk of flooding, in breach of the National Planning Policy Framework. Throughout this process various plans were produced using incorrect data pertaining to the geology of the site, inaccurate and incomplete ground water levels and inaccurate and incomplete topology of surrounding properties, with inadequate modelling of the flood risk to surrounding properties. Furthermore, where sufficient information was provided by the appellant for assessment, South Cambridgeshire Local Plan CC/9[4] was breached for proposed dwellings in all iterations up to and including version 9.

5 The most recent modelling by HR Wallingford, and the associated report from Cannon Consulting appears to have materially amended the scheme from what was assessed at the October 2021 Planning Committee meeting, both in terms of the levels and the gradients across the site and the removal of various basins. Furthermore, it appears that much of the

[3] The SuDS manual (2007)[Folder ref. Doc_53]
[4] South Cambridgeshire Local Plan (Adopted September 2018)[Folder ref. Doc_6_]

underlying data which has been input into the model has not been provided. Despite this, it can be ascertained from what is available that the errors which existed in the previous calculations and plans appear to have persisted (in particular with respect to geology, ground water levels, inaccurate and incomplete topology). Additionally, even on the basis of the flawed modelling, the scheme which has been arrived at appears to increase the flood risk to surrounding properties. It is highly dependent on culverts and the appellant has not addressed the potential for a suitable in-perpetuity management scheme for their maintenance, nor provided evidence of any modelling of the effects of these culverts becoming blocked.

6 It can be inferred from the substantial changes which have been made to the scheme modelled in the latest work by HR Wallingford and Cannon Consulting, that it has been accepted that the previous scheme(s) would not work. The same is true of this, the 10^{th} attempt to find a workable solution.

7 Material obtained via a Freedom of Information request indicated that the appellant was willing to move a predicted flood level on plans submitted without any scientific basis and uncovered a hand annotated image, indicating the appellant's plan to flow water off the site towards surrounding properties on Cow Lane, and in "The Pines" development.

8 An independent report providing commentary on the appellant's flood modelling supported the concerns of residents. The two internationally renowned expert authors concluded that "*in our* [the authors'] *professional opinion, the development will cause a marked increase in the risk of flooding to surrounding properties outside of, and adjacent to, the development site, such as 60 Cow Lane".* The authors provided a detailed critique of the HR Wallingford 2022 report and gave multiple different reasons why its conclusions are likely to be incorrect. Further, the independent experts advised that, due to problems inherent in the prevailing geology and geography, having reviewed the scale and layout of the proposed development, "*the development of this [Land East of Teversham Road] site will be extremely difficult*".

9 Residents are aware of the costly, distressing and traumatic effects of flooding to properties and a recent study indicates that features of post-traumatic stress disorder (PTSD) can persist after such an event. Their other fear is that their properties become uninhabitable, uninsurable and unsaleable, once they have been flooded by this proposed development.

Section 3 Background

10 S/3290/19/RM pertains to a proposed 110 house development on the lowest lying land in Fulbourn. The site stands immediately adjacent to a large spring fed pond, Poor Well, and the area is so wet, that the underlying aquifer used to supply all of Cambridge's water in the 19th Century. Less low-lying parts of Fulbourn in the Teversham Road area flood regularly (including Roberts Way, which is 50 metres from the site, figure A1, Appendix A) and, much of the year, there is standing water at the proposed development site, with marsh-type vegetation, including reeds (figures A2 - A8, Appendix A). The underlying soil appears to local residents to be thick, boggy clay and is shown on the British Geological Survey map to be impermeable West Melbury Marly chalk (figures C1 and C2, Appendix C)[5].

11 Outline Planning Permission (OPP) was turned down on the site in 2015 and that decision upheld by the Planning Inspector in 2016. OPP for a new application was granted by a thin majority in 2017, partly due to the lack of a 5-year housing land supply in the South Cambridgeshire District Council area (now ameliorated).

12 The water table is very close to the surface. Construction work was undertaken at 60 Cow Lane in early April 2018 (figures A9 – A10, Appendix A). When the foundations were being dug, at a point around 6-7 metres from the edge of the proposed development site, ground water level was no more than 40cm below ground level and active pumping was required for at least 4 hours, prior to the foundations being poured. Residents of properties along the southern development boundary are justifiably concerned that any additional drainage run-off southwards from the proposed development, or additional infiltration of water into the ground of the development, will place their properties at risk of flooding and their gardens

[5] Onshore Geoindex

of waterlogging. At present, due to the pre-development topology of the site, water runs north onto the development site from residents' properties and beyond[6].

13 This document summarises residents' concerns pertaining to flood risk, covering:

a. Photographic evidence of flooding on and adjacent to the proposed development site, and high ground water level adjacent to the southern boundary (Appendix A)

b. The chronology of submission of plans (Section 4, Appendix B)

c. Specific concerns about the surface water management and drainage plans (version 9) rejected by the Planning Committee in October 2021 (Section 5, Appendix C and Appendix D).

d. Specific concerns about the amended surface water management and drainage plans (version 10) submitted to the Appeal process in April 2022 (Section 6, Appendix E).

e. Commentary on flood modelling by Professor Roger Falconer and Dr Dongfang Liang (Appendix F)

f. Policy changes that will increase ground water level on this site (Section 7)

g. Psychological morbidity of flooding (Section 8, Appendix H)

[6] Review of surface water management (August 2020)[Folder ref. Doc_13]

Section 4 Chronology of submission of plans

Multiple versions of plans

14 The chronology of the application, with respect to the appellant's multiple amendments to try to mitigate flood risk to the development and, at times, to surrounding properties, is presented in detail in Appendix B.

15 The outline planning was granted on 26 October 2017. The submitted documents supporting the outline planning included a Flood risk and surface water management scheme which acknowledged risk to surrounding properties was a relevant consideration. It was stated that: "*By making space for water* [as part of the layout proposed] *the proposals avoid the potential displacement of run-on to the surrounding development"*[7].

16 The outline planning was accompanied by drainage and surface water condition (Condition 8) as follows: *"Condition 8: Prior to the commencement of the development a detailed surface water drainage scheme for the site, based on the agreed Flood Risk Assessment (FRA) CCE/B411/FRA-03 September 2014 by Cannon Consulting Engineers has been submitted to and approved in writing by the Local Planning Authority. Such a scheme shall include details of the long-term ownership/adoption of the surface water drainage system and maintenance of the same. The scheme shall be constructed, completed and properly retained /maintained thereafter in accordance with the approved plans and implementation programme agreed in writing with the Local Planning Authority. (Reason - To ensure a satisfactory method of surface water drainage and to prevent the increased risk of flooding*

[7] B411 Flood Risk and Surface Water Management Update (January 2017)[Folder ref. Doc_24]

in accordance with Policies DP/1 and NE/11 of the adopted Local Development Framework 2007"[8].

17 The Reserved Matters application was submitted in September 2019. This includes a 'Reserved Matters Planning statement" in which the appellant stated in paragraphs 5.48 – 5.49. Paragraph 5.48 states: "*The application is accompanied by a Surface Water Management Plan, which has been produced to discharge condition 8 of the outline application. This explains in more detail how the proposed drainage system will function. The system also informs the ecology and landscape strategy as it seeks to retain significant portions of the existing site and provides areas of storage across the site, which creates significant ecology and landscape opportunities as described."* Paragraph 5.48 states: "*The proposal therefore is compliant with policy CC/8 of the Local Plan."*

18 At the same time, the "Reserved Matters Planning statement" stated that (Appendix B) the appellant would submit a discharge of condition application with respect to *inter alia* Condition 8, Surface Water Management[9].

19 The basic design of the site consists of three raised development platforms, with water deliberately retained and stored, prior to gradual release, in the central 'Linear Park' area between two platforms, as well as along the southern boundary of the proposed development[10]. 5 bio-retention basins were proposed, as well as various crates beneath the proposed dwellings, with dwellings on platforms roughly 0.6-0.9 m above existing ground level[11].

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[8] Planning Permission subject to conditions S/0202/17/OL (26 October 2017)[Folder ref. Doc_3_]
[9] Reserved Matters Planning Statement (September 2019)[Folder ref. Doc_43]
[10] Reserved Matters Planning Statement (September 2019)[Folder ref. Doc_43]
[11] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]

20 The Reserved Matters application included documents showing the south-eastern development platform falling from south to north (Chris Blandford Associates' drawing (Landscape) Site Sections TRF-CBA-1-GF-M2-L-3000 Rev.P1[12]. Therefore, water falling onto the south-eastern development platform would be expected to drain predominantly towards the central 'Linear Park', rather than towards existing housing south of the development boundary.

21 During the period September 2019 to November 2020, correspondence between Lead Local Flood Authority (LLFA), Council Sustainable Drainage Engineers and the appellant was associated with submission of addition information on 3 December 2019 and an amendment on 27 February 2020 (See Appendix B). This amendment included updated documents related to site layout, which impacts surface water management / drainage (see Section 3.14 of March 2020 Planning Update Note)[13].

22 Sustainable Drainage Engineers repeatedly (see Appendix B) requested surface water modelling. They did so because of layout changes, stating that "*because of the changes to the layout, revised modelling is required*" (16 April 2020; DRAINAGE-5437198, p1 final paragraph[14]). They stress that "*the information requested is fundamental to the proposed strategy and is therefore required at this stage to ensure sustainable principles are fully examined and can be technically assessed at this point, prior to further design evolution. The landscaping will directly impact the drainage strategy and vice versa. Both aspects need to be considered jointly*"[15].

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[12] TRF-CBA-1-GF-M2-L-3000 Site Sections (August 2019)[Folder ref. Doc_28]
[13] Planning Update Note (March 2020) [Folder ref. Doc_5_]
[14] Sustainable drainage Engineer comments (16 April 2020)[Folder ref. Doc_48]
[15] Planning Consultation Response (14/6/2020)[Folder ref. Doc_27]

23 A flood modelling report was commissioned by the appellant from HR Wallingford. This was submitted on 17 August 2020[16],[17]. As shown in figures C3 and C4 (Appendix C)[18], this demonstrated clearly that there was a very significantly increased flood risk to surrounding properties, particularly 60 Cow Lane. However, such increased risk is not permitted under paragraphs 159 and 164 of the National Planning Policy Framework (NPPF)[19]. Please note that this requirement was in paragraph 103 of the previous version of the NPPF[20].

24 A second area of concern was around Finished Floor Levels (FFL). LLFA noted FFLs must be 30 cm above predicted flood levels on 20 March 2020[21]. The sustainable drainage engineer stressed this on 1 September 2020[22]. FFLs were provided on 22 September 2020[23].

25 These September 2020 plans[24] suggested that the slope of the south-eastern development platform had been altered relative to that previously described (see paragraphs 64 - 65, figures C5 – C8, appendix C). At this point the platforms were now highest near Linear Park. Therefore, water falling onto the south-eastern development platform would be expected to drain predominantly away from the central 'Linear Park', towards existing housing south of the development boundary[25]. While the intended direction of the slope is extremely unclear from the information provided, a Freedom of Information request uncovered a hand annotated diagram emailed by the appellant to the LLFA on 23 October

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[16] Review of surface water management (August 2020)[Folder ref. Doc_13]
[17] B411 Teversham Road Fulbourn Cambridgeshire Reserved Matters Application Layout (12 August 2020)[Folder ref. Doc_8_]
[18] Review of surface water management (August 2020)[Folder ref. Doc_13]
[19] National Planning Policy Framework (2021)[Folder ref. Doc_22]
[20] National Planning Policy Framework (2012)[Folder ref. Doc_44]
[21] LLFA response to consultation (FR/19-000431; S/3290/19/RM) (20 March 2020)[Folder ref. Doc_54]
[22] Sustainable drainage Engineer comments (1 September 2020)[Folder ref. Doc_49]
[23] B411-PL-SK-320 Flood Management Strategy[Folder ref. Doc_35]
[24] B411-PL-SK-320 Flood Management Strategy[Folder ref. Doc_35]
[25] B411-PL-SK-320 Flood Management Strategy[Folder ref. Doc_35]

2020 that indicated that the plan, at this point, was for water to flow south off the south-eastern development platform towards the southern boundary (figure D1, Appendix D).

Layout, landscaping and surface water management are inextricably linked

26 Landscape and layout are key determinants of water flows and water retention on site. This can be seen from the multiple interrelated changes to landscape/ layout and surface water management (section 3 and appendix B). As Adam Littler Sustainable Drainage Engineer for SCDC stated on 14 June 2020: *"The landscaping will directly impact the drainage strategy and vice versa. Both aspects need to be considered jointly*"[26].

Postponement from January 2021 Planning Committee meeting (P06)

27 By 18/11/2020, layout/ surface water management plans had reached version P06[27]. This version of the plans was submitted to the Planning Committee for consideration in January 2021. Following receipt the day before the January 2021 Planning Committee meeting of a brief document considering SCDC's legal risk in the event of the development flooding surrounding properties and Mr Eliot Kingsley's draft High Court challenge papers, SCDC deferred consideration of the Reserved Matters Application from the January 2021 Planning Committee meeting. In the January 2021 Planning Committee meeting, it was made very clear that no further amendments by the appellant were to be permitted[28]. The appellant then modified layout further in April and July 2021, adding and then amending the Cow Lane Flood basin[29],[30].

[26] Planning Consultation Response (14/6/2020)[Folder ref. Doc_27]
[27] B411-PL-SK-320 Flood Management Strategy[Folder ref. Doc_35]
[28] Recording of 13 January 2021 Planning Meeting[Folder ref. Rec_55]
[29] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]
[30] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]

28 Residents believe that adding or removing a 300m^2 lake, termed the Cow Lane Flood basin, in this location, is a change in layout and may not be in accordance with the OPP use of that part of the development site. Two separate iterations of this layout change were produced. Version P09 was accompanied by two different versions of an additional document, describing the Cow Lane Flood Basin (P02 produced on 14 April 2021[31]) with an amended version being produced in July 2021 featuring a *"filter drain allowing post flood seepage emptying 100mm x 200mm wrapped stone trench beneath landscaping"* from the Cow Lane Flood Basin[32], also labelled P02 and still dated 14 April 2021.

29 On 29 September 2021, the LLFA replied to residents' queries, clarifying their position. They confirmed that modelling of the impact of the new flood basin had not been carried out and acknowledged that there were uncertainties about ground water levels[33].

Rejection at October 2021 Planning Committee meeting

30 The layout and surface water management plans version P09 were discussed at the October 2021 Planning Committee meeting, at which the Reserved Matters Application was rejected.

Appellant gains permission to submit further information regarding surface water management plans version P09

31 Castlefield International gave notice of their intention to appeal the rejection decision on 24 January 2022. In paragraph 5.13 of their Appeal Statement[34], the appellant states that:

[31] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]
[32] B411-Pl-SK-321_Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[33] LLFA response to resident of 60 Cow Lane (29 September 2021) [FR/19-000431][Folder ref. Doc_29]
[34] Pre-Inquiry Statement of Case (January 2022)[Folder ref. Doc_9_]

"*Additional modelling work will be undertaken to provide precise levels details and to demonstrate that the scheme presented in the Reserved Matters application will not result in any increase in flood risk on or around the site.*"

32 On 29 March 2022, During the Case Management Conference[35] on 29th March 2022, the following was required by the Planning Inspector of the appellant: "*It was agreed that a deadline of 12 noon on 4 April be allowed in respect of the appellant's submission of additional surface water drainage modelling information (and including all underlying data).*

Appellant submits modelling results for a surface water management scheme substantially different from version P09

33 On 4 April 2022, rather than submitting additional information related to flood management strategy P09 (as rejected by South Cambridgeshire District Council (SCDC)), a substantially amended flood management strategy (effectively version 10, 31/03/2022) was submitted specifically for the Planning Appeal[36]. This new flood management strategy required amendments to layout and landscaping compared with previous versions of this Reserved Matters Application. No application to make such amendments was submitted by the appellant.

34 The appellant's covering letter accompanying the version 10 plans[37] comments as follows: "*The modelling report is submitted separately with the topographical site survey, post development ground level plan, and platform outlines used within the modelling all being*

[35] Case management conference Summary Note (APP/W0530/W/22/3291523)[Folder ref. Doc_26]
[36] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[37] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

appended to this note. Together, these are considered to constitute the underlying data since the modelling report explains the modelling undertaken in detail (including the model parameters), as supported by the appended information.

35 The appellant's submission is not conformant with the Planning Inspector's requirement to "*include all underlying data"* [38] because critical data items referred to in the modelling report[39] (discussed in paragraphs 80 – 84 of this proof) are not included.

[38] Case management conference Summary Note (APP/W0530/W/22/3291523)[Folder ref. Doc_26]
[39] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

Section 5 Concerns about surface water and drainage plans (P09), considered at October 2021 Planning Committee meeting

36 There have been very many versions of the plans relating to flood mitigation. This proof will, firstly, focus on those considered at the October 2021 Planning Committee meeting and, secondly, focus on the new flood mitigation scheme provided by the appellant on 4th April 2022, specifically for the appeal process.

37 Matters to be considered in section 5 of this proof are:

a. Flood risk to surrounding properties as demonstrated by the appellant's own plans, as considered by the October 2021 Planning Committee meeting

b. Commentary by experts Professor Roger Falconer and Dr Dongfang Liang on flood risk modelling in plans from October 2021 and the new plans to be considered by the April 2022 appeal process

c. The fact that modelling has used assumptions inappropriate for the geology

d. The fact that modelling has used incorrect/ incomplete ground water data

e. The fact that modelling has used incorrect/ incomplete/ inadequate resolution topology

f. A lack of information and modelling regarding the Cow Lane Flood Basin

g. A lack of modelling of the impact of culvert blockage on the scheme

h. A lack of modelling of the effect of very heavy persistent rain in winter

i. Lack of disclosure of modelling assumptions and methodology

j. Failure to place proposed dwellings 300 mm above predicted flood levels, contravening South Cambridgeshire Local Plan, CC/9

Even with flawed modelling input data, flooding of surrounding properties is predicted

38 The appellant provided version P09 of their flood management strategy, with 100 year plus climate change flood levels (pink numbers) along the southern boundary[40]. Adjacent to the western Cow Lane properties, these flood levels are 10.17m and 10.32m. In their Cow Lane Flood Basin document, they provided the ground heights along that boundary, as being 9.75m and 10.24m, respectively. I have aligned the relevant parts of these two plans in (figure C9, Appendix C). Simple arithmetic, using the appellant's data, shows that flood levels are substantially (8 – 42 cm) above the level of the land at this part of the southern boundary (figures C9 and C10, Appendix C), indicating predictable flooding of some of the properties along Cow Lane[41] [42]. It is presumably for this reason that the appellant has not provided modelling from HR Wallingford of this version of the plans (paragraph 78).

39 In particular, as the proposed Cow Lane Flood Basin, which extends along much of the southern boundary with the development (figures C10, Appendix C), has a top level of 9.90m, flood water at 10.17m (1 in 100 year plus climate change)[43] seems likely to overtop and to flow across the southern boundary into adjacent Cow Lane properties, since the appellant is clear that *"there are no plans to increase ground levels along the south-eastern boundary of the site to prevent floodwater from spilling onto the site from the properties on Cow Lane"*[44].

[40] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[41] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[42] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[43] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[44] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]

40 This indicates that surrounding properties would be at an increased risk of flooding due to the proposed development, in contravention of the paragraphs 159 and 164 of the National Planning Policy Framework[45].

Impact of inconsistencies on flood risk assessment

41 There are multiple flaws in the flooding input data and modelling, which are explained in the remainder of section 5 of this proof. Each of these is likely to underestimate, rather than overestimate, flood risk, indicating that the real extent of flooding, particularly to surrounding properties along the southern boundary, as a consequence of the development, might be significantly worse than that shown. However, even using the appellant's output data, as submitted on 4th April 2022, flood water is still predicted to cross the southern boundary of the development (figure C9, Appendix C). There is also concern about an email uncovered via a Freedom of Information request, in which the appellant was willing to move a predicted flood level on submitted plans without any scientific basis (figure D2, Appendix D).

Commentary on flood modelling by Professor Roger Falconer and Dr Dongfang Liang

42 Due to residents' concerns about modelling of the flood mitigation scheme, a report was commissioned from recognised flood modelling experts Professor Roger Falconer (RAF) and Dr Dongfang Liang (DL) and this is included in appendix F. The key points from this report are discussed as in paragraphs 43 to 46.

43 DL and RAF inspected the site on 7 March 2022 and commented that the "*terrain was flat and demonstrated the characteristics of a floodplain"*, and that *"the development site was shown to act as a natural floodwater retention ground".* Therefore, building on this site

[45] National Planning Policy Framework (2021)[Folder ref. Doc_22]

presents potential risks to surrounding properties for which the fields are currently acting as a natural sustainable drainage solution [DL/RAF section 2.4, Appendix F].

44 The development scheme involves elevation of new builds. DL and RAF comment that this approach has inherent risks, in that it will "*inevitably reduce space for water and thus reduce infiltration to the ground below and evaporation. It also has the potential to adversely affect the free passage of water through the site northwards, stopping rainwater falling outside the site from flowing to the site"*. In view of this, they note that *"it is extremely likely that raising the floor levels on the site to reduce the risk of flooding to properties on the site will be accompanied by an increase in the flood risk to properties outside of the site, such as the Cow Lane houses"* [DL/RAF section 3.1.3, Appendix F].

45 The appellant has commissioned HR Wallingford to conduct flood modelling on a new surface layout. This report purports to show that the "*layout presented with the appeal scheme can be developed without increasing off-site flood risk to properties"*. DL and RAF comment that "*we are deeply concerned with the above conclusion drawn from the 2022 report, as it violates the basic physical principles*". [DL/RAF section 3.2.10, Appendix F] In particular, DL and RAF present multiple different reasons why the conclusions of the HR Wallingford 2022 report are likely to be incorrect. In brief, these are:

a. The 'summer storm' scenario modelled does not reflect the real-world rainfall events likely to be encountered, such as those which flooded multiple villages in Eastern England in 23/24 December 2020. Because these real world scenarios feature prolonged storms, and the drain down time for the on-site storage is very long, DL and RAF note "*it is extremely disappointing that no consideration was given in the Cannon reports* [accompanying

Discharge Conditions application in 2019] *to address these unsatisfactory designs*" [DL/RAF section 3.3.3, Appendix F].

b. They "*doubt the efficacy of these excavated storage facilities in mitigating flood risk".* This is true of the "*April 2022 plans, where drainage culverts are not provided for the southern excavated area. If the storage facilities are always filled with groundwater seeped out of their banks, then they will have little – if any – effect on reducing flood risk"* [DL/RAF section 3.3.7, Appendix F].

c. They *"suspect that the HR Wallingford reports have adopted the incorrect assumption of the ground permeability and thus significantly underestimated .. the surface water flood risk"*. Their grounds for thinking this are (i) even under the dry weather conditions present during a site visit the site was partially waterlogged, and (ii) the presence of Melbury Marly Chalk, which has a high clay content and is relatively impermeable, as shown in British Geological survey data. Taken together these are incompatible with the soil at the development site being *"very permeable"* in the HR Wallingford 2022 report[46] [DL/RAF section 3.2.4, Appendix F].

d. There is a lack of detail as to methodology, and input data [DL/RAF section 3.2, 3.1, respectively, Appendix F].

e. There are concerns that the surface profiles modelled are incorrect [DL/RAF section 3.1.2, Appendix F].

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46 Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

f. There is concern that the output data shown is incompatible with the flat nature of the site: they write that it is "*worrying that the HR Wallingford modelling study in 2022 shows significant anomalies in predicting the post-development flood depth distributions. The flood depth should vary gradually, unless there are significant variations of the ground elevations"* [DL/RAF section 3.1.4, Appendix F].

g. Regarding the output data, they state that there is uncertainty about the depths shown outside the development site. They comment that "*the flood extents and depths outside the site are shown to be exactly the same in the pre- and post-development conditions, which is illogical. We suspect these figures [Figure 4.5-4.8] do not show the correct flood extents and depths outside the site"* [DL/RAF section 3.2.11, Appendix F]

h. Significant data is missing, including flow velocity information [DL/RAF section 3.2.16, Appendix F].

46 They conclude: *"We believe that these flaws* [as above, and outlined in their report] *make it misleading to claim that the proposed site development would not increase off-site flood risk to properties south of the site. In our professional opinion, the development will cause a marked increase in the risk of flooding to surrounding properties outside of, and adjacent to, the development site, such as 60 Cow Lane. More accurate knowledge on the ground permeability and groundwater level variations and more reliable hydrodynamic simulations would be needed to determine the degree of increased flood risk to the Cow Lane properties.". Further, they* comment that, due to problems inherent in the prevailing *geology and geography, and given the scale and layout of the proposed development, "the* *development of this [Land East of Teversham Road] site will be extremely difficult"* [DL/RAF section 4.2, Appendix F].

Flaws in input data and modelling

47 Residents raised the following concerns (discussed in further detail below)

a. The geology assumed by HR Wallingford is incorrect as the site is impermeable West Melbury Marly Chalk, not highly permeable "free draining" chalk.

b. Bore hole readings are missing from the highest reading bore hole.

c. Bore hole data is included only for the driest months of the year (February to July).

d. Readings taken by residents at bore holes are much higher than those submitted by the appellant.

e. No accurate topological data for surrounding properties is included.

f. Inconsistent heights of land at southern boundary are shown on different plans.

g. The appellant's topological plan gives roof heights of surrounding properties, but does not label them as such.

h. Some plans contain a mix of current and proposed ground levels.

i. There is conflict between contemporaneous plans and site sections regarding the slope of the south-eastern development platform.

j. The Cow Lane Flood Basin cannot function as an infiltration basin (April 2021 version) due to high ground water level.

k. Inadequate information is provided about the angle of the Cow Lane Flood Basin culvert (added July 2021).

l. Effect of Cow Lane Flood Basin culvert (July 2021) on potential retrograde Chalk Stream flow into the Poor Well Water conservation has not been modelled.

m. No modelling of the impact of the Cow Lane Flood basin on flooding of properties at the southern boundary.

n. There is no modelling of the effects of blockage of the 5 x 150 mm pipes and other culverts, including Cow Lane Flood Basin culvert.

o. Very heavy persistent rain in winter has not been modelled.

p. Modelling assumptions and methodology are undisclosed.

q. Remodelling with ground water at 40cm, rather than 60cm, has never been provided.

r. Failure to place proposed dwellings 300 mm above predicted flood levels.

s. Failure to place proposed dwellings 300 mm above road levels.

The underlying geology is not free draining chalk

48 A key assumption in Cannon's modelling and the HR Wallingford models concerns the nature of the rock under the development. This is important because it impacts the rate at which water will permeate the ground from the surface. We have been made aware by

Cambridgeshire Geological Society that the site does not lie on free draining chalk, as assumed by both Cannon[47] and HR Wallingford[48] [49], thus invalidating all of their modelling, because there will be more surface run-off and less absorption than the models have predicted. The correct geology is shown in figures C1 and C2 (Appendix C), together with a letter from Cambridgeshire Geological Society.

49 This inaccuracies about geology were pointed out by Christine Donnelly and Dr Reg Nicholls (chair) of Cambridgeshire Geological Society to Fulbourn Forum, on 14 April 2022 by email, in the following terms: *"…we wanted to point out that the statement about the geology in the attached report (page 5 under background to the catchment) is misleading as it states that the 'underlying geology is free draining chalk'. This is not true."*

50 *"Although the underlying geology is part of the Chalk Formation, it cannot be described as free-draining. It is the lowest of the Chalk strata, the West Melbury Marly Chalk, which has a high clay content and is relatively impermeable, particularly in some areas. It underlies much of the fen edge in this area and its lack of 'free draining' quality results in many patches of wet 'fen' - as see e.g., Teversham Fen and Fulbourn Fen to the north. Further proof of its relative impermeability is the line of springs to the south, along the outcrop of the Totternhoe Stone - a harder band of Chalk that is fissured and, therefore, allows free drainage of water through it. At its base, where it overlies the West Melbury Marly Chalk, numerous springs occur due to the water not being able to penetrate the underlying the clay-rich Chalk."*

[47] B411 Flood Risk and Surface Water Management Update (January 2017)[Folder ref. Doc_24]
[48] Review of surface water management (August 2020)[Folder ref. Doc_13]
[49] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

51 *"The proposed development is very near to the spring line- in fact it looks like one of the springs (at Poor's Well) is actually part of the development. This spring site is of considerable geomorphological and geological interest (as are other chalk springs along the fen edge) and may well qualify as a Local Geological Site. We are currently looking at such sites to propose their designation as they are key features in the landscape heritage of Cambridgeshire. There seems to be no mention of this spring line in the report and, therefore, no reference to the significant source of flowing water, adjacent, if not actually within the site."*

52 A second email from them 15 April 2022 stated: *"The main take home message is that the report from Wallingford has made an erroneous assumption that the rock is permeable chalk. It appears to be impermeable Lower chalk which has many clay layers - thus drainage would be problematic."* A formal letter detailing this geological information is included in appendix C (figures C1 and C2). The fact that the site is relatively impermeable to water concurs entirely with the observations of local residents that the site is frequently waterlogged with standing water (figures A2 - A8, Appendix A).

53 It is of note that during the extension of the nearby Cambridge Biomedical Campus, a flood modelling drainage strategy report by Peter Brett Associates states: *"As the underlying Marly Chalk Formation is less permeable, rainwater percolates through the upper Chalk deposits before flowing through the Totternhoe Stone and emerging as a spring" in paragraph 2.2.1 of "Evidence regarding land south of the Cambridge Biomedical Campus | Flood modelling and drainage strategy report"*[50]. It goes on to state, in paragraph 4.1.1. *"Initial geotechnical desk study assessment … indicates that the Nine Wells spring line is located to the south of the site where the 'Totterhole Stone Member' and 'Zig Zag Chalk'*

[50] Evidence regarding land south of the Cambridge Biomedical Campus | Flood modelling and drainage strategy report [Folder ref. Doc_39]

meets the less permeable 'West Melbury Marly Chalk'…". Paragraph 4.1.2 states: *"Initial soakaway testing indicates a low rate of infiltration to groundwater. Reliance on infiltration measures alone will not be possible"*, while paragraph 4.1.3 states "*Although the potential infiltration is low…*". Thus this report "Evidence regarding land south of the Cambridge Biomedical Campus | Flood modelling and drainage strategy report"[51] indicates that any assumption that the proposed development site lies on '*free draining chalk'* is completely unwarranted. This appears to completely invalidate the modelling undertaken by Cannon at OPP stage and HR Wallingford at OPP stage and in August 2020 and April 2022, which will have assumed more rapid infiltration of water than is possible.

54 In the OPP document, Cannon states correctly that the site is on West Melbury Marly chalk[52], but on page 68 of this pdf document, in the HR Wallingford report, it is stated to be free draining chalk. Permeability indices for free draining chalk are around 5m/day (=5.79x10^{-5} metres per second), while for clay, they are between 5 x 10^{-5} and 5 x 10^{-3} metres per day (= 5.79 x 10^{-8} metres per second, at fastest)[53], which indicates that water would permeate and drain away through clay 1000 to 100,000 times more slowly than through free draining chalk. The OPP document[54] produced by Cannon uses a permeability coefficient (permeability index) of 0.000010 metres per second (= 1 x 10^{-5} metres per second) when considering bioretention ponds. This indicates that all the calculations were done assuming the site was on free draining chalk, rather than West Melbury Marly chalk, which contains

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[51] Evidence regarding land south of the Cambridge Biomedical Campus | Flood modelling and drainage strategy report [Folder ref. Doc_39]
[52] B411 Flood Risk and Surface Water Management Update (January 2017)[Folder ref. Doc_24]
[53] British Geological Survey. Guide To Permeability Indices. (2006; CR/06/160N)[Folder ref. Doc_47]
[54] B411 Flood Risk and Surface Water Management Update (January 2017)[Folder ref. Doc_24]

multiple layers of clay. This fact appears to invalidate the modelling undertaken by both HR Wallingford and Cannon at all stages of the application[55] [56] [57].

Ground water levels used in modelling are inaccurate and incomplete

55 A critical set of values in the models is based on ground water assessments from boreholes. Three boreholes were studied 6 - 7 years ago (page 36 of B411 Surface water management (12 September 2019))[58] (figure C11, Appendix C). Given the concern about flood risk on the site, one would expect more up-to-date readings, for which there has been ample opportunity, since the Reserved Matter application was not submitted until September 2019.

56 Two years' monitoring was undertaken, but the highest reading borehole (WS6) was only studied for the drier of the two years (2015)[59], because it apparently could not be found in 2016. We find it hard to understand how the bore hole could suddenly not be found. It is difficult to believe that the company tasked with taking the readings did not dig a new one. We dug a bore hole in our own garden, as a response to these plans, to monitor ground water levels and this took under 30 minutes without any power tools.

Residents' measurements of bore hole data

57 To verify the appellant's bore hole data, residents (Dr Elizabeth Soilleux and Dr David Wyllie) took bore hole readings on a number of occasions (data in figure C11, photograph of reading being taken on 01.06.2021in figure C12, Appendix C). On 01.06.21, ground water in bore hole WS1a was 0.43 m below the surface, while on 04.06.21, it was 0.45 m

[55] B411 Flood Risk and Surface Water Management Update (January 2017)[Folder ref. Doc_24]
[56] Review of surface water management (August 2020)[Folder ref. Doc_13]
[57] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]
[58] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]
[59] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]

below the surface (measurement by Dr Elizabeth Soilleux and Dr David Wyllie, corroborated by Mr Robert Culshaw), contrasting with appellant's reading for June (05/06/2015) of 0.88 m[60], indicating that residents' readings are up to 0.45 m nearer to the surface. Similarly, on 07.03.22, residents measured the ground water level in bore hole WS1a as 0.45 m below the surface, contrasting with appellant's reading for March (23/03/2016) of 0.98 m[61], indicating that residents' readings are up to 0.53 m nearer to the surface. On 12.04.22, a resident (Mr Eliot Kingsley) measured the ground water level in bore hole WS1a as 0.65 m below the surface, contrasting with appellant's reading for April (28/04/2016) of 0.79 m[62], indicating that this reading is 0.14 m nearer to the surface (figure C11, Appendix C).

58 Residents understand that the ground water depth is critical for modelling and that a level of 0.6m was assumed in the flood risk assessment[63]. If it is inaccurate, the predictions of the model will seriously underestimate the flood risk, because the ground water level will have been assumed to be lower than it really is. The highest reading bore hole gave a single reading above 0.6m, which was 0.59m (figure C11, Appendix C)[64] before it went missing. Residents believe that a figure of 0.6m should not have been used, as the precautionary principle certainly has not been applied and has suggested that modelling should have been repeated with a ground water level of 0.4m should have been used, based on their readings (figure C11, Appendix C).

[60] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]
[61] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]
[62] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]
[63] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]
[64] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]

Non-representative bore hole data

59 Use of non-representative data from February to July, a selection which represents the 6 months with the lowest rainfall of any possible 6 month stretch (as demonstrated in figure C13, Appendix C), has the potential to mis-assess current groundwater levels and cause the modelling to underestimate flood risk. Finally, alterations in climate, particularly increasing rainfall patterns, often with short periods of very heavy rain, are now being seen (figure C14, Appendix C). This indicates that historical water table estimates, e.g., these readings from 6-7 years ago[65] may seriously underestimate current and future winter ground water levels.

60 As residents measured ground water levels as slightly more than 40cm (0.4m) below surface level (figure C11, Appendix C), it would be appropriate, according to the precautionary principle, to repeat flood modelling using a level of 0.4m, rather than 0.6m, so that there has been proper assessment of flood risk to surrounding properties. This has not been performed.

Inaccurate topology: Surface profiles accompanying modelling include roof heights

61 More detailed topological information was provided, as part of requested additional flood modelling data (figure C10, Appendix C)[66], but no accurate topological data for surrounding properties was included as part of the data. The only levels outside the development boundary provided were what residents presume are the roof heights of houses, in excess of 17 m, while ground levels are around 10m (figures C10 and C15, Appendix C). The appellant did not differentiate roof heights of houses from ground levels (compare figures C10 and C15, Appendix C). Residents still believe that the topology being used is inaccurate

[65] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]
[66] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]

and remain concerned that roof heights might have been inadvertently used in the modelling, rather than ground levels.

Inaccurate topology: Inconsistency in boundary land heights and profiles in appellant documents

62 There are also inconsistencies in land level at the boundary on the submitted plans between different documents. The topological data submitted by the appellant in Fulbourn General Topological Plan Additional Information[67] (green arrow in figure C16, Appendix C) indicates a boundary land level with 60 Cow Lane of just below 10.2m, while other documents submitted by the appellant[68] [69] show the level to be 9.89m, which concurs with a recent survey commissioned by residents in response to these inconsistencies (figure C17, Appendix C). The LLFA and planning officer involved in this case were concerned by these inconsistencies, as shown in email correspondence obtained via a Freedom of Information request (figure D3, Appendix D). Key points demonstrated by the recent topological survey are that the appellant's ground height readings at the boundary are correct in the Cow Lane Flood Basin plan[70] (figure C10, appendix C), but not in the topology plan[71] (figure C16, appendix C). These ground levels at the boundary and those measured in the garden indicate that many parts of the garden of 60 Cow Lane are below the predicted 1 in 100 +40% flood level of 10.17m in version P09 of the surface water management plans and that parts are also below 9.97m, the predicted 1 in 100 +40% flood level in the April 2022 surface water management plans submitted to the Appeal process. This indicates (even on the appellant's

[67] Fulbourn General Topological Plan Additional Information (from file title; no date provided)[Folder ref. Doc_41]
[68] TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 April 2021)[Folder ref. Doc_4_]
[69] B411-Pl-SK-321_Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[70] B411-Pl-SK-321_Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[71] Fulbourn General Topological Plan Additional Information (from file title; no date provided)[Folder ref. Doc_41]

own flawed modelling which underestimates flood risk) that surrounding properties would be at an increased risk of flooding due to the proposed development, in contravention of the paragraphs 159 and 164 of the National Planning Policy Framework[72].

Inaccurate topology: Misleading superimposition of pre-development levels on post-development profile

63 The inappropriate mixing of current and proposed heights on plans is confusing. For example, the revised surface water and drainage management plan, showing the new Cow Lane Flood Basin[73] is misleading, in that pre-development land heights are shown across the development platforms, while post-development levels are given just in the immediate area around the new Cow Lane Flood Basin (figure C10, Appendix C). While this probably did not affect flood risk modelling, the fact that the ground levels marked on the area of the proposed development appear lower than those of the adjacent Cow Lane properties at the southern boundary may have led the LLFA to conclude erroneously that there was no risk of increased flooding to surrounding properties[74]. This is because they might have assumed that any flood water would drain from Cow Lane properties towards the proposed development site, rather than the opposite way round, as would be seen to be the case if correct post-development levels were marked on the plan.

Inaccurate topology: Inconsistency between ground levels on site sections and other plans

64 When finished floor levels of proposed dwellings were provided in April 2021, a further concern came to light. The cross-sections of the site (known as Site Sections), showed the

[72] National Planning Policy Framework (2021)[Folder ref. Doc_22]
[73] B411-Pl-SK-321_Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[74] LLFA response to resident of 60 Cow Lane (29 September 2021) [FR/19-000431][Folder ref. Doc_29]

south-eastern development platform to tilt from south to north in all iterations up to P04 (April 2021) (figures C5 and C6, Appendix C)[75] [76]. However, the site plan with finished floor levels (also from April 2021)[77] indicated that the development was now intended to slope north to south (figures C7 and C8, Appendix C), i.e., towards the Cow Lane houses, potentially increasing water flows towards them. However, the site plan and contemporaneous site section, both from the April 2021 amendment, conflict with each other (figures C7 and C8, Appendix C)[78] [79], regarding the direction of the slope, which raises the questions about which topology was used in the flood modelling. While the intended direction of the slope is extremely unclear from the information provided, a Freedom of Information request uncovered a hand annotated diagram emailed by the appellant to the LLFA on 23 October 2020 that indicated that the plan, at this point, was for water to flow south off the south-eastern development platform towards the southern boundary (Figure D1, Appendix D). This suggests that the site plan[80] shows the intended direction of slope and the conflicting site section[81] is incorrect.

65 Being unable to provide clarity on something as significant to flood risk as this is totally unacceptable, as this determines whether water from the south-eastern development platform runs off mainly towards the Cow Lane properties at the southern boundary or mainly towards Linear Park in the centre of the development. This most likely indicates that

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[75] TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 November 2020)[Folder ref. Doc_2_]
[76] TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 April 2021)[Folder ref. Doc_4_]
[77] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[78] TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 April 2021)[Folder ref. Doc_4_]
[79] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[80] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[81] TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 April 2021)[Folder ref. Doc_4_]

the August 2020 flood modelling by HR Wallingford was done with a slope causing water to flow towards Linear Park, while the April 2021 version intends water to flow the opposite way towards the southern boundary. If this is the case, modelling results from the August 2020 flood modelling by HR Wallingford are no longer relevant and the flood risk to surrounding properties in the April 2021 version of the plans is therefore substantially higher than that previous estimate.

Infiltration basins are proposed but not permitted

66 A key problem identified by the LLFA[82] was that the Cow Lane Flood Basin (which first appeared as an amendment to the plans in April 2021[83] [84], which was badged as an infiltration basin. Drainage by infiltration is not permitted unless the ground water level is at least 1 metre below the base of the infiltration basin, as per table 13.1, page 13-5 in the SuDS Manual[85]. The ground water level measured by residents ranged between 43 and 65cm (0.43 and 0.65 m) below ground level and the appellant's measurements were less than 100cm (1 m) (figure C11, Appendix C). In fact, ground water levels are so near the surface that the bottom of Cow Lane Flood Basin might be below ground water level, at least some of the time, limiting its utility, by decreasing its capacity available to accept surface water.

67 Consequently, in the final version of the plans to be put before the October 2021 Planning Committee meeting, the appellant, in July 2021 changed the Cow Lane Flood Basin, from

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[82] Comments from LLFA (5 July 2021)[Folder ref. Doc_20]
[83] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]
[84] TRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)[Folder ref. Doc_46]
[85] The SuDS manual (2007)[Folder ref. Doc_53]

an infiltration basin[86] to an attenuation basin, by adding a culvert to drain water into the adjacent Chalk Stream, without changing the date or version number of the plans[87]. The addition of the Cow Lane Flood Basin and its subsequent modification from an infiltration to attenuation to basin was presumably still considered to be part of version P09 of the surface water management plans[88], although these were not updated and the Cow Lane Flood Basin appeared on separate plans.

Insufficient information about Cow Lane Flood Basin culvert

68 The angle of this culvert was not provided and there was no modelling to prove that there would be neither (a) retrograde flow up the Chalk Stream from the culvert outflow, delivering development run-off water into the Poor Well Water conservation area, nor (b) an excessive flow along the Chalk Stream and off the development site at a rate exceeding the maximum permitted greenfield discharge rate from the site of 0.3 l/s/ha (litres per second per hectare)[89].

No modelling of the impact of the Cow Lane Flood basin on flooding of properties at the southern boundary

69 Another question concerning owners of surrounding properties was whether the Cow Lane Flood Basin might actually increase their flood risk even further, by collecting flood water near the boundary and then potentially overflowing straight into the gardens of Cow Lane properties and also into the Poor Well Water conservation area, causing both flooding and

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[86] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]
[87] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[88] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]

[89] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]

contamination with development run-off water. In addition, the effect of blockage of the Cow Lane culvert should have been modelled.

No modelling of the impact of culvert blockage on the scheme

70 The effect of blockage of culverts and other watercourses has not been modelled. The system has been considered by the Sustainable Drainage Engineer to be at high risk of blockage[90], depending on (amongst other things) 5 x 150 mm diameter pipes[91] to mitigate flood risk. The system is agreed to require multiple filters and a regular maintenance schedule to keep it patent[92]. To this system, a stone trench (culvert) from Cow Lane Flood Basin[93] was added in July 2021 (figure C10, Appendix C). In view of this, one would expect to see modelling results indicating the effects of pipe/ culvert blockage, but no such analysis has been forthcoming, despite requests from residents. Filters in pipes do little to reassure, in the absence of any proper in-perpetuity maintenance strategy

71 The appellant stated in a document submitted in 2019[94]: *"Currently maintenance of the surface water management will be undertaken by a private management company (details of which will be determined at the appropriate later stages)."* Given the complexity of the surface water drainage system, residents feel that this presents an unacceptable risk. To date, the appellant has not demonstrated that there is any way of properly managing what appears to be a very complex drainage system.

[90] Planning Consultation Response | Sustainable Drainage Engineer (14 December 2019)[Folder ref. Doc_23]
[91] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]
[92] B411 Teversham Road Fulbourn Cambridgeshire Surface water management (27 February 2020)[Folder ref. Doc_15]
[93] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[94] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]

72 St Ives in Cambridgeshire has various housing developments that rely on culverts. During severe weather with heavy rainfall on 24th – 30th December 2020, there was rapid and severe flooding, with a combination of surface water and sewage, of 96 properties, 32 of them internally. This was due, at least in part, to blockage of poorly maintained culverts, as detailed in appendix 4 and the Cambridgeshire County Council report on the floods[95]. This shows the risk of a scheme dependent on culverts and watercourses and the importance of a properly funded and appropriately drawn up management strategy for maintenance of any flood mitigation scheme. Condition 8 of the outline planning permission[96] mandates this and has not been satisfied. In particular, there is no detail of how any scheme will be monitored, managed and funded in perpetuity. For flood management, when such incredibly complex mitigation is proposed (particularly culverts that can readily become blocked), this is irresponsible.

Effect of very heavy persistent rain in winter has not been modelled

73 The half drain-down time for this development is long – in previous versions of the plans, it was stated that *"The drain down time is necessarily long because the greenfield rate is so low. We* [the appellant] *have increased the outflow slightly to reduce the half drain down to less than 7 days"* but the LLFA's required 24-hour half drain down was not achieved[97] [98].

74 In previous versions of the plans it was stated that modifications were made so that the scheme is *"able to accommodate a six hour duration 1 in 10 storm (7 mm/hr or 42 mm*

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95 Flood Investigation Report | St Ives | December 2020[Folder ref. Doc_52]
96 Planning Permission subject to conditions S/0202/17/OL (26 October 2017)[Folder ref. Doc_3_]
97 B411 Surface water Management (3 December 2019)[Folder ref. Doc_36]
98 LLFA response to consultation (FR/19-000431; S/3290/19/RM)[Folder ref. Doc_31]

total) within 24 hours of the end of the 7 day 1 in 100 storm plus 40 % climate change"[99]. Dealing with this occurrence was considered necessary in previous versions but has not been repeated, and without detailed and transparent modelling undertaken with relevant assumptions (such as ground water levels and ground permeability), scheme viability remains uncertain.

75 Proper assessment of the impact of serial storms cannot be an optional extra. It accompanies many serious flooding events, such those occurring in 10 East Anglian towns and villages on 23rd – 24th December 2020, when widespread flooding following a storm falling onto landmass which had already experienced sustained rainfall, as detailed in the Cambridgeshire County Council report on the flooding in St Ives (Appendix G)[100]. There is no modelling to indicate that the proposed surface water and drainage management scheme could mitigate flooding under these circumstances.

Modelling assumptions and methodology are undisclosed.

76 Our multiple concerns about inappropriate and incomplete input data and inappropriate assumptions, which would underestimate flood risk, are detailed throughout section 5. Despite this, a number of properties are clearly at increased flood risk. It is well known in the data analysis/ modelling world that inaccurate input data will lead to inaccurate output data (results). Inaccurate assumptions and the use of the wrong type of model will have similar effects. The appellant declines to provide us with all underlying data (as required by HM Planning Inspector), so we cannot attempt to check or reproduce their analyses.

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[99] B411 Teversham Road Fulbourn Cambridgeshire Surface water management (27 February 2020)[Folder ref. Doc_15]
[100] Flood Investigation Report | St Ives | December 2020[Folder ref. Doc_52]

Failure to place proposed dwellings 300 mm above predicted flood levels

77 Version P09 of the surface water management plans[101] showed post-development land heights across the development, together with predicted 1 in 100 year plus climate change and 1 in 1000 year flood levels and road heights (figure C18, Appendix C). While finished floor levels should be 300 mm above the levels of the roads "where appropriate and practicable" (and surely that requirement must be appropriate here, given the potential flood risk to proposed dwellings), at least 16 proposed dwellings failed that. Furthermore, finished floor levels should "where appropriate" (and again surely that requirement must be appropriate here, given the potential flood risk to proposed dwellings) be 300 mm above predicted 1 in 100 year plus climate change flood levels and at least 8 proposed dwellings fail that. Thus, the plans were not compliant with South Cambridgeshire Local Plan CC/9[102], as recognised in the 13th October 2021 meeting.

[101] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[102] South Cambridgeshire Local Plan (Adopted September 2018)[Folder ref. Doc_6_]

Section 6 Concerns about surface water and drainage plans, April 2022 (effectively version P10)

Appellant's request to submit additional flood modelling data

78 In their Appeal Statement (paragraph 5.13)[103], the appellant states that: "*Additional modelling work will be undertaken to provide precise levels details and to demonstrate that the scheme presented in the Reserved Matters application will not result in any increase in flood risk on or around the site".* Residents were surprised that the scheme that the appellant chose to model was not the scheme presented in the Reserved Matters application, but instead showed substantial changes to layout (such as heights and slopes) and landscaping (use of open space along the southern boundary), compared with the version (P09, plus July 2021 version of Cow Lane Flood Basin[104], scrutinised by the October 2021 Planning Committee. Changes from the previous flood mitigation scheme are summarised in paragraph 85, with key concerns about this new scheme in paragraph 86. This has led residents to the obvious assumption that version 9 of the surface water and drainage management plans[105] and the second version of the Cow Lane Flood Basin plans (amended in July 2021 without either a new version number of new date on the plan) [106] presented an unacceptable flood risk. Given that 9 previous versions did not work, there is little confidence that a tenth will either.

[103] Pre-Inquiry Statement of Case (January 2022)[Folder ref. Doc_9_]
[104] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[105] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[106] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]

Requirement for the provision of all underlying data

79 At the Case Management Conference[107] on 29 March 2022, the following was required by the Planning Inspector of the appellant: "*It was agreed that a deadline of 12 noon on 4 April be allowed in respect of the appellant's submission of additional surface water drainage modelling information (and including all underlying data). This should be submitted to PINS/the main parties at the same time. It was agreed that the Council would then carry out public consultation between 5 and 15 April 2022 with any representations to be sent to PINS. PINS will forward any representations received to all the main parties*".

Input data provided

80 In their covering note, the appellants address the requirement for *all underlying data* as follows*: "The modelling report is submitted separately with the topographical site survey, post-development ground level plan, and platform outlines used within the modelling all being appended to this note. Together, these are considered to constitute the underlying data …"*

81 These elements are present as below:

a. topographical site survey pages 3 - 8. This data was obtained by Survey Solutions in May 2014.

b. post-development ground level for western development platform (incorrect) and for edges only (also incorrect in places) for the south-eastern and south-western development platforms page 9.

[107] Case management conference Summary Note (APP/W0530/W/22/3291523)[Folder ref. Doc_26]

c. platform extents page 9.

d. platform outlines used within the modelling including 'Flood levels plan' page 10 and 'Surface water management strategy' page 11[108]

82 We note the HR Wallingford 2022 report states that: "*The ground elevations of the 2D mesh were based on LiDAR topographic data with a 0.5 m horizontal resolution" (section 2.3)."*[109]. This grid is not available to us, as it has not been presented by the appellant as part of this application, although some ground elevation data has been provided during previous iterations of the surface water management plan, e.g., (figure C10, Appendix C).

83 Similarly, we note that the HR Wallingford 2022 report states that "*Post development ground levels were provided by Cannon Consulting Engineers*". We assume these are the incomplete and inaccurate data provided on page 9 of the appellant's cover note[110].

84 Residents suspect that the way data was submitted or, in places, omitted, will have caused the flood model to make various inaccurate assumptions about land levels, but we cannot tell this from the material provided, as we do not believe that we have been provided with all the underlying data.

Synopsis of changes made

85 When generating the April 2022 surface water and drainage management plans (effectively version 10), the appellant has again made substantial changes to the layout of the proposed

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[108] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[109] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]
[110] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

development[111] [112], indicating the inseparability of layout and surface water management. Key changes (possibly of an extent not permitted at this stage) made in April 2022 compared with the version of the surface water management and drainage strategy considered by the Planning Committee in October 2021 (summarised in figure E1, Appendix E) are:

a. Removal of 4 proposed drainage basins (total surface area of 400-500 square metres) along the southern boundary, when page 11 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[113] is compared with TRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)[114] , B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[115] and B411-PL-SK-320 Flood Management Strategy (14/4/2021)[116].

b. Gardens of around 8 proposed properties have been sunk 60-70cm below the houses and the rest of the development, according to pages 2 and 9 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[117]. These gardens will deliberately be allowed to flood, in place of the 3 previously proposed drainage basins along the southern boundary, raising feasibility and safety issues and concerns about whether anybody would buy these houses (figure E1, Appendix E).

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[111] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[112] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]
[113] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[114] TRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)[Folder ref. Doc_46]
[115] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[116] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[117] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

c. Making the sides of the development platforms steeper, according to pages 2 and 9 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[118], although exact details are not provided, raising concerns about their stability against erosion and about future residents' safety. This presumably constitutes a change to landscaping and layout.

d. Substantial changes to finished floor levels of almost all the properties on the northern development platform (figure E2, Appendix E), when page 11 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[119] is compared with B411-PL-SK-320 Flood Management Strategy (14/4/2021)[120] (figure E2, Appendix E).

e. The addition of a south to north culvert running approximately North North West (NNW) and emanating approximately due north of No. 50 Cow Lane and running into the Linear Park (figure E3, Appendix E)[121]. This is absent in the plans from the appellant on page 11 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[122], but present in figure 3.1 of the HR Wallingford 2022 report[123]. Invert levels and the gradient of this are not provided.

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[118] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[119] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[120] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[121] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]
[122] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[123] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

Summary of concerns

86 Key concerns generated by the 2022 HR Wallingford report[124] and "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[125] (discussed in further detail in paragraphs 87 - 102) are as follows:

a. Although the HR Wallingford report[126] states that there is no increased flood risk to surrounding properties, the predicted flood level (9.97m) at the essentially flat boundary with Cow Lane properties is substantially (22cm) above ground level at the southern boundary of the development, so this indicates that HR Wallingford may have been given incorrect data about the topology of the gardens of the properties along Cow Lane.

b. Persisting concerns about incorrect geology, incorrect/ missing ground water level data, incorrect/ missing topology, mixing of pre- and post-development ground heights on plans and lack of modelling of (a) prolonged heavy rainfall, (b) higher ground water levels and (c) the effects of blocked culverts, as detailed in Section 5.

c. Lack of topological input information in surrounding areas (the Pines and Cow Lane) given to HR Wallingford as input data.

d. Failure to provide topology of surrounding properties, precluding accurate modelling of their flood risk.

[124] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]
[125] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[126] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

e. Missing or inaccurate data on development platform heights given to HR Wallingford as input data. In addition to height, direction of slope cannot be calculated.

f. Failure to provide topology of surrounding properties, precluding accurate modelling of their flood risk.

g. Failure to label apparently hollowed out ground at the exact site of the previous Cow Lane infiltration basin, apparently identical to previous version submitted in April 2021, which was not to permitted (paragraph 66), as per table 13.1, page 13-5 in The SuDS Manual[127]), due to high ground water levels.

h. Inadequate details of new culvert running North North West (NNW) and emanating approximately due north of number 50 Cow Lane and running into the Linear Park.

i. Insufficient information provided to explain exact input data, assumptions and methodology used.

j. Failure to ensure that proposed dwellings are 300 mm above road levels (in accordance with South Cambridgeshire Local Plan, CC/9[128]).

k. Flood water introduced into the zone of the built development (via the 8 sunken gardens).

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[127] The SuDS manual (2007)[Folder ref. Doc_53]
[128] South Cambridgeshire Local Plan (Adopted September 2018)[Folder ref. Doc_6_]

l. Failure to explain that the 4 sunken gardens to the west are also acting as infiltration basins (not permitted due to height of ground water).

m. Failure to explain how the 8 sunken gardens will be constructed, as the appellant would have to construct a waterproof retaining wall on three sides, with steps down from the house level.

n. Failure to consider safety aspects of sunken gardens

o. Failure to explain how very steep edges to development platforms are acceptable

The data presented show increased flood risk to surrounding properties

87 The appellant has provided diagrams in which it appears that neither the development nor surrounding properties will be subject to increased flood risk (as seen by comparing their figures 4.1 - 4.4 with figures 4.5 – 4.8 in the 2022 HR Wallingford report[129]).

88 However, the statement in the April 2022 HR Wallingford report that there is no increased flood risk to surrounding properties conflicts with their results in, for example, their figure 4.7, reproduced here as figures E4 – E5 (Appendix E)[130]. The assertion that there is no increased flood risk to surrounding properties also conflicts with page 10 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[131], on which a flood level of 9.97m is shown at the boundary, at a point which, on page 8 of is shown to be at 9.75 m (figure E6, Appendix E), using data derived from pages 9 and 10 of "CCE B411 Teversham

[129] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]
[130] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]
[131] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

Road Fulbourn modelling and sw note 02.pdf"[132]. Boundary levels are also confirmed by data in figure C10, (Appendix C)[133]. As shown using the appellant's own figures, there is a predicted flood of up to 22cm (9.97 – 9.75m = 0.22m = 22 cm) at the southern development boundary, separated from the adjacent 60 Cow Lane garden only by chainlink fencing (figure E6, Appendix E). How this water is modelled not to cross the flat boundary, at which there is only a chainlink fence (figure E7, Appendix E), is a mystery. The conclusions made by HR Wallingford will depend on the exact data given to them by the appellant. If erroneous use of roof heights as ground level (paragraph 61) is not the explanation, it is possible that HR Wallingford was told there was a 25 – 30 cm bank of earth around the edge of the development, or some form of impermeable barrier. Otherwise, perhaps output data compared against erroneous topology in the Cow Lane gardens such as the low resolution, elevated profiles shown in (figure C16, Appendix C)[134]. In summary, incorrect input data appear to have compromised model outputs. Concerningly, it is not clear what topological data were really used for the land outside the development boundary and we are unable to check because the appellant has not provided the full data and model information to us, thus not complying with the instructions of HM Planning Inspector.

89 It therefore appears that the latest iteration of the flood modelling, despite being performed with some incorrect/ omitted data that will lead to an underestimate of risk, still relies on the flooding of existing gardens along the southern boundary.

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[132] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

[133] B411-Pl-SK-321_Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]

[134] Fulbourn General Topological Plan Additional Information (from file title; no date provided)[Folder ref. Doc_41]

Lack of topological information in areas surrounding the development

90 We are concerned that roof heights (figure C10, Appendix C) and p8 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[135]), rather than the ground levels (shown on residents' survey, figure C17), for surrounding properties may have been used in modelling, if these were taken into a computer model which "believed" them to be ground level. We have no way of knowing how the model handles input data, as no details are provided to us. If the model undertakes interpolation (either linear or non-linear) of the height data between two points and was fed roof height data for properties along the southern boundary, this might explain why the HR Wallingford model shows a predicted flood of 22cm at the southern boundary, but claims that no surrounding properties will be flooded (see below). Another possibility is that, when considering the topology of the surrounding land, the low resolution data in figure C16 (appendix C), rather than correct, higher resolution topological data has been used. The low resolution topological data provided by the appellant (figure C16, appendix C)[136] estimates development boundary land heights to be higher than the appellant's own measurements[137] [138], and also higher than those shown on the survey commissioned by residents (figure C17, Appendix C)[139].

There is insufficient information to model flood risk to the Pines development

91 Boundary levels and adjacent on-development land levels bordering the Pines development are not shown at all in p3-8 of "CCE B411 Teversham Road Fulbourn modelling and sw

[135] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[136] Fulbourn General Topological Plan Additional Information (from file title; no date provided)[Folder ref. Doc_41]
[137] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[138] B411-Pl-SK-321_Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]
[139] Topological survey of gardens of housing along Cow Lane (14 April 2022)[Folder ref. Doc_45]

note 02.pdf"[140] and the "thumbnail" diagram from page 8 of that document is reproduced as figure E8 (appendix E) to demonstrate this. There may be a substantial flood risk here, but the topological diagrams miss this part of the boundary altogether, without even producing a page covering this region[141]. We cannot tell whether any topological data for this part of the development was submitted.

92 In "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[142], on page 9, topological input data for HR Wallingford's model are given. Topological input data are provided for the western development platform, but no input data are provided for the northern or south-eastern development platforms, which appears inconsistent and makes little sense (figure E9, Appendix E).

93 On page 9 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[143], the aim appears to be to give accurate post-development topological input data, as the edges of the development platforms (red lines) are largely correctly annotated (but see paragraphs 94 - 97), as shown in figure E10 (Appendix E). However, all the heights marked on the western development platform, inside the red line, which should be post-development heights, are incorrect, as they are pre-development heights, some of which are over a metre lower than they would be post-development (compare figure E10 with E11, Appendix E). By making a model assume that water might pool around the level that is marked 9.22m, this inaccuracy could falsely lower the predicted flood risk at this part of the southern boundary, adjacent to the Pines and contributes to the problem (paragraph 91) that the flood risk to the Pines

[140] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[141] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[142] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[143] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

cannot have been assessed properly. Furthermore, some of the levels marked on the western development platform (figure E12, Appendix E) would be below the water table, some of the year round, as there is an area with a ground level of 9.22m, while ground water levels can be up to 9.3m (paragraph 98). It is hard to have any confidence in any of the modelling done on the basis of this input data.

Missing or inaccurate data on development platform heights

94 Cannon's explanatory document about the April 2022 modelling ostensibly provides all the submitted input data to the April 2022 modelling. It is concerning that the topology is very incomplete and seriously inaccurate (paragraph 93). As noted in paragraph 92, the appellant has failed to provide proposed land levels within the south-eastern and northern development platforms, except around the edge (figure E9, Appendix E) leaving these areas completely blank in the input data document. The exception is the western development platform (paragraph 93), for which data are provided, but they are incorrect by over a metre in places.

95 Residents are very concerned about whether the lack of any topological input data being marked on the development platforms has biased the results of modelling or made them inaccurate. It is likely that a computer model will require some topology. Where topological data are missing, it seems likely that the model will undertake some form of interpolation, to fill in the missing land heights. Put simply, it will impute (estimate) ground level (topological) data by making assumptions about the likely shape of the land (e.g., that it is a straight or curved line), effectively averaging out land heights between any 2 points for which it does have data.

96 In addition to missing data on the south-eastern and northern development platforms and entirely wrong data on the western development platform, data shown on page 9 of "CCE

B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[144] appears to have been provided in two additional incorrect ways. In general, as one would expect, figures for the land height at the edge of the development platform, but on the platform, should be marked on or inside the red line that represents the edge of the development platform (figures E9 – E17, Appendix E). Accordingly, land levels off the platform should be outside this red line. Firstly, there are places in which pre-development, off-platform land heights are marked as being on the edge of the development platform (figures E13 and E14, Appendix E) potentially causing the model to interpolate a much lower average development platform height than is actually proposed. Secondly, the topology is substantially incorrect around the sunken gardens (figures E15 – E17, Appendix E). While elsewhere around the development platforms, the post-development ground heights given on the red line at the edge of the development platform are (very nearly) always the on-platform heights and are above 10 metres, there appear to be inaccuracies around the sunken gardens. The red line marking the edge of the development platform here bears the original pre-development ground heights that are proposed for the sunken gardens. These existing "sunken" land heights (roughly 9.90 m or 10.0 m, respectively, rather than 10.5 m – 10.75 m (figures E15 – E17, Appendix E). If a computer model is given these erroneous data, it may well calculate heights incorrectly across the south-eastern development platform. This is because it is likely to assume that the platform slopes gently from the northern edge of the south-eastern development platform to the existing ground level around these sunken gardens. In turn, this might lead to a prediction of less water pooling along the southern boundary and so would give the perception of there being a lower flood risk.

[144] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

97 Looking at what has been used as input data, (figures E9 – E17, Appendix E), there is likely to be very significant inaccuracy in the modelling results, all tending to underestimate, rather than overestimate, the flood risk to surrounding properties. The incorrect and incomplete input data provided may also have more complex impacts, as the ICM InfoWorks software offers "terrain sensitive meshing", in which the size of the triangles (the small units of land analysed in the model) varies, depending on the exact way the land slope. Together, these artifacts may provide an explanation for the decrease in the predicted 100 year plus climate change flood modelling since the previous HR Wallingford modelling in August 2020.

An undrained (non-permitted) infiltration basin may have been reintroduced

98 The Cow Lane Flood Basin, present in surface water drainage plans submitted by the appellant in April and July 2021, is no longer labelled on the April 2022 plans. However, the surface profile shown in the unlabelled diagram on page 9 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[145] shows excavations down to 9.4 m in exactly the same location as the previous plans showing the Cow Lane Flood Basin. No culvert is now seen, meaning that, although not marked on the plans as a basin at all, this has been converted from an attenuation basin back to an infiltration basin. As set out above, it is a requirement, as per table 13.1, page 13-5 in The SuDS Manual[146] that any infiltration basin must be at least 1m above the seasonally high ground water level (paragraph 66). Thus, the previously proposed attenuation basin (first version of the Cow Lane Flood Basin) from the April 2021 plans[147], that was purported to drain by a combination of infiltration

[145] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[146] The SuDS manual (2007)[Folder ref. Doc_53]
[147] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]

and evaporation (in a British climate) has reappeared. As the land height at the nearby bore hole (water measurement well) WS1a is given as 9.73m on page 8 of "CCE B411 Teversham Road Fulbourn modelling and sw note 02.pdf"[148], and our highest water table reading is 43 cm or 0.43m (figure C11, Appendix C), this indicates that water table is at 9.30m, at least some of the time, making it only 10 cm (0.1m) below the 9.4 m base of this clandestine infiltration basin.

99 As discussed in paragraphs 48-54, the geology of West Melbury Marly Chalk (figures C1 and C2, Appendix C), which comprises layers of impermeable clay, would also preclude any drainage by infiltration, as mandated by the SuDS Manual in Table 15.1 on page 15-3[149].

A new and little described culvert is proposed

100 A new culvert is proposed running from the south-eastern part of the development to Linear Park, but no invert level, slope or flow-control technologies are provided, so the likely effectiveness, probability of blockage, and risk of retrograde flow cannot be assessed (figure E3, Appendix 3)[150]. Again, the limited information provided precludes reproduction of the appellant's flood modelling and is contrary to the requirement of HM Planning Inspector to provide all underlying data.

Failure to ensure that proposed dwellings are 300 mm above road levels (in accordance

[148] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]
[149] The SuDS manual (2007)[Folder ref. Doc_53]
[150] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

with South Cambridgeshire Local Plan, CC/9)

101 Multiple properties on the northern development platform have undergone substantial changes in finished floor levels. Road levels are not marked anywhere on the plans provided by Cannon in April 2022. However, assuming that road levels have not been changed since TRF-CBA-1-GF-M2-L-1010, version P06, 12/04/2021[151] and TRF-CBA-1-GF-M2-L-1011, version P06, 12/04/2021[152] (versions considered by October 2021 Planning Committee meeting), there are multiple dwellings with finished floor levels that are not 300mm above the road levels (figure E18, Appendix E), with some finished floor levels of proposed dwellings apparently at the same level as the road. Finished floor levels should "where appropriate and practicable" (and surely that requirement must be appropriate here, given the potential flood risk to proposed dwellings) be 300 mm above road levels. Thus, the plans are not compliant with South Cambridgeshire Local Plan CC/9[153].

The 4 sunken gardens to the west act as a non-permitted infiltration basin

102 The more westerly set of 4 sunken gardens close to the southern development boundary are not drained in any way, as there is no culvert, and are thus acting as an infiltration basin The lowest point in these gardens is 9.6m (figure E3, Appendix E) and no point in them is 1 m above the ground water level (which would require them to above 10.3m). They are not permitted to act as an infiltration basin as per table 13.1, page 13-5 in The SuDS Manual[154], which states that any infiltration basin must be at least 1m above the seasonally high ground

[151] TRF-CBA-1-GF-M2-L-1010 1000 Series Hard Landscaping Sheet 1 (12 April 2021)[Folder ref. Doc_57]
[152] TRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)[Folder ref. Doc_46]
[153] South Cambridgeshire Local Plan (Adopted September 2018)[Folder ref. Doc_6_]
[154] The SuDS manual (2007)[Folder ref. Doc_53]

water level. In addition, the following concerns were raised about the sunken garden arrangement:

a. Flood water has been introduced into the zone of the built development, which the platforms aimed to prevent.

b. There is little explanation of how the 8 sunken gardens will be constructed, as the appellant would have to construct a waterproof retaining wall on three sides, with steps down from the house level. This completely new layout arrangement has not been consulted upon and is a substantial amendment to landscape and layout.

c. Failure to consider safety aspects of sunken gardens

Section 7 Policy changes will increase groundwater levels on this site

103 We are now aware of the Environment Agency's endorsement[155] of "a new chalk stream strategy to protect 'England's rainforests'"[156]. This includes the intention to decrease water abstraction from Cambridgeshire aquifers, in order to protect chalk streams and related ecology. This aims to raise ground water levels, including in areas such as Wilbraham, the next village with which the fen is contiguous, where the intention is for the river to flow as it formerly did. Given the large water catchment area of the proposed development site, if ground water levels rise, as envisaged by this document, the proposed development will increase flood risk to surrounding properties, even further than already predicted by the appellant's various flood modelling iterations.

Section 8 Psychological morbidity of flooding

104 A Post Traumatic Stress Disorder (PTSD)-like effect of flooding has been described in those who suffer flooding of their properties, with significant long term psychological morbidity. Therefore, the public health risk of putting owners of surrounding properties at risk of such psychological morbidity needs to be considered. Residents adjacent to the site are exceptionally concerned about the flood risk to their properties. A key publication on the subject is included in Appendix H.

105 This underscores the fact that the issue of an increase in flood risk to neighbouring properties should be given significant weight in the planning balance. The appellant has not shown that the flood risk caused to neighbouring residents by its proposed layout and

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[155] New strategy launched to protect chalk streams (15 October 2021)[Folder ref. Doc_57]
[156] Catchment Based Approach | Chalk Stream Restoration Strategy 2021 (Main report)[Folder ref. Doc_1_]

landscaping are capable of being appropriately mitigated. Indeed, the evidence clearly indicates that it cannot.

Section 9 Statement of Truth

106 I can confirm that this statement is true to the best of my knowledge and belief.

Signature [redacted] **Date 26th April 2022**

Contact Details

Name Dr Elizabeth Soilleux, MA MB BChir PhD FRCPath PGDipMedEd

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Appendix A Photographs of the development site and surroundings

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Figure A1. Flooding on Roberts Way around 50 metres from the proposed development (2 October 2019).

Figure A2. Standing water on many parts of the development site is a regular occurrence. Site of proposed western development platform looking north-west (6 May 2012).

Figure A3. Standing water on many parts of the development site is a regular occurrence. Site of south-eastern development platform (date 23 November 2014). The waterlogging is in keeping with there being clay here, rather than it being free draining chalk.

Figure A4. Standing water on many parts of the development site is a regular occurrence. Western aspect of south-eastern development platform looking east, showing marsh vegetation (date 23 November 2014). The waterlogging is in keeping with there being clay here, rather than it being free draining chalk.

Figure A5. Standing water on many parts of the development site is a regular occurrence. Site of south-eastern development platform (date 23 November 2014). The waterlogging is in keeping with there being clay here, rather than it being free draining chalk.

Figure A6. Standing water on many parts of the development site is a regular occurrence. Site of south-eastern development platform (date23 November 2014). The waterlogging is in keeping with there being clay here, rather than it being free draining chalk.

Figure A7. Standing water on many parts of the development site is a regular occurrence. Site of south-eastern development platform (date 1 January 2021). The waterlogging is in keeping with there being clay here, rather than it being free draining chalk.

Figure A8. Standing water on many parts of the development site is a regular occurrence. Site of south-eastern development platform (date 1 February 2021). The waterlogging is in keeping with there being clay here, rather than it being free draining chalk.

Figure A9. Ground water level at the rear of 60 Cow Lane 6-7 metres from southern boundary of the proposed development site, 4 April 2018. A pump was running at this point (blue piping) to drain the excavated trench. Ground water level was 40cm (0.4m) below the surface.

Figure A10. Ground water level at the rear of 60 Cow Lane, 6-7 metres from southern boundary of proposed development site, 4 April 2018. A pump had been running for 30 minutes to drain the excavated trench. Ground water level was 40cm (0.4m) below the surface.

Appendix B Chronology of submission of plans

This summary focusses on surface water and drainage plans and flood risk mitigation.

26 October 2017	Granting of Outline Planning Permission. A condition for drainage and surface water management (condition 8) was included Planning Permission subject to conditions S/0202/17/OL (26 October 2017)[Folder ref. Doc_3_].
6 September 2019	Documents are submitted for the Reserved Matters Application. These include a 'Reserved Matters Planning statement" in which the Appellant stated: Section 5.48: "*The application is accompanied by a Surface Water Management Plan, which has been produced to discharge condition 8 of the outline application. This explains in more detail how the proposed drainage system will function. The system also informs the ecology and landscape strategy as it seeks to retain significant portions of the existing site and provides areas of storage across the site, which creates significant ecology and landscape opportunities as described.* *5.49 The proposal therefore is compliant with policy CC/8 of the Local Plan."* At the same time, the "Reserved Matters Planning statement" stated that stated that (see section 1.7) the Appellant would submit a discharge of condition application with respect to *inter alia* Condition 8, Surface Water Management Reserved Matters Planning Statement (September 2019)[Folder ref. Doc_43].
12 September 2019	The appellant provides a document detailing surface water management plans B411 Surface water management (12 September 2019)[Folder ref. Doc_16].
11 October 2019	Harry Pickford of the Lead Local Flood Authority (LLFA) responds stating proposals are not acceptable. Concerns include flooding to central parkland area and roads within proposed development LLFA response to consultation (FR/19-000431; S/3290/19/RM) (15 October 2019)[Folder ref. Doc_50].
3 December 2019	Further information about drainage is submitted by the appellant. B411 Surface water Management (3 December 2019)[Folder ref. Doc_36]
19 December 2019	Harry Pickford of the LLFA responds stating proposals are still not acceptable. There are still concerns over flooding of central area of proposed development. Also raises concerns that culverts could become blocked LLFA response to consultation (FR/19-000431; S/3290/19/RM)[Folder ref. Doc_31].
27 February 2020	Appellant submits an amendment as described in a Planning Update Note Planning Update Note (March 2020) [Folder ref. Doc_5_]. Updated information for both the Reserved Matters and Discharge Condition flooding related documents was provided as part of this amendment.
15 March 2020	Simon Bunn SCDC Sustainable Drainage Engineer responds. Planning Consultation Response | Sustainable Drainage Engineer (15 March 2020)[Folder ref. Doc_14] Proposals are considered unacceptable: "*The drainage proposals are also more akin to the information submitted for an outline permission and more detailed engineering drawings are required to demonstrate that the scheme is suitable."* Simon Bunn refers back to his comments from December 2019 Planning Consultation Response | Sustainable Drainage Engineer (14 December 2019)[Folder ref. Doc_23] *"The information supplied is not detailed enough for the discharge of condition 8. The appellant is indicating that the level of information required would be not be available until post planning stage. This is not acceptable.* *The discharge of surface water from the development is inextricably linked with the management of the surface water flood risk that is present on the site. The information submitted does not provide any surface water flood risk management information.*

	The proposals also now appear to be draining to an existing pond that does not appear to have an outlet. This is unacceptable." Twelve items of detail required to assess the proposal are listed.
20 March 2020	Harry Pickford LLFA responds: Objections removed, but it is noted that Finished flood levels must by 300 mm above the maximum flood depth. LLFA response to consultation (FR/19-000431; S/3290/19/RM) (20 March 2020)[Folder ref. Doc_54] Response says this decision is based on: B411 Surface water management (12 September 2019)[Folder ref. Doc_16] B411 Surface water Management (3 December 2019)[Folder ref. Doc_36] B411 Teversham Road Fulbourn Cambridgeshire Surface water management (27 February 2020)[Folder ref. Doc_15]
16 April 2020	Adam Littler SCDC Drainage Engineer Response: Proposals are unacceptable since "*because of the changes to the layout, revised modelling is required"* p1 final paragraph of Sustainable drainage Engineer comments (16 April 2020)[Folder ref. Doc_48]
26 May 2020	Barton Willmore decline to produce the information requested by Sustainable Drainage Officers. Planning Application S/3290/19/RM [25542/A5/PD] (26 May 2020)[Folder ref. Doc_33]
14 June 2020	Adam Littler SCDC Drainage Engineer Response: Proposals still unacceptable because changes to layout require further modelling. Requirements in 16 April 2020 letter must be addressed since *the information requested is fundamental to the proposed strategy and is therefore required at this stage to ensure sustainable principles are fully examined and can be technically assessed at this point, prior to further design evolution. The landscaping will directly impact the drainage strategy and vice versa. Both aspects need to be considered jointly*. Planning Consultation Response (14/6/2020)[Folder ref. Doc_27]
17 August 2020	Surface Water Flood Management documents are submitted, in the form of an HR Wallingford Expert Report. Review of surface water management (August 2020)[Folder ref. Doc_13] Information from Cannon Engineers was used in the preparation of their report. B411 Teversham Road Fulbourn Cambridgeshire Reserved Matters Application Layout (12 August 2020)[Folder ref. Doc_8_] This report predicts flooding to the properties of surrounding residents.
1 September 2020	Chris Gray SCDC Drainage Engineer Response: Cannot sign off condition 8 (surface water drainage) as a discharge condition. More information on finished flood levels (FFLs) is needed. Sustainable drainage Engineer comments (1 September 2020)[Folder ref. Doc_49]
9 September 2020	Email from Paul Derry of Barton Willmore bemoaning lack of progress and complaining that they have had to deal with three different SCDC drainage engineers. He does not provide the FFLs referred to on 20 March and 1 September but suggests that the request for details of floor levels be added as a condition to any approval. Email from Barton Willmore to SCDC Planning Officer[Folder ref. Doc_32]
22 September 2020	Cannon Engineers' Flood Management Strategy drawing B411-PL-SK-320 Rev.P01, shows floor levels revised. Before revision, this drawing was first dated 18 September 2020. B411-PL-SK-320 Flood Management Strategy (16/9/2020)[Folder ref. Doc_38] This drawing is the first time that the floor levels are shown with the flood levels. It was also the first time that it appeared that the southern development platform was now falling north to south (not south to north as shown in all previous site sections), i.e. draining water more towards the Cow Lane properties than in the former version, where the slope was depicted as south to north.
9 October 2020	Chris Gray SCDC Drainage Engineer Response. Proposals acceptable subject to conditions. Sustainable drainage Engineer comments (9/10/2020)[Folder ref. Doc_37] The required condition is: *before development commences on site finished floor levels are provided, which show that the risk of flooding within the development is 'reduced'.* There is no mention of the risk to properties outside the development area
23 October 2020	Appellant explains their surface water management plans to the LLFA by email. Documents accompanying this illustrating pouring water off the development boundary onto the surrounding properties (figure 11, appendix 1).

	Material obtained via Freedom of Information request.
10 November 2020	Appellant offers to shift a flood level as recorded on plans submitted to Council (figure 12). Material obtained via Freedom of Information request.
19 November 2020	Amended section documents are submitted. These include TRF-CBA-1-GF-M2-L-3000_3000_Series_Site_Sections_(12_November_2020)[Folder ref. Doc_2_] and B411-PL-SK-320 Flood Management Strategy[Folder ref. Doc_35] Chris Gray SCDC Drainage Engineer Response. Proposals acceptable. Conditions removed. Sustainable drainage Engineer comments (19/11/2020)[Folder ref. Doc_34]
13 January 2021	Application goes to the planning committee but is withdrawn on the day by South Cambridge District Council before consideration, for two reasons: 1. Receipt of draft High Court papers for judicial review (Mr E. Kingsley), alleging failure to follow due process by SCDC, as multiple dwellings are not within the Outline Planning Permission development boundary on the version submitted. 2. Document detailing SCDC's likely legal risk in the event of flooding surrounding properties (Dr E. Soilleux). It was agreed by the Planning Committee that deferral was **ONLY** for SCDC to take legal advice regarding the above and specifically **NOT** for them to allow the appellant to submit yet more out-of-time amendments Recording of 13 January 2021 Planning Meeting[Folder ref. Rec_55]
8 February 2021	Microsoft Teams meeting between residents, flood risk assessment personnel from SCDC and the planning officer, Katie Christodoulides, regarding residents' concerns.
14 April 2021	A Layout Update is submitted. This amendment includes the construction of a large flood basin, the Cow Lane Flood Basin, see B411-PL-SK-321 Rev.P02 at end of document: [FLOOD_RISK_UPDATE_NOTE__AMENDED_-5695403.pdf].
21 May 2021	Sharon Brown, Deputy Delivery Manager in SCDC's Planning Office met with concerned residents and local Councillors via Teams. She advised that the Applicant's plans were not conformant with Outline planning proposals, but that she believed it was necessary to allow the appellant to make multiple further amendments to the plans, despite the clear instructions from the Planning Committee at their January 2021 meeting that a deferral of a decision at the January meeting was not to allow the Appellant to make further amendments Due to serious resident concerns discussed in the meeting, it was agreed that surface water and drainage management would not be assessed as a discharge condition.
June 2021	Residents submit objections to amended plans of 14 April 2021, stressing that they believe that • The council has a statutory duty to prevent flooding to surrounding properties • However the plans provided indicate their properties will flood due to water exfiltration from the development • that the borehole readings on which Developer modelling is based (which date from 2014/15) do not represent contemporaneous readings so modelling underestimates flood risk • Inadequate detail has been provided around the Cow Lane Flood basin, and more generally • No hydrological modelling has been carried out Submission to the Planning Committee (13 June 2021)[Folder ref. Doc_12]
5 July 2021	LLFA writes to Planning Officer, objecting to latest surface water management plans. He writes: *Currently, the proposals do not give confidence that surface water flows will be retained on the site, as the modelled depths of flooding along the southern boundary are greater than the southern boundary levels.* Objections include 1. use of infiltration in the Cow Lane Flood basin. 2. Absence of detailed plans including the position of any outfall from the Cow Lane Flood basin.

	Comments from LLFA (5 July 2021)[Folder ref. Doc_20]
8 and 9 August 2021	Residents object to recently revised documents on the following grounds: • Flood levels are above garden levels at multiple points (p2) • Plans submitted are internally inconsistent and this is salient to model interpretation (p1) • There is uncertainty about whether ground or roof heights have been used in critical calculations • No hydrological modelling of Cow Land Flood basin carried out (p3) • Discharge from Cow Lane Flood basin may exceed green field discharge rate (p3,10) • Independent review of these complex schemes is required (p5) Submission to the Planning Committee (8 August 2021)[Folder ref. Doc_10] Letter from 60 Cow Lane resident to SCDC Planning Officer (9 August 2021)[Folder ref. Doc_42]
9 September 2021	The LLFA withdraw their objections, apparently acquiescing to surface water management being dealt with as a discharge condition, but stating: *"It must be investigated and demonstrated as part of the discharge of condition application whether there is a clearance to groundwater from the base of the attenuation features, to avoid groundwater ingress. If groundwater is discovered to be shallower than previously recorded, measures will be required to ensure that this does not impact the proposed surface water drainage strategy, or significantly displace groundwater"* LLFA response to consultation (FR/19-000431; S/3290/19/RM) (9 September 2021)[Folder ref. Doc_51]
26 September 2021	Residents question LLFA's position of 'no objection', suggesting this view is unsustainable on seven grounds. FR/19-000431 Comments on S/3290/19/RM (26 September 2021)[Folder ref. Doc_7_]
22 September 2021	Discharge condition application (S/3209/19/DC) for surface water and drainage is withdrawn Request to withdraw Condition 8 From application S/3209/19/DC[Folder ref. Doc_25]
29 September 2021	LLFA replies to residents, clarifying their position. This confirms that modelling of the impact of the new flood basin has not been carried out. It also acknowledges there are uncertainties about ground water levels. LLFA response to resident of 60 Cow Lane (29 September 2021) [FR/19-000431][Folder ref. Doc_29]
13 October 2021	Planning committee meeting. Concerns are noted by residents that the submitted plans remain in breach of the South Cambridgeshire Local Plan Policy CC/9 (paragraph 1b): *"Floor levels are 300mm above the 1 in 100-year flood level plus an allowance for climate change where appropriate and where appropriate and practicable also 300mm above adjacent highway levels."* South Cambridgeshire Local Plan (Adopted September 2018)[Folder ref. Doc_6_] The planning application was refused by SCDC planning committee on 5 grounds, the second of which was the provision of insufficient data regarding analysis of flood risk. Application for Approval of Reserved Matters (20 October 2021)[Folder ref. Doc_11]
24 January 2022	Castlefield International gave notice of their intention to appeal the rejection decision. The appeal hearing is 24th – 30th May 2022. In their Appeal Statement (paragraph 5.13), the appellant states that: "*Additional modelling work will be undertaken to provide precise levels details and to demonstrate that the scheme presented in the Reserved Matters application will not result in any increase in flood risk on or around the site."* Pre-Inquiry Statement of Case (January 2022)[Folder ref. Doc_9_]
29 March 2022	During the Case Management Conference on 29th March 2022, the following was required by the Planning Inspector of the appellant: "*It was agreed that a deadline of 12 noon on 4 April be allowed in respect of the appellant's submission of additional surface water drainage modelling information (and including all underlying data).*

	This should be submitted to PINS/the main parties at the same time. It was agreed that the Council would then carry out public consultation between 5 and 15 April 2022 with any representations to be sent to PINS. PINS will forward any representations received to all the main parties". Case management conference Summary Note (APP/W0530/W/22/3291523)[Folder ref. Doc_26]
4 April 2022	Further to the Case Management Conference of 29 March 2022, the Appellant submits new flood modelling data. This is for a new layout, different from that reviewed on 13 October 2021. The appellant's covering letter B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18] accompanies the modelling report Update to surface water flood management (1 April 2022)[Folder ref. Doc_17] and comments as follows: "*The modelling report is submitted separately with the topographical site survey,post development ground level plan, and platform outlines used within the modelling all being appended to this note.* *Together, these are considered to constitute the underlying data since the modelling report explains the modelling undertaken in detail (including the model parameters), as supported by the appended information.* *This is consistent with the data supplied during the course of both the outline planning application and reserved matters application.* *We have not previously, or now, provided the model itself as this would require compatible software for import and only facilitates re-running of the results which are already set out in detail in the modelling report*". Modelling data for version 9 of the surface water and drainage scheme, which accompanied the rejected Reserved Matters Application on 13th October 2021, was not submitted.
April 2022	SCDC conducts a public consultation on the above modifications, to which over 30 responses are received.

Appendix C Figures for versions of surface water and drainage management plans up to October 2021

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Cambridgeshire Geological Society

Web site: www.cambsgeology.org

E-mail: info@cambsgeology.org

Twitter: @CambsGeology

Elizabeth Soilleux
Fulbourn Forum

Re: Flooding Consultation on Planning Appeal Teversham Road

Dear Elizabeth.

Please find below our comments on the appeal documents supplied.

Although the underlying geology is part of the Chalk Formation, it cannot be described as "free-draining". It is the lowest of the Chalk strata, the West Melbury Marly Chalk, which has a high clay content and is relatively impermeable, particularly in some areas. It underlies much of the fen edge in this area and its lack of 'free draining' quality results in many patches of wet 'fen' - e.g. Teversham Fen and Fulbourn Fen to the north. Further proof of its relative impermeability is the line of springs to the south, along the outcrop of the Totternhoe Stone - a harder band of Chalk that is fissured and, therefore, allows free drainage of water through it. At its base, where it overlies the West Melbury Marly Chalk, numerous springs occur due to the water not being able to penetrate the underlying the clay-rich Chalk.

The proposed development is very near to the spring line- in fact it looks like one of the springs (at Poor's Well) is actually part of the development. This spring site is of considerable geomorphological and geological interest (as are other chalk springs along the fen edge) and may well qualify as a Local Geological Site. We are currently looking at such sites to propose their designation as they are key features in the landscape heritage of Cambridgeshire. There seems to be no mention of this spring line in the report and, therefore, no reference to the significant source of flowing water, adjacent, if not actually within the site.

Attached is a geology map taken from the British Geological Survey website which shows the (light yellow) West Melbury Marly Chalk to the north of the Totternhoe Stone (the narrow band of darker green that passes through Fulbourn) and the (lighter green) Zig Zag Chalk to the south. You can see that the site is just to the north of the Totternhoe Stone.

This information is given without predjudice and forms our opinion of the geology of the area in question.

Dr Reg Nicholls
Chair, Cambridshire Geological Society

Figure C1. Letter from Cambridgeshire Geological Society about HR Wallingford assuming the wrong geology.

See also Figure C2.

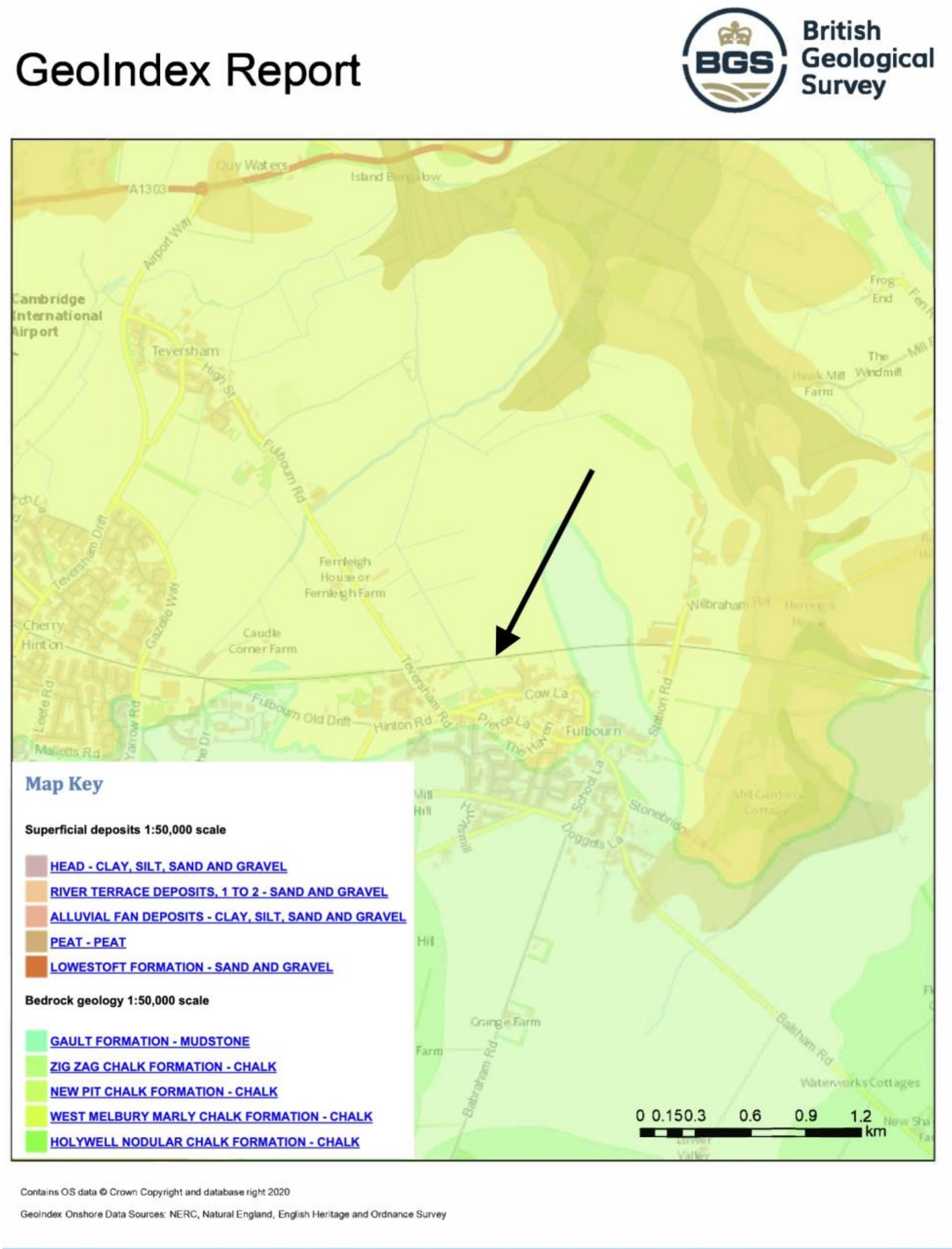

Figure C2. Letter from Cambridgeshire Geological Society, April 2022, together with British Geological Survey data showing the development site is made of impermeable West Melbury Marly Chalk not 'free draining chalk', as suggested by HR Wallingford.

Arrow indicates the northern boundary of the development site. See also figure C1. Figure derived by Cambridgeshire Geological Society from Onshore Geoindex[1].

[1] https://mapapps2.bgs.ac.uk/geoindex/home.html?_ga=2.259952778.1090462005.1649927734-771910022.1649927734

Figure C2. Original surface water and drainage plans (P01, September 2019), comprising crated storage and 5 bio-retention ponds.

It is the belief of residents, although not very clear from the plans[2], that these 5 bio-retention ponds must be lined and drained in some way, as drainage by infiltration is not permitted, due to the ground water level not being 1 metre below their bases as per table 13.1, page 13-5 in the SuDS Manual[3].

[2] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]
[3] The SuDS manual (2007)[Folder ref. Doc_53]

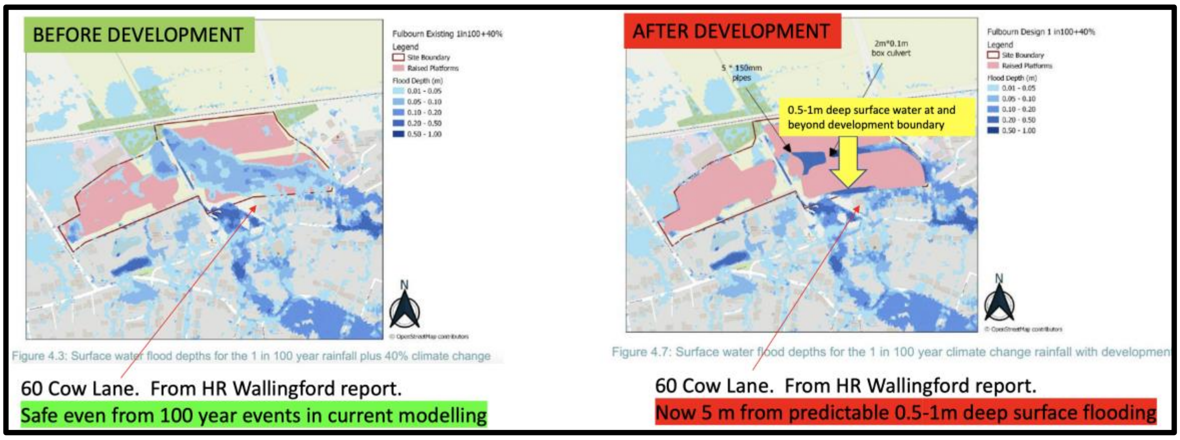

Figure C3. Predicted 1 in 100 year +40% flood risk before and after development version P01.

Taken from HR Wallingford's Review of surface water management (August 2020)[4].

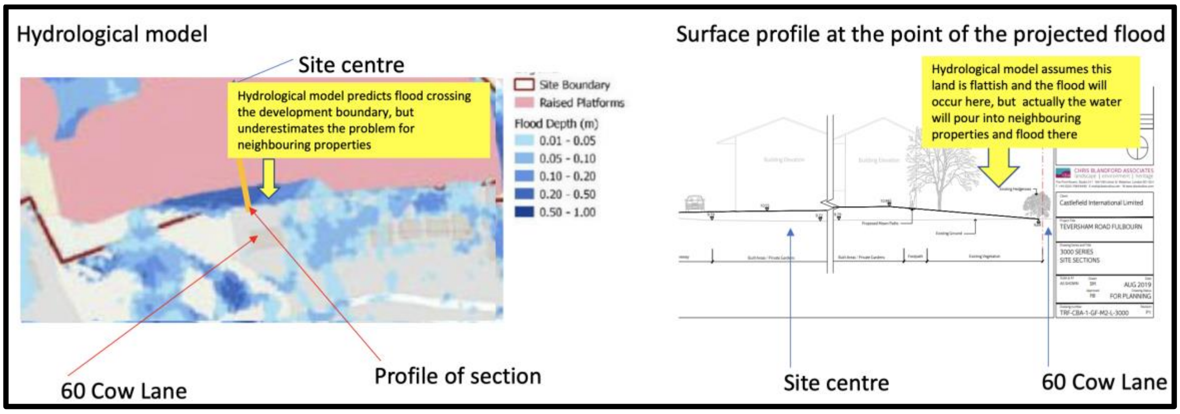

Figure C4. Correlation between predicted 1 in 100 year +40% flood risk after development version P01 and topology of site boundary.

Taken from HR Wallingford's Review of surface water management (August 2020)[5]. This indicates that flood water will flow south over the boundary into existing Cow Lane properties.

[4] Review of surface water management (August 2020)[Folder ref. Doc_13]
[5] Review of surface water management (August 2020)[Folder ref. Doc_13]

Original Site Section P1 06.09.19

NOTE: Sections P0 23.08.19 P2 28.02.20 and SO 08.11.19 all missing

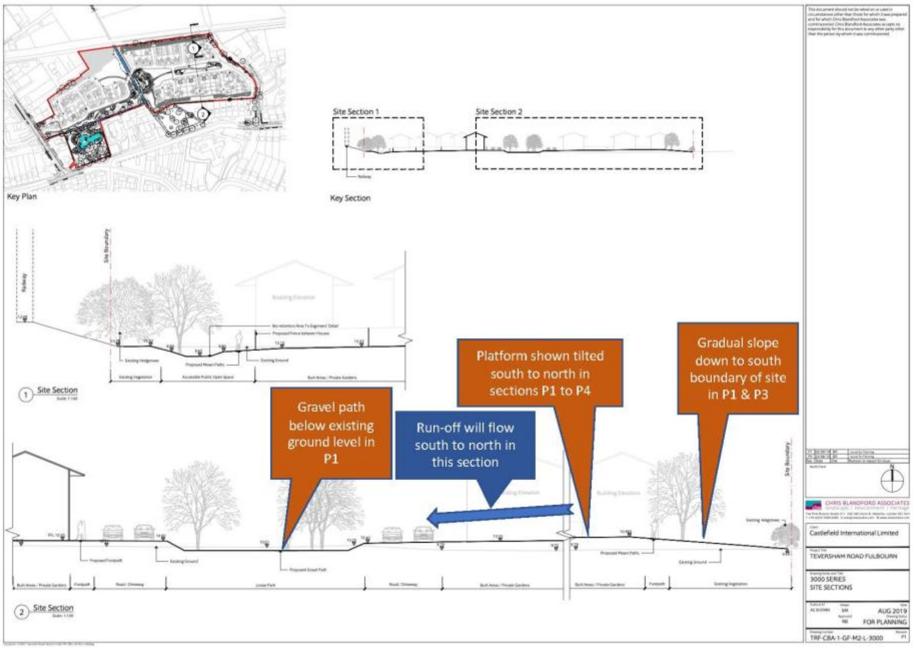

Figure C5. Original site section P1 12.11.20 shows development platform sloping south to north.

Taken from TRF-CBA-1-GF-M2-L-3000__2__SITE_SECTIONS-5580258.pdf, version P02, November 2020[6].

[6] TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 November 2020)[Folder ref. Doc_2_]

Final Section P4 drawing 12.04.21

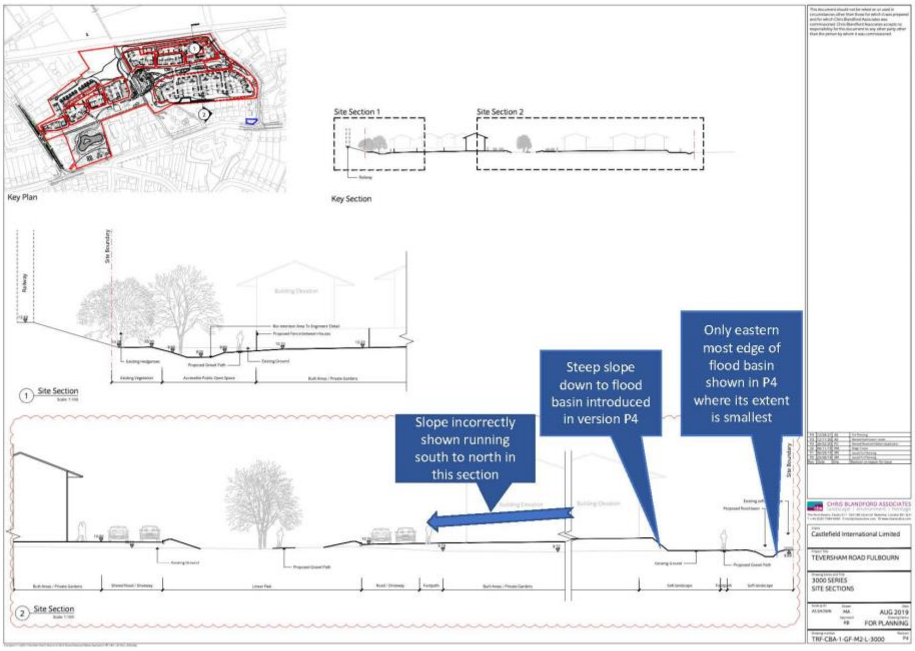

Figure C6. Site section P4 12.04.21 shows development platform sloping south to north, in conflict with plans at that time (reproduced in figure C7).

Taken from TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections, version P04 (12 April 2021)[7].

[7] TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 April 2021)[Folder ref. Doc_4_]

Figure C7. Site plan produced on 14.04.21 indicates that the north-eastern development platform slopes from north to south, in conflict with contemporaneous site section (figures C6 and C8).

Site plan B411-PL-SK-320 version P09, 14/04/2021[8]

[8] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]

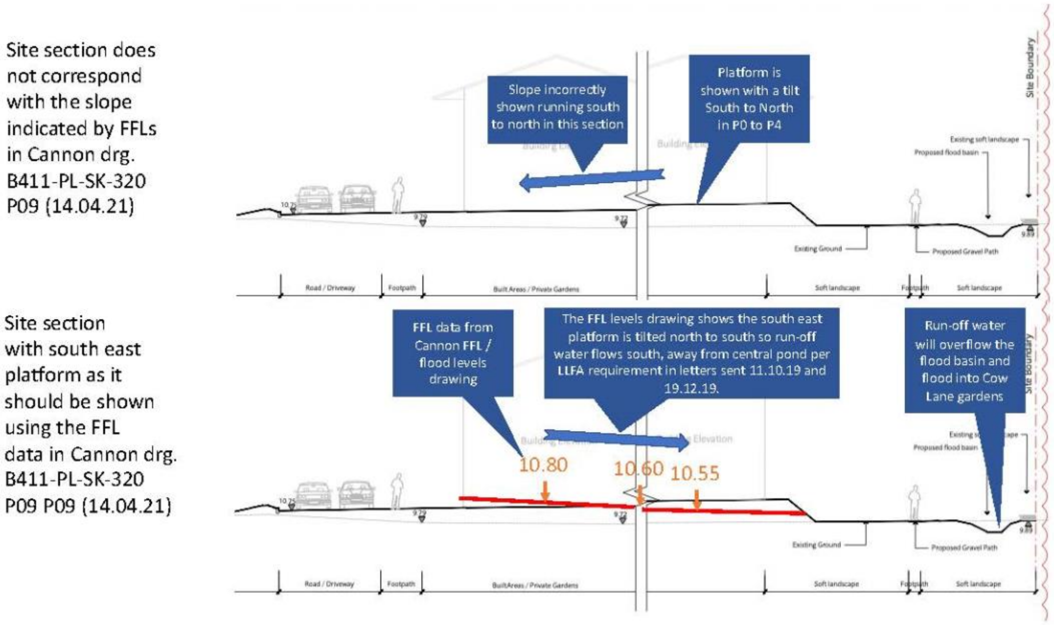

Figure C8. Serial section amended by Rule 6 party (red line) to match the appellant's site plan produced on 14.04.21.

Orange figures are finished floor levels taken from the site plan B411-PL-SK-320 version P09, 14/04/2021[9]. Site section is taken from TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections, version P04 (12 April 2021)[10]. This comparison indicates that the provided site sections are not consistent with the contemporaneous site plan (figure C7) B411-PL-SK-320 version P09, 14/04/2021[11].

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[9] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]

[10] TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 April 2021)[Folder ref. Doc_4_]

[11] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]

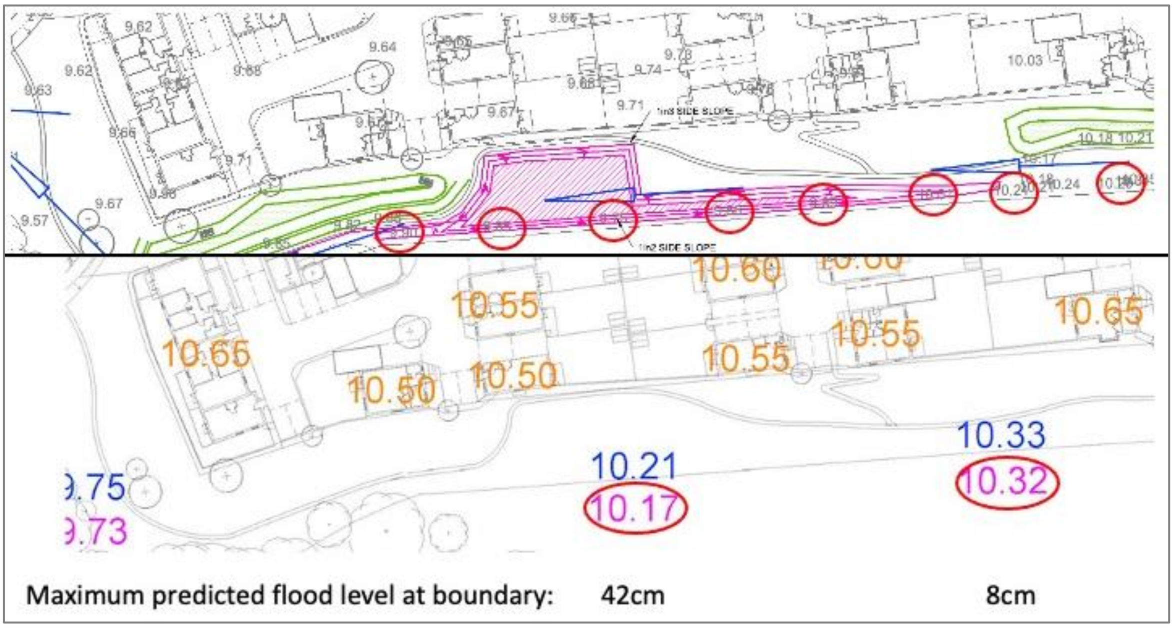

Figure C9. Predicted flood levels at southern boundary submitted to October 2021 Planning Committee Meeting.

Boundary land levels are shown in red circles the upper panel, with 100 year +40% predicted flood levels (pink numbers in red circles) in the lower panel. Simple arithmetic shows that flood levels are substantially (8-42 cm) above the level of the land at the boundary along most or all of the southern boundary, indicating likely flooding to many properties along Cow Lane. Taken from B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[12] and B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[13].

[12] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]

[13] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]

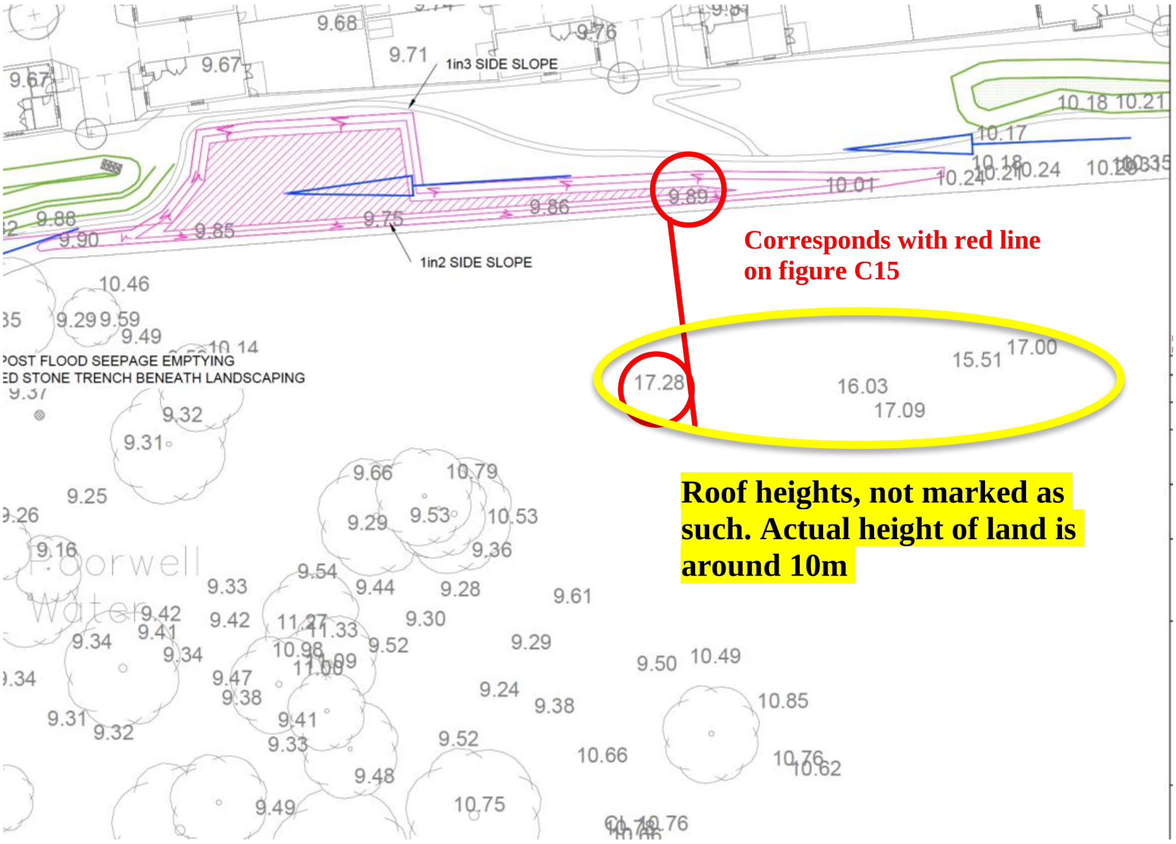

Figure C10. Topology data shows roof heights only for Cow Lane properties.

It is unknown whether roof heights were fed into flood modelling. Taken from B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[14] and COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426.pdf[15].

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14 B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]

15 B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]

Date	WS3a (mbgl)	WS6a (mbgl)	WS1a (mbgl)	Residents' readings (WS1a) for comparison	Maximum discrepancy
05/02/2015	0.92	0.63	0.65		
16/02/2015	1	0.66	0.75		
13/03/2015	1.03	0.67	0.74		
28/04/2015		0.6	0.79	0.65 (12.04.22)	**0.14**
28/05/2015	1.14	0.59	0.81		
05/06/2015	1.08	0.66	0.88	0.43 (01.06.21); 0.45 (04.06.21)	**0.45**
16/11/2016	1.1	***Highest reading borehole goes “missing”***	0.8		
18/01/2016	1.03		0.68		
24/02/2016	1		0.71		
23/03/2016	0.78		0.98	0.45 (07.03.22)	**0.53**
19/04/2016	0.99		0.68		
20/05/2016	1.25		1		

Figure C11. Appellant’s and residents’ bore hole readings.

Data from page 36 of B411 Surface water management (12 September 2019)[16]. Note that the highest reading bore hole went “missing” in the wetter of the two years that readings were taken Bore hole WS1a readings by the appellant are compared with those by residents (right hand column).

[16] B411 Surface water management (12 September 2019)[Folder ref. Doc_16]

Figure C12. Example of bore hole WS1a reading 43 cm on 01.06.2021.

Measurement being taken by Dr David Wyllie; photograph by Dr Elizabeth Soilleux.

	January	February	March	April	May	June	July	August	September	October	November	December
Precipitation / Rainfall (mm)	45	33	41	41	45	49	48	52	50	49	51	49

Figure C13. Average monthly rainfall in Cambridge.

Note that if any consecutive 6 month period was selected, that giving the lowest values would be February to July, which was the period selected by the appellant in both 2015 and 2016 from which to present bore hole measurement data. Source: https://en.climate-data.org/europe/united-kingdom/england/cambridge-78/

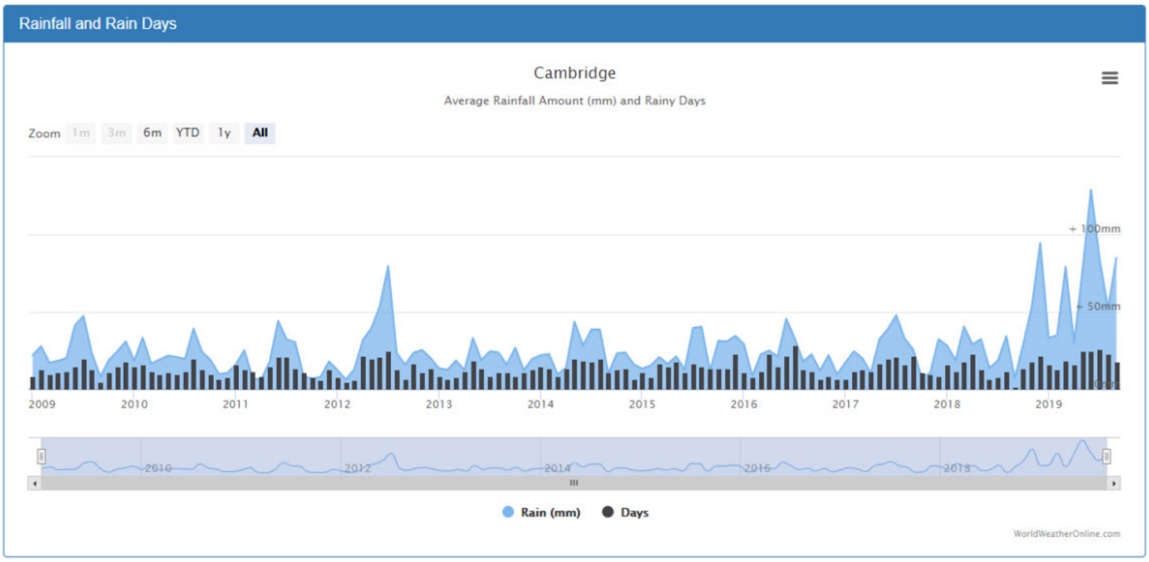

Figure C14. Representation of average annual rainfall in Cambridge.

Source: https://www.worldweatheronline.com/cambridge-weather-history/cambridgeshire/gb.aspx

Figure C15. Ground levels in 60 Cow Lane's garden for comparison with appellant's topology.

Appellant's ground levels are shown in red boxes, at the points to which they refer. Comparison with (figure C10), indicating that 60 Cow Lane's garden is flat, not part of the side of a ravine. Data taken from B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[17] and COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426.pdf[18].

[17] B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. Doc_21]
[18] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]

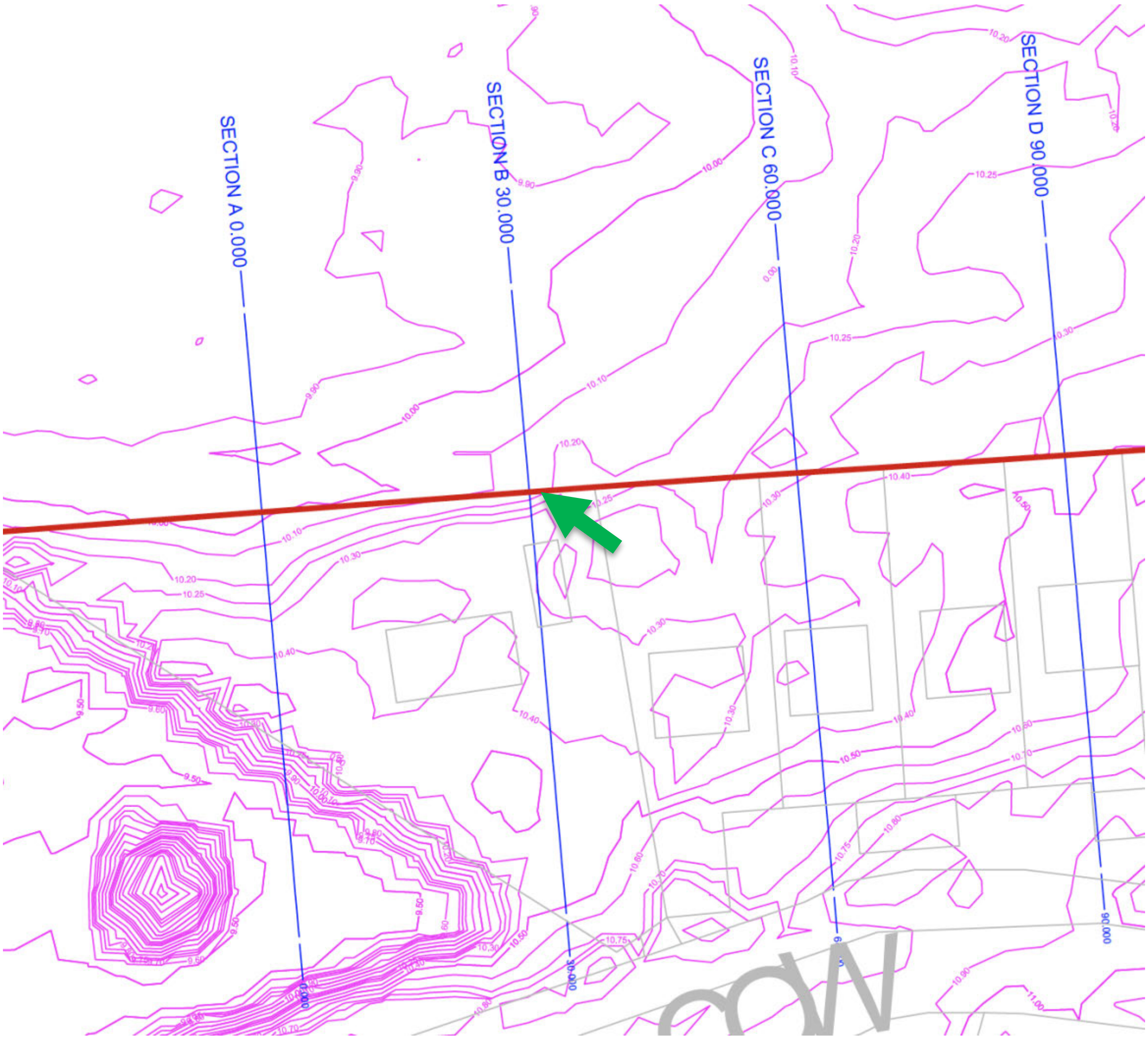

Figure C16. Topological data submitted by the appellant is in conflict with data in other appellant-submitted plans.

The red line is the southern boundary of the development. For comparison with figures C10 and C17, on which the boundary level at the point marked with the green arrow is 9.89 m. On this diagram, the same point is just below 10.2m. Taken from Fulbourn General Topological Plan Additional Information (from file title; no date provided)[19]

[19] Fulbourn General Topological Plan Additional Information (from file title; no date provided)[Folder ref. Doc_41]

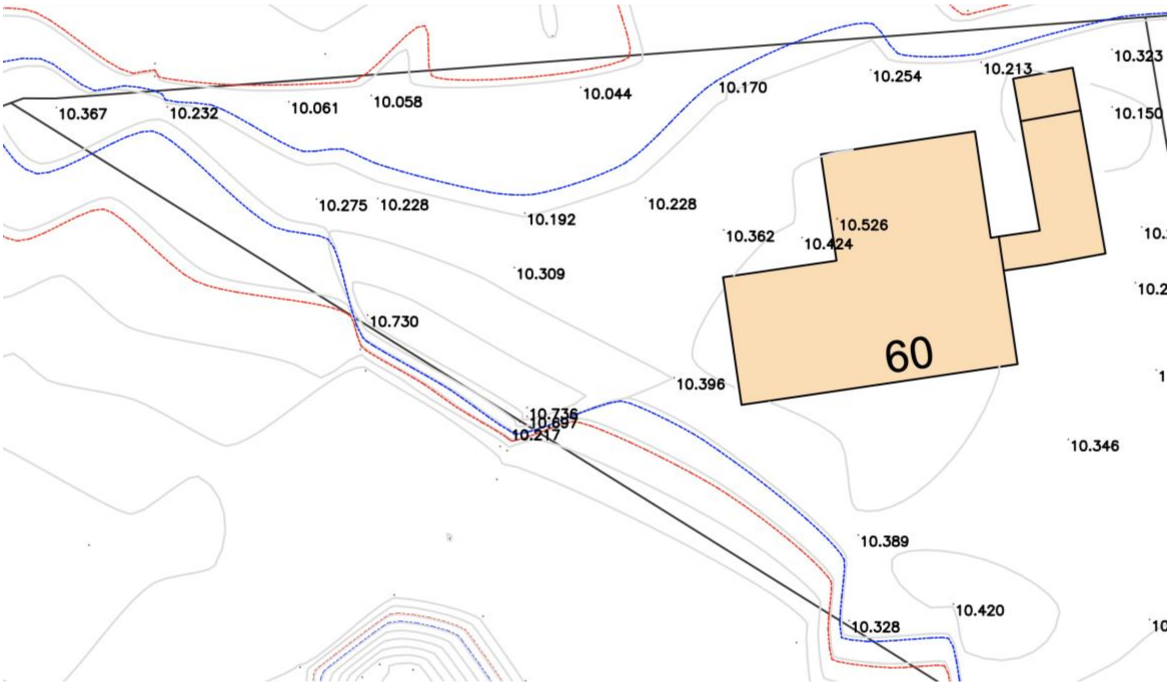

Figure C17. Topological survey commissioned by residents.

Resident commissioned topological survey[20] for comparison with figures D12 and D14. Blue line represents 10.17m (level of predicted 100 year +40% flood in surface water management plans, P09), while red contour line represents 9.97m (level of predicted 100 year +40% flood in new surface water management plans submitted in April 2022 for the Appeal Inquiry hearing), indicating that these floods will cross the southern boundary, consistent with the concerns of residents. As the flood risk assessment is based on multiply flawed data (Section 5 of main body of proof), this risk is likely to represent a substantial underestimate of the risk to properties along the southern boundary. Boundary ground heights concur with the appellant's resident commissioned topological survey[21], but Ordnance Survey data or other low resolution topological data has been used by the appellant for the remainder of the surrounding land. predicted 100 year +40% flood levels taken from B411-PL-SK-320 Flood Management Strategy (14/4/2021)[22] and B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[23].

[20] Topological survey of gardens of housing along Cow Lane (14 April 2022)[Folder ref. Doc_45]
[21] Topological survey of gardens of housing along Cow Lane (14 April 2022)[Folder ref. Doc_45]
[22] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[23] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

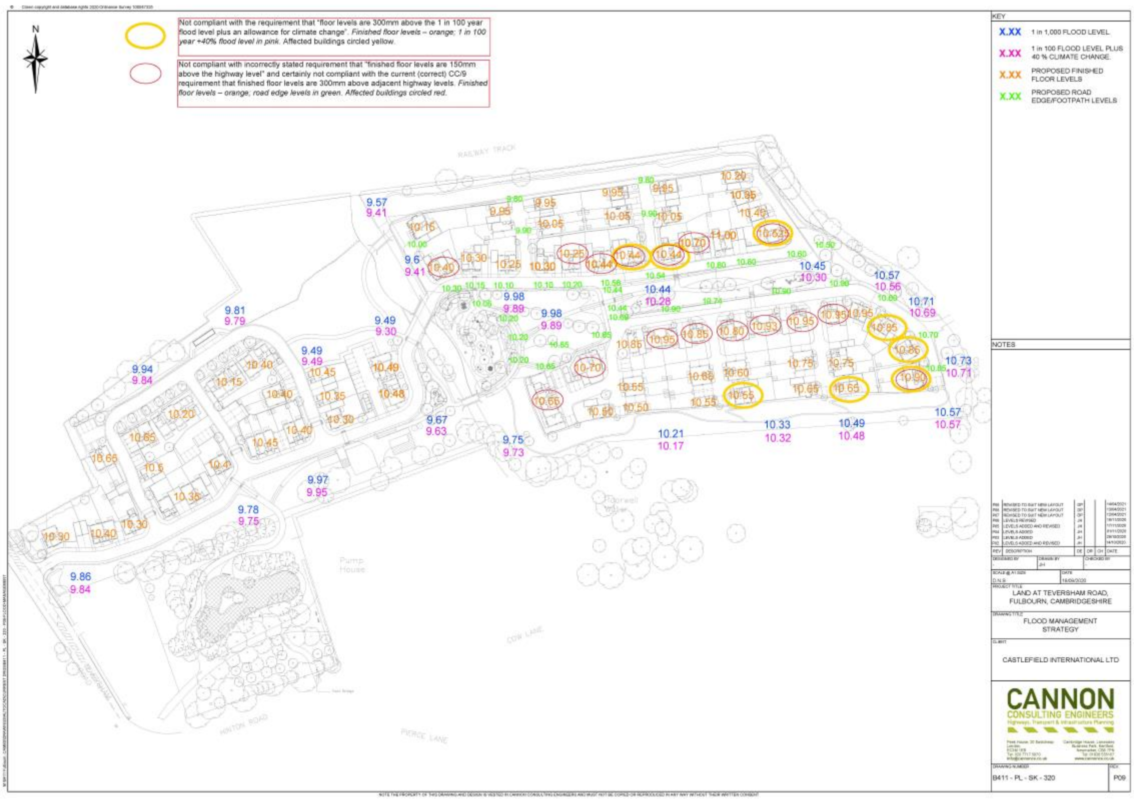

Figure C18. Annotated version P09 of the surface water management plans, showing multiple non-compliances with CC/9 of South Cambridgeshire Local Plan.

Non-compliances are marked with yellow circles (finished floor levels not 300 mm above 1 in 100 year flood level + 40%) and red circles ((finished floor levels not 300 mm above road level). Site plan B411-PL-SK-320 version P09, 14/04/2021[24] was the version considered by the Planning Committee on 13th October 2021. Details of South Cambridgeshire Local Plan can be found here[25].

[24] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]
[25] South Cambridgeshire Local Plan (Adopted September 2018)[Folder ref. Doc_6_]

Appendix D Material obtained via Freedom of Information Request

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Figure D1. Appellant's emailed hand annotated diagram shows the intention to drain the development site by flowing water onto surrounding properties.

This figure was emailed from the appellant to LLFA, on 23 October 2020. The blue lines are described as the "overland flow routes".

[redacted]

From: [redacted]
Sent: 10 November 2020 18:01
To: '[redacted]
Cc: [redacted]
Subject: RE: Teversham Road, Fulbourn-flood management

Evening [redacted]

The FFLs are above the 100 year plus CC levels, and we can add 10 mm to the FFL of the 10.7 FFL to make it up to the nearby thousand year flood level if that helps?

Re your second point the 9.98 flood level in the second of the two flood storage areas (I marked it up as area B I think) cant reasonably be applied to the areas to the north as the flood bank (the road on its northern boundary) prevents the water from spilling northwards.

As a point of detail the 10.1 is most likely the result of interrogating the triangulated flood level mesh for the area as the model is only reporting a depth of 0.001 m for the area. So the level is correct, but the flooding is incredibly shallow (the result of direct rainfall tipping off a surface). Interrogating the mesh immediately next to it (the red triangle on the screengrab below) generates a thousand year level of 9.571. The 100 year plus CC level of 9.41 is from the flood mesh triangle a couple of meters away (second screengrab below). Would it help if shifted the 9.41 m flood level on the plan a couple of metres south?

Figure D2. Email from appellant to LLFA, indicating willingness to move a flood level on the plans.

The reason for moving the figure of 9.41m does not appear to be data driven and raises questions about data manipulation (my highlighting).

From: [redacted]@cambridgeshire.gov.uk>
Sent: 26 August 2021 12:24
To: [redacted]
Subject: RE: Teversham Road, Fulbourn - S/3290/19/RM

Good afternoon [redacted]

Apologies on the delay with this one. I have been catching up with everything following some leave.

I have had a look through the information and have a few concerns and queries. Would you prefer these in an email or formal letter?

The concerns are around consistency between the finished levels that have been provided on the topo surveys as they do not match that within some of the other plans. For example, the topo survey provided indicates that the ground levels at the sites southern boundary are approximate 10.20m AOD, whereas the previously submitted information indicates that this level is closer to 9.8m AOD. This discrepancy is around 0.4m between the plans.

The other concern I think needs raising is around these groundwater levels. The ground investigation was undertaken a few years ago, and I am unsure what the weather conditions were at the time of these being undertaken, but the record shows a groundwater level of approx. 0.8m below ground level. When you were out on site with the residents, there is evidence to indicate that this groundwater level may be higher, at around 0.4m below ground level. I think this may need to be looked into, as I am uncertain whether this will require a change in the design if the groundwater levels will fluctuate to a higher level than previously anticipated.

I am conscious that this is a reserved matters application, so would appreciate some guidance as to whether these are valid things to raise at this point, or whether it is better dealt with under the discharge of conditions application?

Kind regards

Figure D3. Email correspondence between the LLFA and planning officer, indicating awareness of inaccurate borehole readings and site topology data.

This email shows there was concern about whether it was appropriate for these matters relating to surface water management to be dealt with under the discharge of conditions application or as reserve matters. It also admits the LLFA's uncertainty about ground water levels and topology.

Appendix E Figures for new versions of surface water and drainage management plans April 2022 (effectively version P10)

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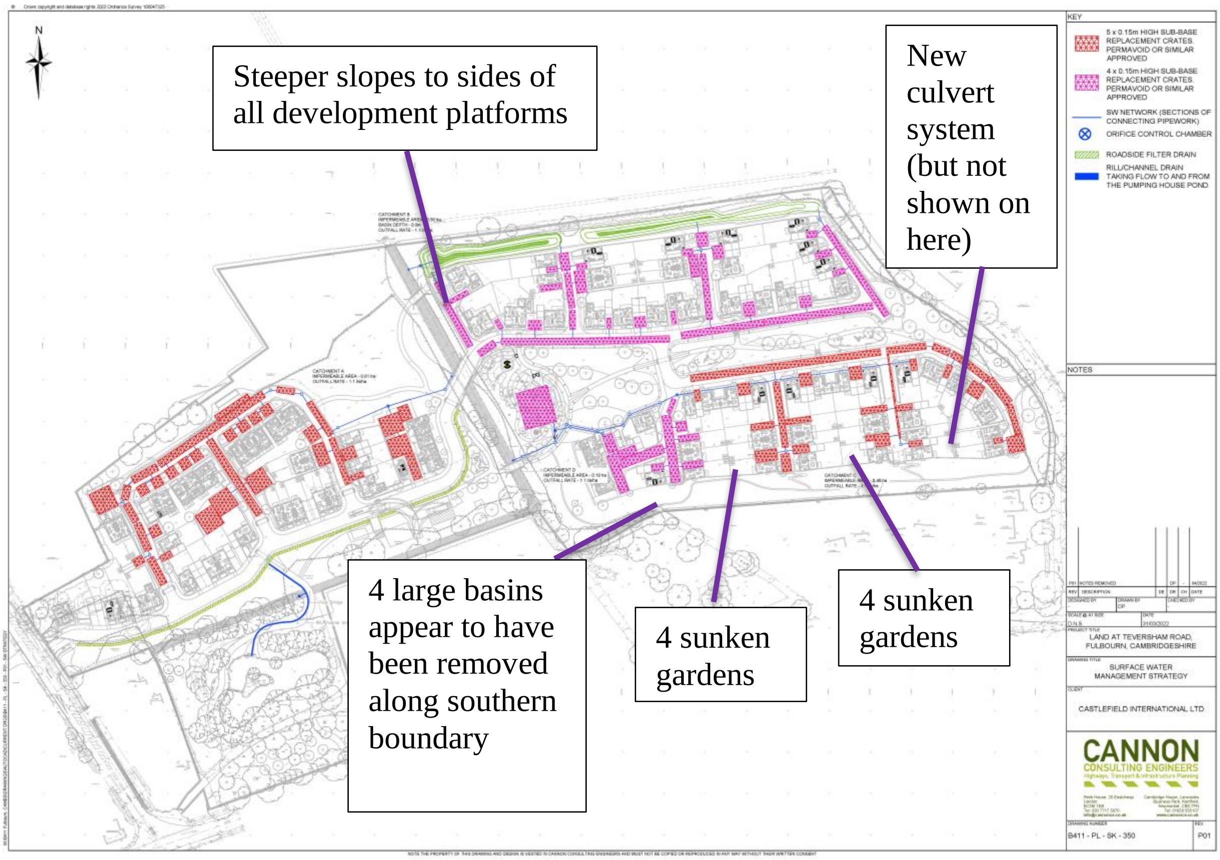

Figure E1. New flood management plans presented for the Appeal, which are very different from version P09 (second version) rejected by the Planning Committee in October 2021.

Figure taken from page 11 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[1]. Changes are determined by reading the appellant's notes and comparing the figure on page 11 of these notes withTRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)[2]. Note that the new south to north culvert emanating from the south-eastern corner is absent from this set of plans, but present in the HR Wallingford model (shown in figure E3, Appendix E).

[1] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

[2] TRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)[Folder ref. Doc_46]

Figure E2. New flood management plans presented for the Appeal, shows very substantial changes in finished floor levels on the northern development platform compared with the previous version (P09) of the flood mitigation strategy that was rejected by the Planning Committee in October 2021.

Upper part of figure taken from April 2022 surface water management strategy, page 10 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[3]. Lower figure taken from flood mitigation strategy version P09, April 2021, presented to the Planning Committee in October 2021 B411-PL-SK-320 Flood Management Strategy (14/4/2021)[4]. Circles show all the finished floor levels amended in April 2022, some by as much as 500mm, altering the slope of parts of the northern development platform.

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[3] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

[4] B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. Doc_40]

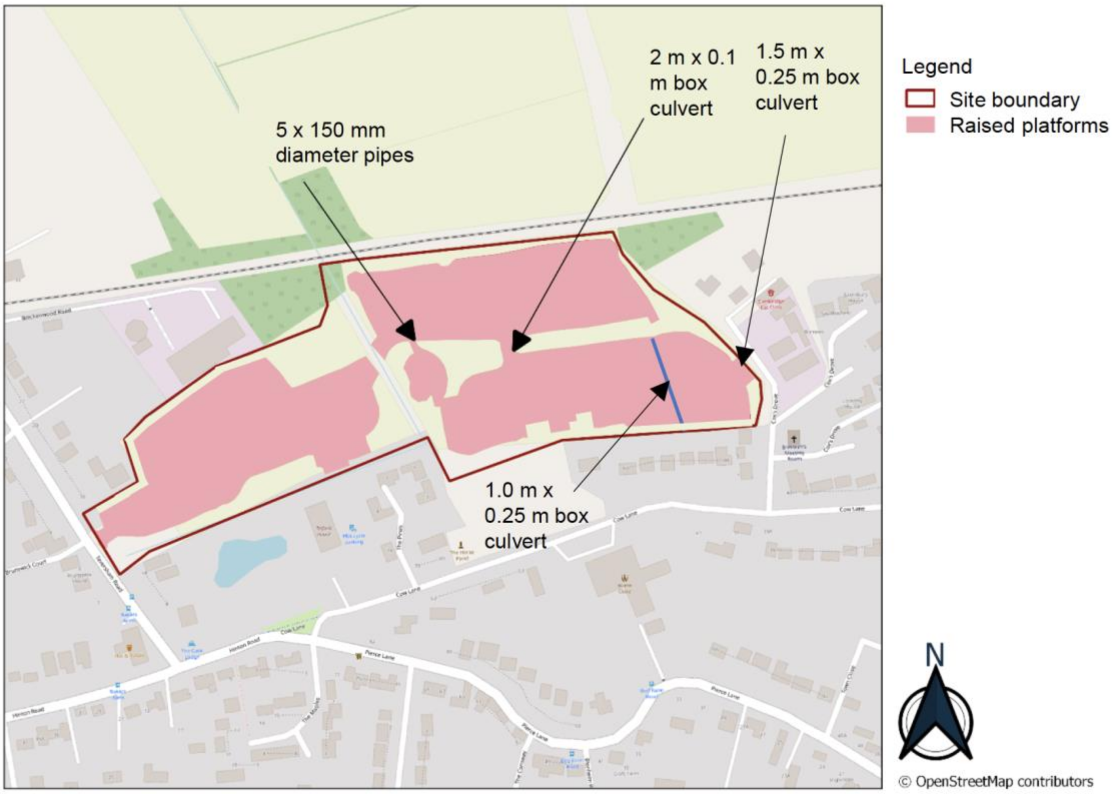

Figure 3.1: Development scheme showing the areas of land which are proposed to be raised

Figure E3. New culvert, details of which are shown only in the HR Wallingford report and not on Cannon's own plans (figure E1, Appendix E).

Figure reproduced from HR Wallingford's "Update to surface water flood management" (1 April 2022)[5].

[5] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

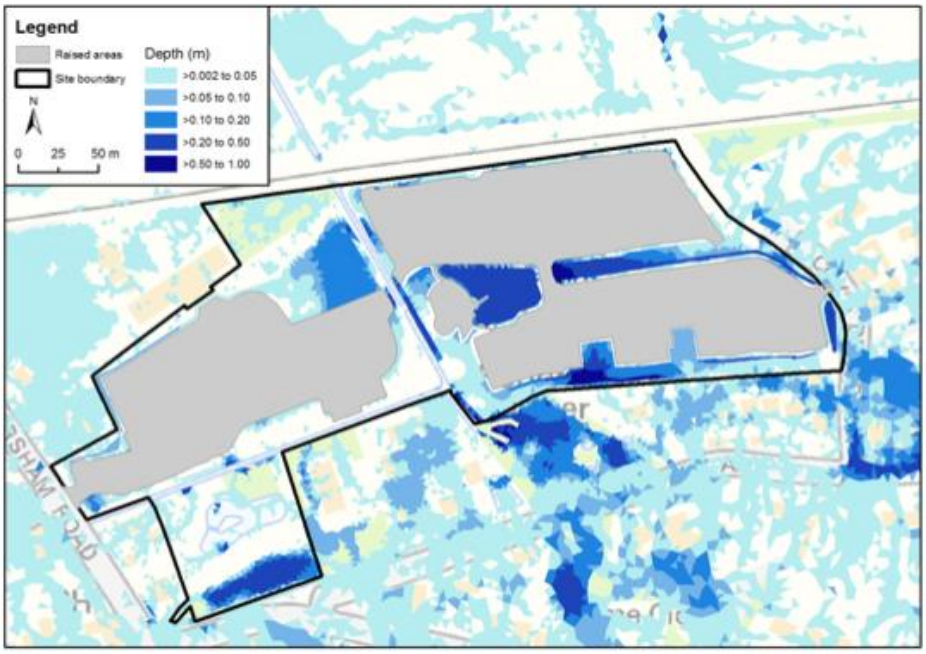

Figure 4.7: Surface water flood depths for the 1 in 100 year climate change rainfall with development in place

Figure E4. Predicted 1 in 100 year plus climate change flooding reproduced from figure 4.7 of the April 2022 HR Wallingford report.

Note "Update to surface water flood management (1 April 2022)"[6] predicts deep flooding along the southern boundary near the south-eastern development platform adjacent to the Cow Lane properties.

[6] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

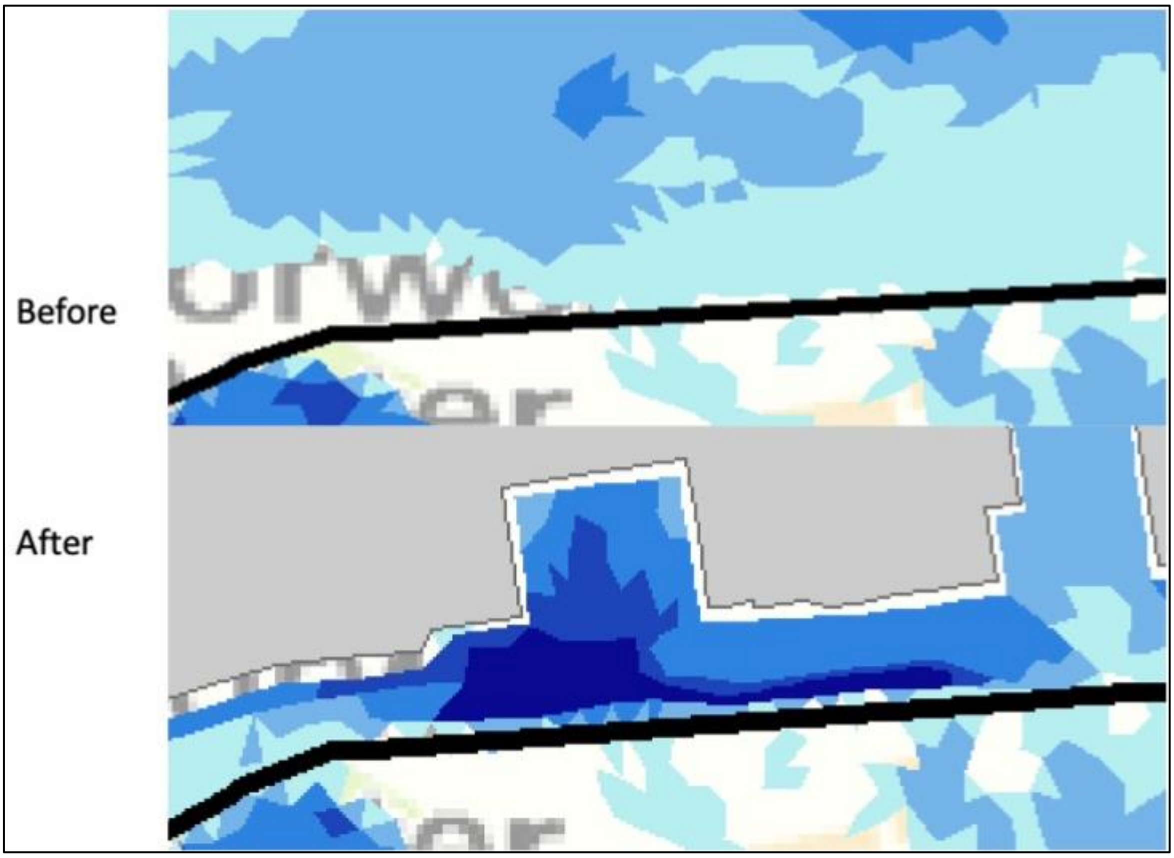

Figure E5. Predicted 1 in 100 year plus climate change flooding, region along 60 Cow Lane boundary before and after development.

Deeper colours indicate increased flood depths including to the boundary post development (lower panel) compared with pre-development (upper). Magnified from figure 4.7 of " Update to surface water flood management" (1 April 2022)[7].

[7] Update to surface water flood management (1 April 2022)[Folder ref. Doc_17]

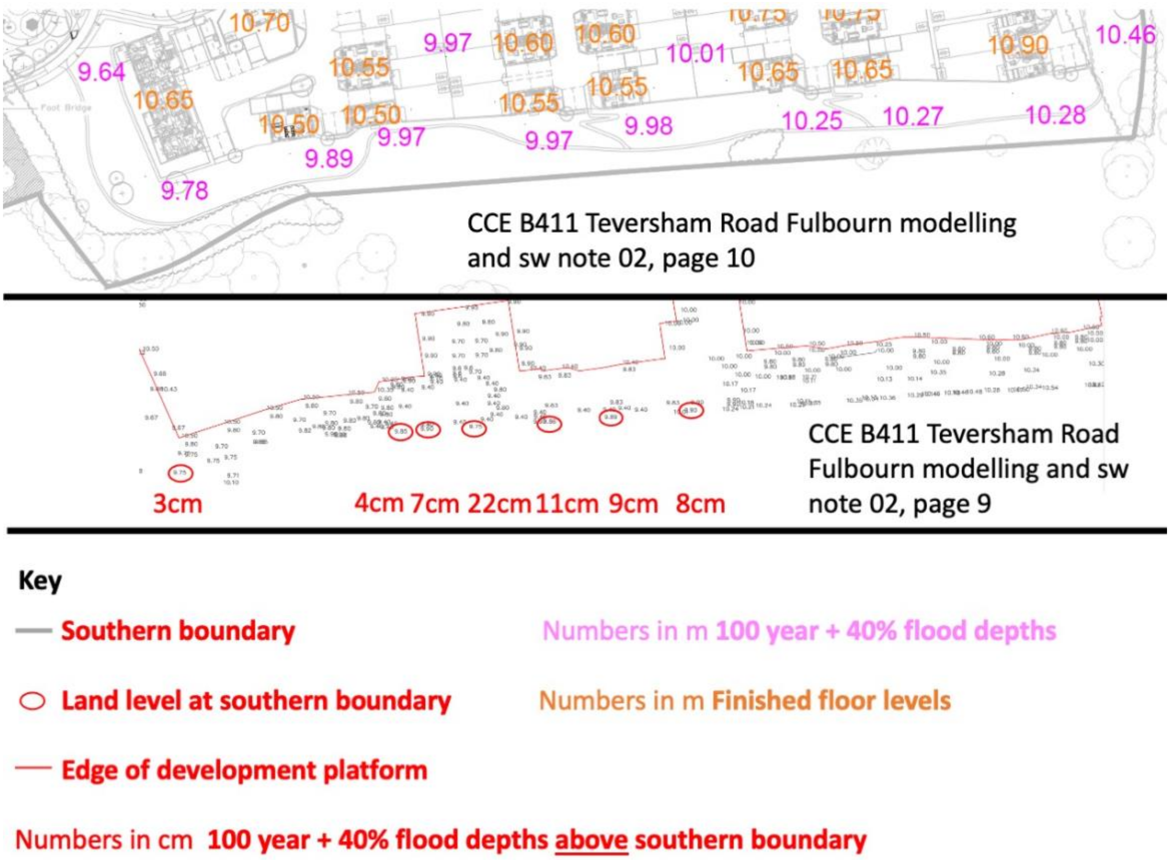

Figure E6. Predicted flood level at development boundary calculated by subtracting boundary land levels from the adjacent predicted 1 in 100 year plus climate change flooding.

All information was taken from pages 9 and 10 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[8]. Boundary levels are also confirmed by data in figure C10, (Appendix C) B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[9].

[8] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

[9] B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. Doc_19]

Figure E7. Chainlink fencing at the southern boundary of the proposed development at approximately the point where the boundary land level is 9.75m, looking from the garden of 60 Cow Lane into the proposed development site at the bottom of the fence.

The chainlink fence is most unlikely to stop flood water 22cm deep (figure E6) from crossing this boundary.

Figure E8. Lack of topological information at boundary with the Pines.

The Pines development is marked "P". Thumbnail taken from page 8 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[10].

[10] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

Figure E9. HR Wallingford was provided with topological input data (albeit incorrect data) for the western development platform, but no input data were provided for the north-eastern or south-eastern development platforms.

Data taken from page 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[11].

[11] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

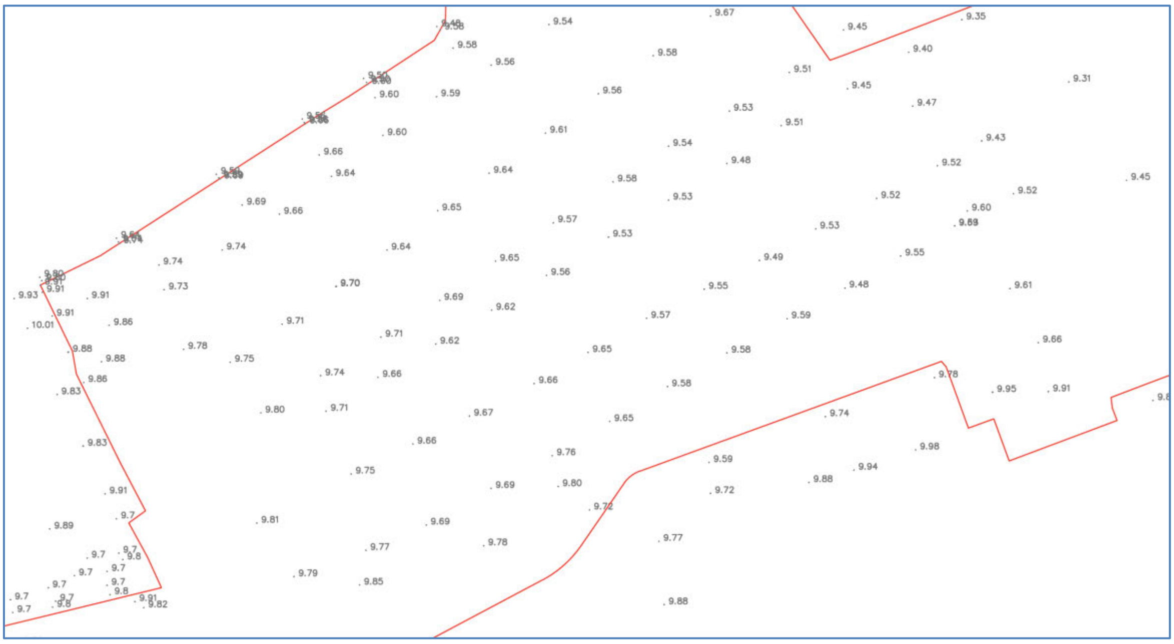

Figure E10. Incorrect data for post-development height of the western development platform submitted to HR Wallingford for flood modelling by Cannon Consulting Engineers.

The heights shown are pre-development heights. Note that the levels on the platform marked as being as low as 9.31m shown here and 9.22 m in one place (figure 41), possibly below the ground water level at some times of year, compared with actual post-development heights of 10.15 – 10.65m (figure 40). Taken from page 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[12].

[12] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

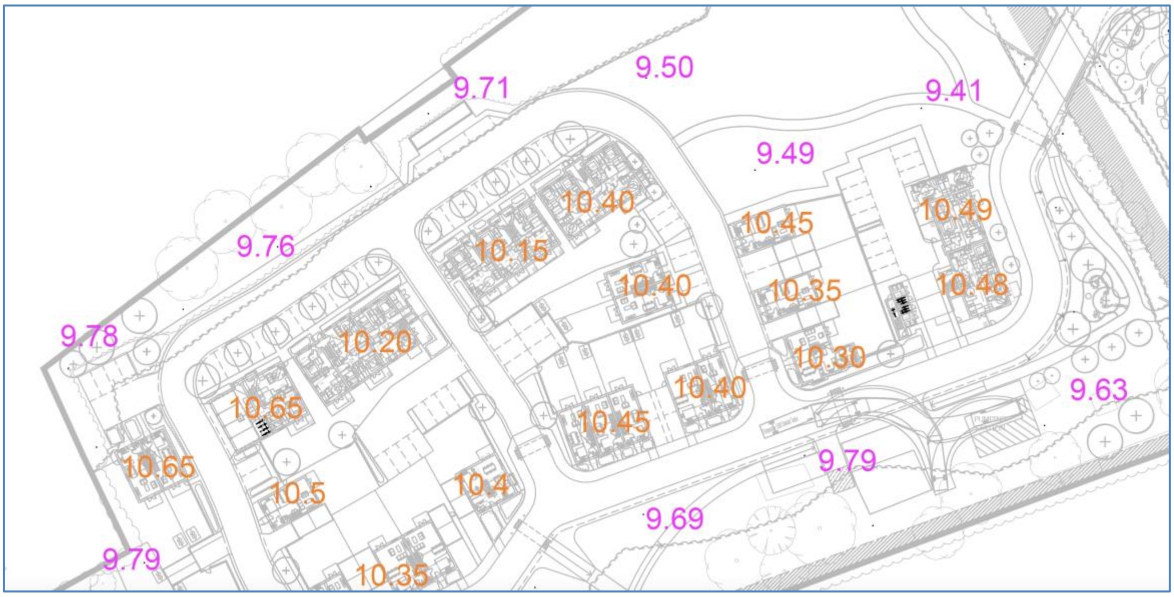

Figure E11. Actual post-development heights on Western development platform.

For comparison with figure 39. Taken from page 10 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[13].

[13] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

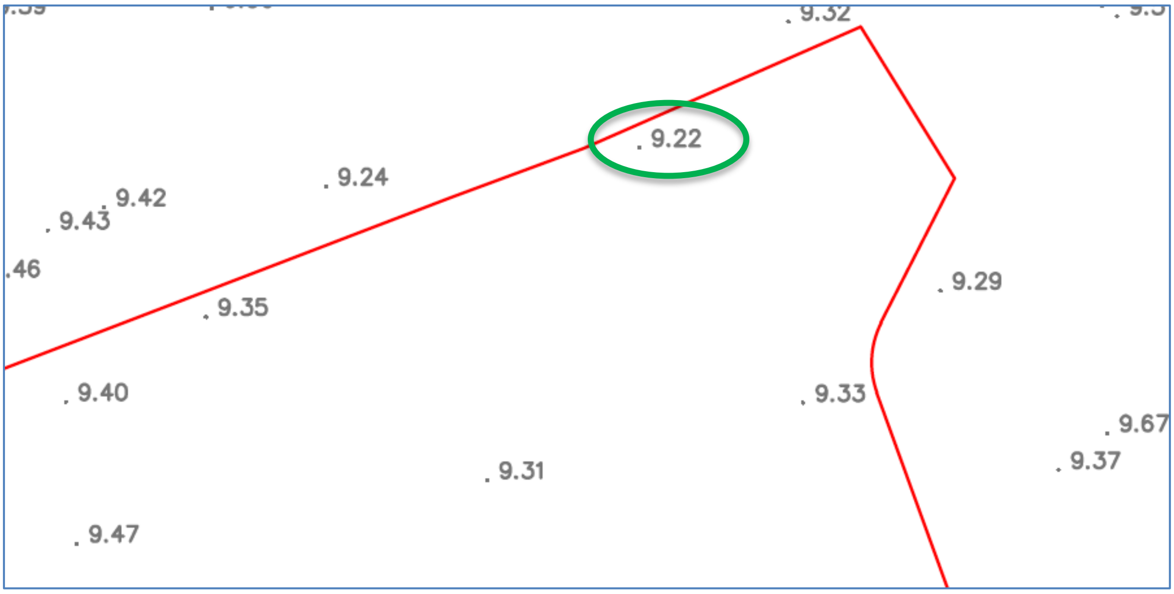

Figure E12. Western development platform labelled as being as low as 9.22m, meaning that either houses on it will flood or HR Wallingford was given erroneous data.

9.22 m (my green circle) is below the water table at times, when it is as high as 9.3m (as measured by residents (calculated by combining figure 21 and figure 48, as explained in paragraph 121). Taken from page 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[14].

[14] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

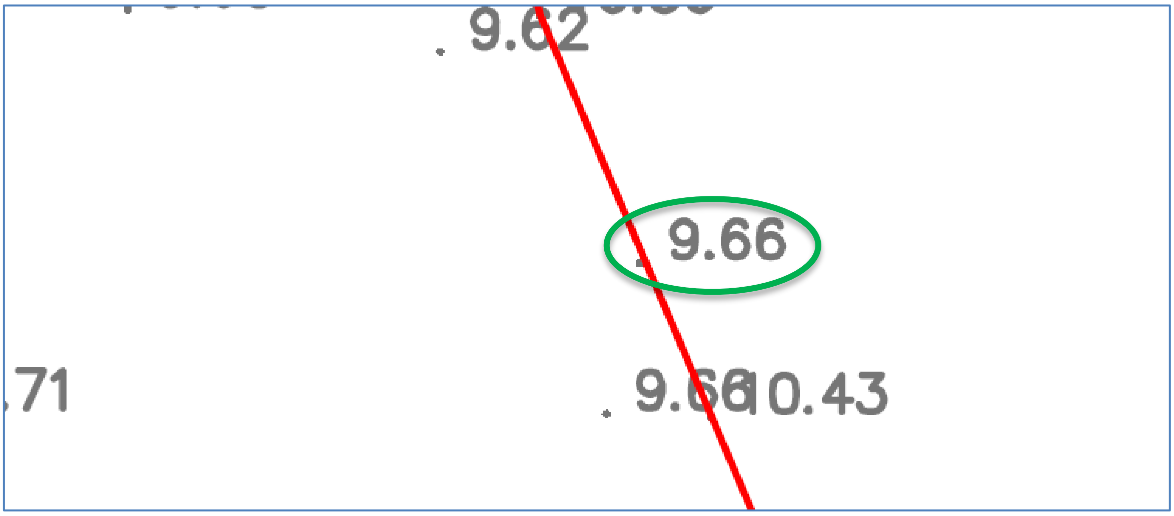

Figure E13. South-eastern development platform western edge, with existing, rather than proposed, ground level labelled on platform edge, in input data provided to HR Wallingford, raising the risk of incorrect interpolation of topology.

This indicates that input data given to HR Wallingford may have been erroneous. Taken from page 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[15].

[15] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

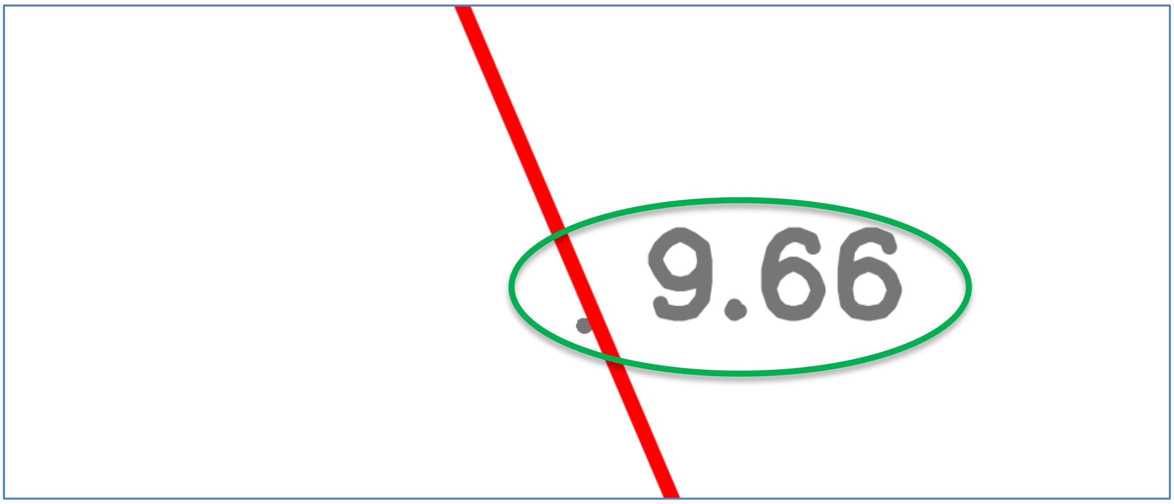

Figure E14. South-eastern development platform western edge, with existing, rather than proposed, ground level labelled on platform edge (higher magnification), in input data provided to HR Wallingford, raising the risk of incorrect interpolation of topology.

This indicates that input data given to HR Wallingford may have been erroneous. Taken from page 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[16].

[16] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

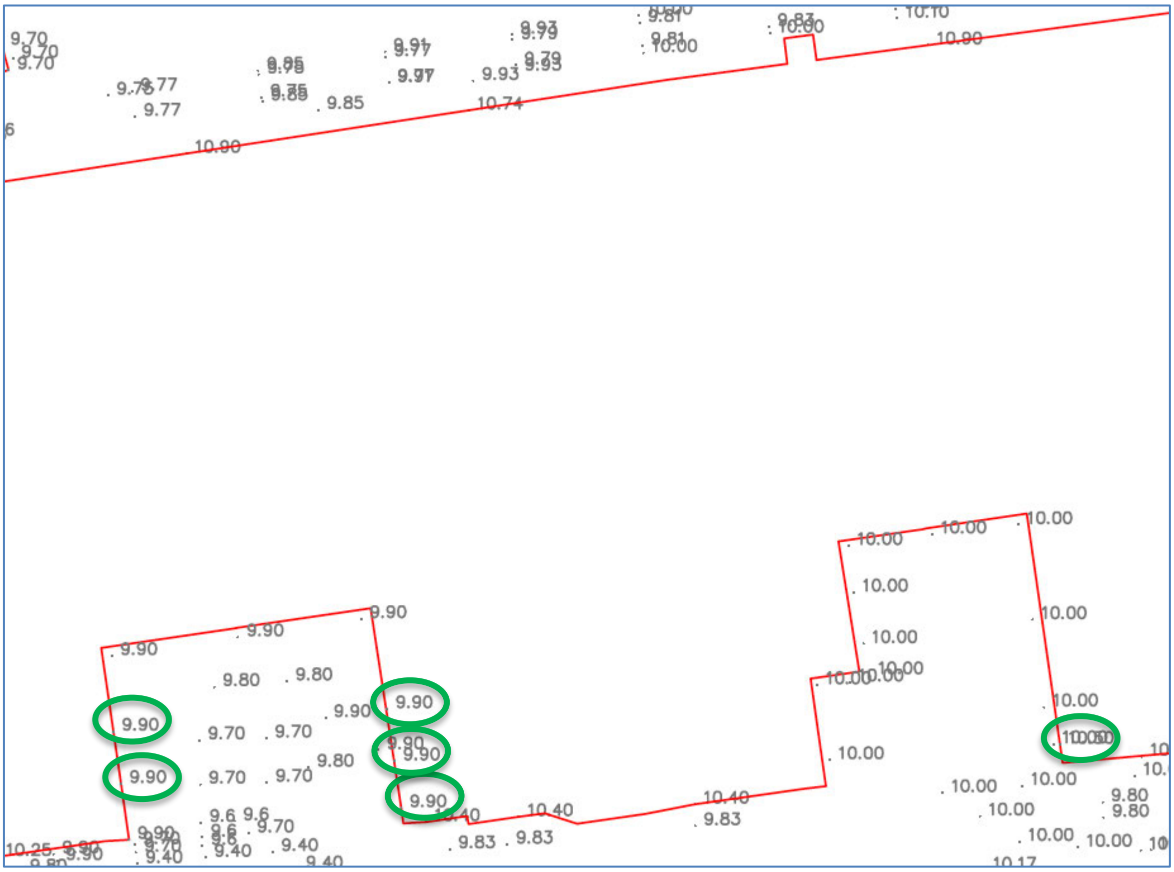

Figure E15. South-eastern development platform as shown in input data provided to HR Wallingford bears no post-development (platform-level) topology, except at its edge, which is incorrect around sunken gardens

As explained in figures 44 and 45, all other parts of the red line representing the edge of the development platform bear on-platform levels. Around the sunken gardens, the red line itself bears garden (off-platform) levels (green circles). Interpolation of heights across the platform must have been undertaken, due to the lack of information and this would presumably have caused the height of parts of the platform to be underestimated by up to 50cm (0.5m). The screenshot from this plan indicates that HR Wallingford was given erroneous data, which is likely to have led to an underestimate of the risk of flooding at the southern boundary. Taken from page 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[17].

[17] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

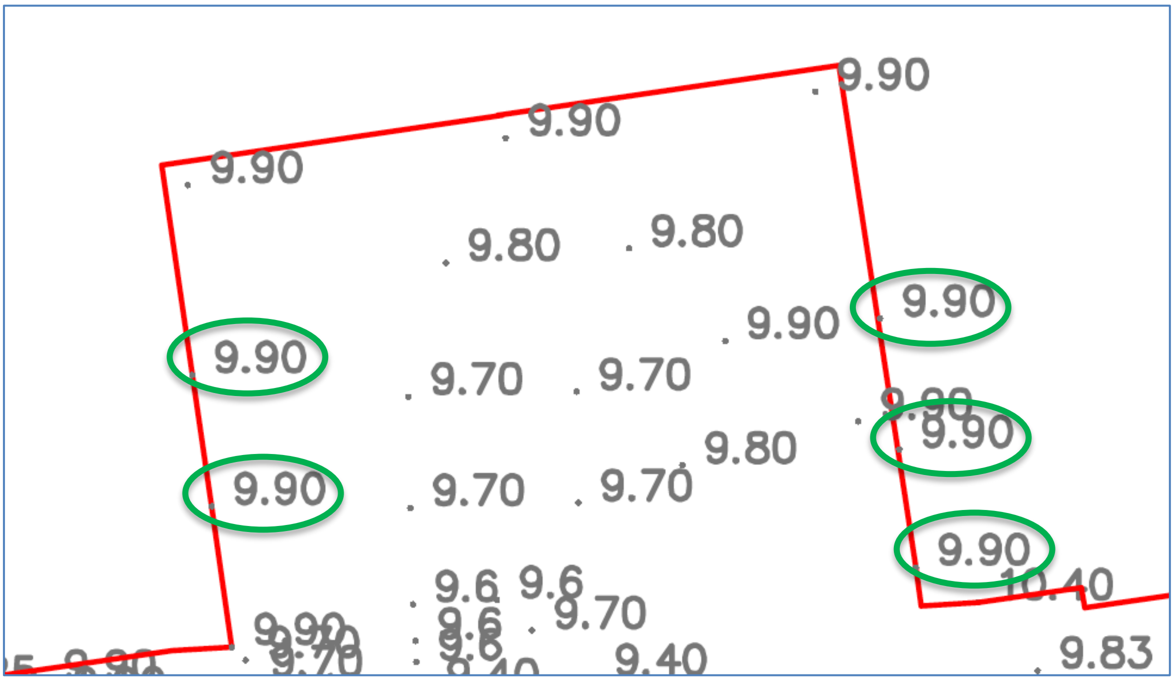

Figure E16. South-eastern development platform western sunken gardens as shown in input data provided to HR Wallingford is incorrectly labelled around western sunken gardens.

Some of the ground levels pertaining to the gardens (9.90m in green circles) are labelled as being on the red line, while no proposed heights (which should be in excess of 10.40m) are present on the red line. If interpolation is used, a computer will presumably assume that this red line is at 9.90m and therefore make incorrect assumptions for most or all parts of the south-eastern development platform. Residents assume that lowering the apparent height of this development platform is likely to decrease the rate of surface water flow off it. This indicates that HR Wallingford was given erroneous data. This is likely to have led to an underestimate of the risk of flooding at the southern boundary. Taken from page 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[18].

[18] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

Figure E17. South-eastern development platform western sunken gardens as shown in input data provided to HR Wallingford is incorrectly labelled around eastern sunken gardens.

Some of the ground levels pertaining to the gardens (10.00m in green circles) are labelled as being on the red line, while no proposed heights (which should be in excess of 10.50m) are present on the red line. If interpolation is used, a computer will presumably assume that this red line is at 10.00m and therefore make incorrect assumptions for most or all parts of the south-eastern development platform. Residents assume that lowering the apparent height of this development platform is likely to decrease the rate of surface water flow off it. This indicates that HR Wallingford was given erroneous data. This is likely to have led to an underestimate of the risk of flooding at the southern boundary. Taken from page 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[19].

[19] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

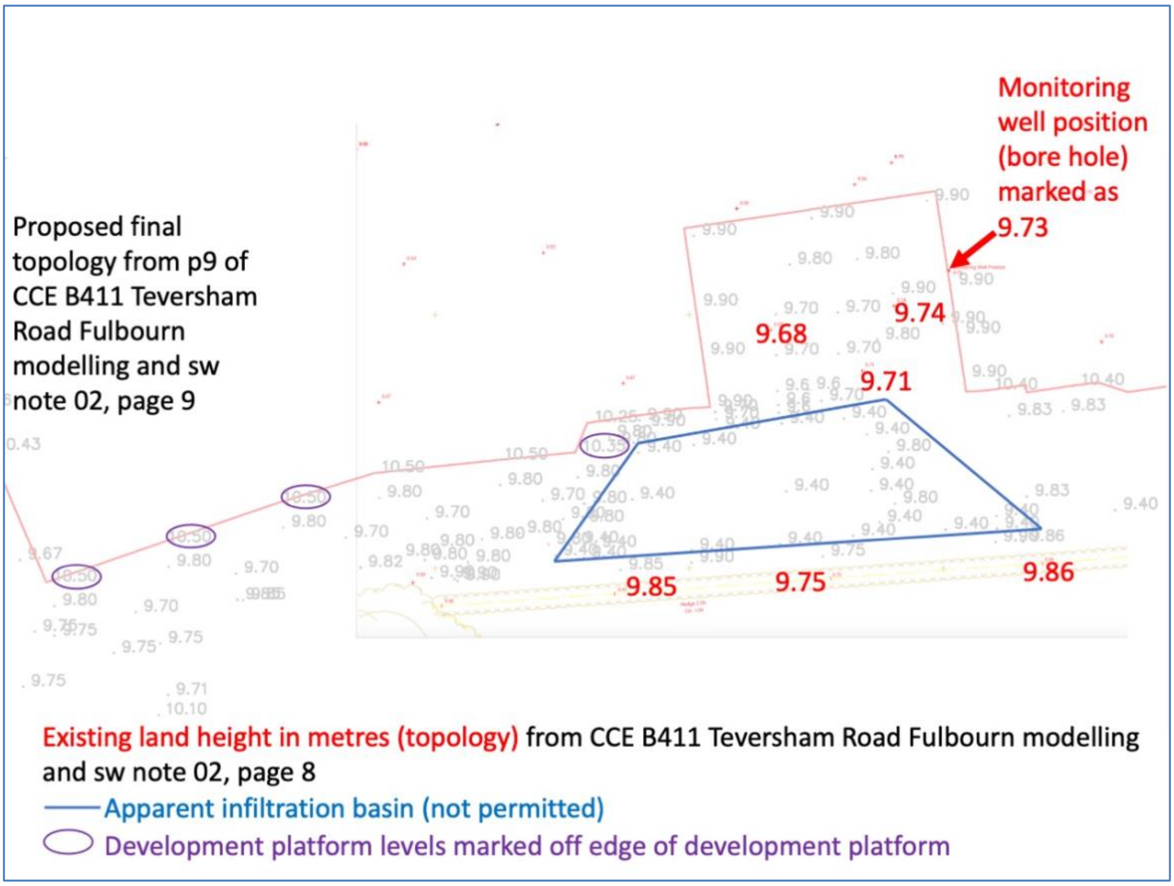

Figure E18. Lowered land at the former site of the proposed Cow Lane Flood Basin indicates that this area is to be used as an infiltration basin (not permitted by the SuDS Manual[20], Table 13.1, p13-5, due to high ground water level).

Produced by overlying images from pages 8 and 9 of B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[21]. Monitoring well/ borehole at which residents' most superficial reading was 43cm (0.43m) below ground level is marked and this indicates that the position of the water table (ground water level) can be as high as 9.3m AOD at this point (paragraph 98 of main text of proof).

[20] The SuDS manual (2007)[Folder ref. Doc_53]

[21] B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. Doc_18]

Figure E19. Finished floor levels are not 300mm above road levels, with some at or below road levels.

Finished floor levels – orange
100 year plus climate change flood levels – pink
Road levels (added by Dr E. Soilleux) – green.

Finished floor levels should "where appropriate and practicable" (and surely that requirement must be appropriate here, given the potential flood risk to proposed dwellings) be 300 mm above road levels. Thus, the plans are not compliant with South Cambridgeshire Local Plan CC/9[22]. Road levels taken from TRF-CBA-1-GF-M2-L-1010, version P06, 12/04/2021[23] and TRF-CBA-1-GF-M2-L-1011, version P06, 12/04/2021[24].

[22] South Cambridgeshire Local Plan (Adopted September 2018)[Folder ref. Doc_6_]
[23] TRF-CBA-1-GF-M2-L-1010 1000 Series Hard Landscaping Sheet 1 (12 April 2021)[Folder ref. Doc_57]
[24] TRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)[Folder ref. Doc_46]

Appendix F Commentary on flood modelling by Professor Roger Falconer and Dr Dongfang Liang

SECTION 78 OF THE TOWN AND COUNTRY PLANNING ACT 1990 (AS AMENDED)

INQUIRY INTO THE APPEAL BY CASTLEFIELD INTERNATIONAL LIMITED AGAINST REFUSAL OF RESERVED MATTERS APPLICATION BY SOUTH CAMBRIDGESHIRE DISTRICT COUNCIL AT LAND AT TEVERSHAM ROAD, FULBOURN

REPORT COMMISSIONED BY SAVE FULBOURN FIELDS AND FULBOURN FORUM (RULE 6 PARTY)

BY

PROF ROGER A FALCONER FREng ForMemCAE PhD DSc(Eng) CEng CEnv C.WEM FICE FCIWM AND DR DONGFANG LIANG MA PhD CEng MICE

Planning Appeal Ref: APP/W0530/W/22/3291523
Planning Application Ref: S/3290/19/RM

TOWN AND COUNTRY PLANNING

(INQUIRIES PROCEDURE) (ENGLAND) RULES 2000

Table of Contents

1. INTRODUCTION

1.1 PROF FALCONER BIO-DETAILS

1.1.1. Roger Falconer is Emeritus Professor of Water and Environmental Engineering (previously Professor 1997-2018) in the School of Engineering at Cardiff University, Chair Professor in the Yangtze Institute for Conservation and Development at Hohai University (China), Director of Roger Falconer Water Consultancy and Director of two other engineering and environmental companies. He was previously Head of the Department of Civil and Environmental Engineering and Professor of Environmental Hydraulics at the University of Bradford (1986-97) and Lecturer in Hydraulics at the University of Birmingham (1977-86). His research, development and consultancy interests are in water-environmental modelling, including flooding, where his models have been acquired by over 40 companies and government agencies and applied to over 100 Environmental Impact Assessment studies worldwide. His DIVAST (Depth Integrated Velocities And Solute Transport) model provides one of the 2-D engines available within Flood Modeller (by Jacobs) and is one of the most widely used models, both in the UK and internationally, for flood risk modelling (www.floodmodeller.com). He has published over 400 papers in journals and conference proceedings (many on flooding), with a h-index of 61, and has delivered over 550 presentations world-wide on flooding, water quality, tidal energy and water security.

1.1.2. Roger Falconer has a PhD from Imperial College (1976), and higher doctorate degrees from the universities of Birmingham (DEng, 1992) and London (DSc(Eng), 1994). He is a Fellow of the: Royal Academy of Engineering, Chinese Academy of Engineering (Foreign Member), European Academy of Sciences (EurASc), Institution of Civil Engineers (CEng, CEnv), and Chartered Institution of Water and Environmental Management (CEnv, C.WEM). He was President (2011-15) and now Hon Member (2017) of the International Association for Hydro-Environment Engineering and Research (IAHR). He has received many awards for his research and its impact, including the Royal Academy of Engineering Silver Medal (1999).

1.1.3. He consults regularly on UK and international flooding projects, currently serves as a member of the Thames Water Independent Expert Group (of 3) (reviewing the June 2021 London Floods), Chairs the Wharfe Partnership Board (founded following the Defra announcement of the UK's first riverine bathing water on the River Wharfe, Ilkley), and serves on the Environment Agency's Yorkshire Region Flood and Coastal Committee. He has previously served on the UK Government's National Flood Resilience Scientific Advisory Group and the Welsh Government's Flood Risk

Management Committee (2006-16). He regularly gives TV and media interviews on flooding events.

1.2 DR LIANG BIO-DETAILS

1.2.1. Dongfang Liang is an Associate Professor at the University of Cambridge and Fellow of Churchill College. He is a Chartered Engineer (CEng) and a Fellow of the Higher Education Academy (FHEA). He is an Associate Editor of the Journal of Hydrodynamics and Proceedings of the ICE – Maritime Engineering, Co-chair of the Institution of Civil Engineers (ICE) Cambridgeshire Branch, and a Technical Programming Committee member of the International Society of Offshore and Polar Engineers (ISOPE). He was awarded: the Matsumae International Fellowship, Alexander von Humboldt Fellowship for Experienced Researchers, Marie Curie Fellowship and Royal Academy of Engineering Industrial Fellowship. He has received several Best Paper Awards.

1.2.2. Dr Liang obtained his BEng and PhD degrees from Tsinghua University, China. His main research interests lie in hydrology and hydraulics, in which fields he has published over 200 refereed journal and conference papers, with a h-Index of 25. Before joining the University of Cambridge in 2006, he worked as a research associate for the Flood Risk Management Research Consortium in the UK. He has collaborated with some of the major civil engineering companies in his research, including Jacobs, Mott MacDonald and Arup.

1.3 BACKGROUND

1.3.1. On 27th February 2021, Prof. Falconer and Dr Liang were approached by Dr Soilleux and Dr Wyllie, on behalf of Save Fulbourn Fields Group, to review the risk of flooding in relation to Planning Application S/3290/19/RM “Land East of Teversham Road, Fulbourn” prior to and at the Planning Appeal Process, involving South Cambridgeshire District Council (SCDC) and Castlefield International. This site is proposed for property development and was first considered for planning approval in 2015. Of note, the site is identified on the Environment Agency’s surface water flood map as being affected by surface water flooding during periods of extreme flood events (HR Wallingford, 2020).

1.3.2. The proposed site for property development involves the construction of 110 new houses on approximately 6.85 hectares of land, to the East of Teversham Road, Fulbourn, with the latest proposal submitted for planning approval in 2017. Outline Planning Permission was granted by SCDC Planning Committee in July 2017. A Reserved Matters application was submitted in September 2019 (ref: S/3290/19/RM: Land East of Teversham Road, Fulbourn), which has in the meantime been amended on a number of occasions.

1.3.3. Initially, surface water management details pursuant to condition 8 of the Outline Approval (ref. S/0202/17/OL), which required details of a surface water drainage scheme to be agreed, were submitted as part of a Discharge of Conditions application S/3209/19/DC, but subsequently withdrawn from consideration.

1.3.4. However, numerous documents related to surface water management were provided to us and were included as part of the serial revisions to the Reserved Matters application, with revisions driven in part by the Lead Local Flood Authority and resident concerns. The chronology of these modifications as advised to us is summarised below. The set of documents considered in the Reserved Matters application is summarised in the Planning Officer report as below:

1.3.5. The reserved matters application is supported by an array of plans, documents and calculations relating to the surface water drainage strategy for the site, which have been amended several times and subject to the submission of additional supporting information following significant objections to the details provided.

1.3.6. As amended, the application is supported by

- *Surface Water Management documents (Cannon Consulting Engineers, 27 February 2020, 03 December Page 93 2019, 12 September 2019),*
- *Review of Surface Water Management (HR Wallingford, August 2020),*
- *Reserved Matters Application Layout (Cannon Consulting Engineers 13 April 2021, 12 August 2020),*
- *Flood Management Strategy (Cannon Consulting Engineers, 14 April 2021) and*
- *Cow Lane Flood Basin (Cannon Consulting Engineers, Dated: 14 April 2021).*

1.3.7. *These documents and plans have been produced to demonstrate that the proposed development is deliverable from a drainage perspective [para 217,218 of Planning Officer report].*

1.3.8. Ultimately, we understand that this application was rejected by the SCDC Planning Committee in October 2021 on 5 grounds, including the lack of information to assure the Planning Committee that flood risk could be mitigated. Reason 2 for rejection of the application is given below:

1.3.9. Insufficient information has been submitted to demonstrate that the reserved matters scheme can provide a satisfactory scheme of surface water drainage and prevent the increased risk of flooding. The proposal is therefore contrary to Policies CC/7, CC/8 and CC/9 of the South Cambridgeshire Local Plan 2018 and paragraph 167 of the National

Planning Policy Framework 2021 which require development proposals to incorporate appropriate sustainable surface water drainage systems and to ensure that flood risk is not increased elsewhere.

1.3.10. The applicant is now appealing this decision. We have noted that on 4th April 2022 Cannon Consulting Engineers presented the additional flood modelling work undertaken by HR Wallingford, which shows a series of significant changes to the way in which floodwater is managed. It was claimed that "the model also demonstrates that the layout presented with the appeal scheme can be developed without increasing off-site flood risk to properties".

2. SITE VISIT

2.1 On 7th March 2022, we visited the site and met with several members of the Save Fulbourn Fields Group. Prior to our visit, it had not rained for several days. We first met at 60 Cow Lane, Fulbourn. The first observation we made was the proximity of the site for development to this property and other properties along Cow Lane – much closer than the distance implied in the Canon Consulting Engineers drawing number: B411-PL-SK-321. For example, the back wall of the kitchen of 60 Cow Lane (which is nearest to the proposed site for development) is less than 3 m from the site boundary, whereas the drawing implies a much greater distance. Furthermore, on first viewing the level of the gardens of the houses surrounding the proposed site for development one had the impression that the level of the gardens and the site were approximately the same. However, on closer inspection it appeared that there was a slight fall in the garden elevation of 60 Cow Lane (ground elevation at 9.86 m) and the adjacent site elevation of ca. 9.70 m, as confirmed by map elevations. Hence, the ground level drops slightly from the gardens of the existing Cow Lane properties to the proposed site for development. This meant that in wet-weather conditions the flow (albeit small) would be away from the existing properties and towards the site for development. However, in the Flood Management Strategy drawing by Cannon Consulting Engineers, number: B411-PL-SK-320, the '*proposed finished floor levels*' of the properties nearest to 60 Cow Lane are ca. 10.60 m, i.e., 0.7 m higher than the floor level for 60 Cow Lane and other properties to the east of number 60. Raising the ground level of the proposed development site, to be ca. 0.7 m above the floor level of the properties just outside the development site, will increase the risk of flooding to these exterior properties and needs further investigation. We measured the groundwater level to be around 0.4 m below the ground surface using a borehole dug in the middle of the garden.

2.2 Following the site visit to 60 Cow Lane and noting the elevation of the houses to the east of this property, we then visited the boggy site called Poorwell Water, which is just outside the site for development and immediately southwest of 60 Cow Lane. This is regarded by the residents as an area of conservation. This boggy nature reserve (typically 30 m in diameter) provides an area of natural drainage for groundwater in the area. Despite there being no rainfall during the preceding days when we visited, the site was very boggy on the day and the two drainage streams flowing into the bog had relatively high flows. For example, the chalk stream was estimated to be: 1.5 m wide x 0.3 m deep and with an estimated current of 0.25 m/s, giving a flow from the mainstream of typically 0.14 m^3/s. Clearly under wet weather conditions the groundwater level would be higher, and the flow would also be much higher. Furthermore, it appears from the Cannon Consulting Engineers design that drainage from the 'Cow Lane Flood Basin' (as described in April 2021 plans), or successor water storage facilities (in April 2022 plans) after a flood event would drain into this boggy site, thereby increasing the risk of flooding of Poorwell Water. The expected rise in the water level in Poorwell Water will reduce the hydraulic gradient from these storage facilities to Poorwell Water and correspondingly reduce the effectiveness of the storage facilities. Moreover, the high water levels in water storage facilities and Poorwell Water will make it difficult to drain the rainwater falling outside the proposed development site.

2.3 After viewing and surveying the boggy Poorwell Water site, we then visited the development site itself. The terrain was flat and demonstrated the characteristics of a floodplain. The first observation we made was that even under these dry weather conditions the site was partially waterlogged and one needed waterproof footwear to view the site. The fields were covered with natural habitat and biodiversity, and the groundwater table was relatively high, with measured elevation on the day at Cannon's borehole WS1a being ca. 0.4 m below the ground level, which was significantly higher than the groundwater levels reported in Cannon Consulting Engineers (2019), where the maximum groundwater levels were 0.59 m below the ground level. For such dry weather conditions, these high water table elevations confirmed that the site is a natural sink for the floodwater and drainage from the site was poor. The precise knowledge on the ground permeability is also key for calculating the time needed for the floodwater attenuation basins to free up their storage volumes.

2.4 The development site was shown to act as a natural floodwater retention ground that accepts runoff from nearby areas during rainfall. This has been confirmed by the HR Wallingford report (2022), as it acknowledges that *the source of the water that causes the surface water flooding to the existing site is mainly from the adjacent housing and the site itself*. It was apparent from the site visit that the risk of flooding to the Cow Lane properties would potentially be increased if the site were to be developed, particularly since the development would significantly reduce room for water on the site and partially block the northward passage of floodwater.

3. ASSESSMENT OF AVAILABLE DATA

3.1 GROUND ELEVATIONS

3.1.1. Since flooding is a gravity-driven phenomenon and the floodwater normally flows downslope, the accuracy of the ground elevations is crucial in any flood risk analysis. We do not have full access to the topological data for the revised development scheme, but we are concerned that some elevations outside the development site are incorrectly labelled.

3.1.2. In the topographical survey drawings (B411-PL-SK-320 and 321, B411-PL-SK-350 and 351), the elevations for 60 Cow Lane and other areas adjacent to the site for development indicate ca. 17.0 m, while ground levels inside the development site are ca. 9.8 m. These elevations outside the development site were clearly wrong, and we were advised that these might refer to the rooftop rather than the ground. Clearly, this gives a false impression and an extremely conservative perception of the vulnerability of these surrounding houses to flood risk. In our view, the digital elevations of the bare earth, with the vegetation and building features filtered out, should be used in the flood risk analyses. The HR Wallingford report (2022) states that *the ground levels have been taken from the local site topographic survey provided to us*. It seems that the elevations of the rooftops of the Cow Lane houses were mistakenly taken to be the ground elevations in the HR Wallingford 2D hydraulic model study, which may result in a serious underestimation of the flood risk to the existing houses along Cow Lane.

3.1.3. The HR Wallingford modelling study in 2020 was commissioned for the original site elevations, with the finished floor levels of 9.67 m – 10.03 m for the houses along the southernmost boundary near the houses along Cow Lane. The HR Wallingford report advises: *"It is possible to raise the development so that it is unaffected by surface water flooding".* We note that in the Flood Management Strategy drawing B411-PL-SK-320 the corresponding *"proposed finished floor levels"* of these houses have been raised by typically 0.85 m to 10.50 m – 10.90 m. Raising the floor levels of the houses inside the development site means less storage capacity across the site for the floodwater. It is extremely likely that raising the floor levels on the site to reduce the risk of flooding to properties on the site will be accompanied by an increase in the flood risk to properties outside of the site, such as the Cow Lane houses. As the floodwater volume overwhelms the storage capacity, it is almost certain that the adjacent properties will be inundated with high rainfall events in the region.

3.1.4. It is worrying that the HR Wallingford modelling study in 2022 shows significant anomalies in predicting the post-development flood depth distributions. The flood depth should vary gradually, unless there are significant variations of the ground elevations. It is certain that the site and the surrounding areas are relatively flat. The following points may be related to the incorrect ground elevations or the nonphysical modelling methods used in this report.

3.1.5. Figures 4.5-4.8 show that the water depths around the development platforms are largely zero, while the water depths slightly away from the platforms (by about one grid cell size) are often quite large. How can such large water surface gradients be explained at the platform boundaries?

3.1.6. The onsite water depths near the central-south boundary of the site are quite large in figures 4.5-4.8, but the adjacent offsite water depths at 60 Cow Lane are quite small. We therefore have two unanswered questions: (i) How can the water depth in the southern storage facilities be between 0.5 m and 1.0 m? (ii) Is the designed water depth 0.5 m (considering that the high groundwater level disallows larger depths)? There seems to be an invisible wall separating the high water levels inside the site and the low water levels outside the site. We noticed the hedges at the site boundary in our site visit, but they would not stop water flowing from the site to the adjacent properties outside of the proposed development site.

3.1.7. Section 4.3 of the updated report discusses the changes in peak flood depths pre and post development of the site. It is strange that opposite variations of the flood depths take place suddenly in close proximity. While such drastic changes within the site may be possible because of the significant changes to the ground elevations, we are confused by such drastic changes also existing outside of the site. For example, figure 4.10 shows one part of the Poorwell Water experiences a 5-100 mm rise in water depth, while a neighbouring area of the Poorwell Water sees a 5-100 mm drop. Given that the ground elevations outside the site should remain unchanged, how can these opposite changes in the water depth be justified?

3.2 FLOOD MODELLING BY HR WALLINGFORD

3.2.1. The HR Wallingford report (2020) and an update (2022) were commissioned by Cannon Consulting Engineers. HR Wallingford have an international reputation for their expertise and experience in surface water flood modelling and management and the authors respect their world-wide reputation. However, we feel that some key information is either missing or inconsistent in their two reports. We have the following comments and suggestions regarding their modelling work.

3.2.2. The HR Wallingford report (2020) refers to the UK soils map to check the Standard Percentage Runoff for the catchment and *'this confirms that the predominant soils class in the catchment is very permeable'*. However, when we visited the proposed development site in March 2022, measurements were taken of the groundwater levels relative to the ground level at a borehole at about 50 m from the '*drainage channel that runs through the site*'. As advised previously, it had not rained for several days prior to our site visit and the water table level was just *ca*. 40 cm below the ground level. With the water table still being relatively close to the ground level several days after no rain suggests that the soil at the development site does not appear to be '*very permeable*' as stated in the HR Wallingford report.

3.2.3. These concerns are supported by information provided by Dr Christine Donnelly of the Cambridgeshire Geological Society to Save Fulbourn Fields, and shared with us by Dr Elizabeth Soilleux. The chalk formation underlying the proposed development site is part of the West Melbury Marly Chalk, which has a high clay content and is relatively impermeable. A map using British Geological Survey data showing this is available at https://mapapps2.bgs.ac.uk/geoindex/home.html?_ga=2.259952778.1090462005.1649927734-771910022.1649927734. For a nearby development at Addenbrookes (PBA, 2016), the in-situ tests indicated that the infiltration rates of the West Melbury Marley Chalk were likely to be in the order of $10^{-6} - 10^{-7}$ m/s, which means that 5.8 – 58 days will be needed to empty an attenuation basin of 0.5 m in depth at the proposed development site. Therefore, we would advise that soil samples are analysed and the true permeability determined for the underlying strata of the site before any development. We suspect that the HR Wallingford reports have adopted the incorrect assumption of the ground permeability and thus underestimated the excess rainfall intensity and the surface water flood risk.

3.2.4. In the HR Wallingford study, it is advised that '*the summer rainfall produced a higher peak flow than the winter storm profile for the rainfall depth-duration-frequency*' and that '*this is because it is more "peaky" than the winter profile, owing to the prevalence of intense convective storms during the summer*'. Whilst we agree that convective summer storms can be more 'peaky' than winter storm events, we are concerned that the extreme rainfall events during the winter months have not been considered. The level of flood risk in this region is not only dependent on the peakiness but also on the ground saturation, water table and base flow during the preceding days. The duration of the storm used for examining the flood risk of the development is 3.25 hours. The prolonged wet weather in winter will lead to high groundwater levels, large base flow rates and almost bank-full water depths in drainage channels. The saturated ground may well give rise to a large excess runoff, and the high water table level is likely to adversely affect the effective operations of the proposed pipes, culverts, channels, roadside filter drains and water storage facilities.

3.2.5. We are not convinced that the level of the flood risk in the summer is greater than that in the winter. Indeed, the serious flooding events have been recorded on 23/24 December 2020, which affected St Ives, Alconbury, Broughton, Brampton, St Ives, Swavesey and elsewhere as described in investigations conducted by Cambridgeshire County Council (https://www.cambridgeshire.gov.uk/business/planning-and-development/flood-and-water/flood-risk-management/flooding-and-flood-investigations), which were featured by the heavy winter rain falling onto saturated land. In our view, both summer and winter events should have been investigated to give the upper bound flood risk predictions.

3.2.6. A few important hydraulic modelling details are not explained in the HR Wallingford reports, including:

3.2.7. How were buildings modelled? Was the "building-hole" or "building-block" method used (Cea et al., 2010; Liang et al., 2015)? How did the modeller take into account the influences of the proposed properties' density and layout? The reports first gave an average triangular mesh element area of 16 m^2, but then mentioned the deployment of high-resolution triangular cells, with the cell areas varying between 4 m^2 and 9 m^2 on the development site. Is this mesh fine enough to describe the detailed local building layout accurately, where houses and access to the houses will be raised but their gardens will not (CCE B411 note dated 4th April 2022)?

3.2.8. In the revised hydraulic model used in the HR Wallingford model (2022), *the boundary of each platform includes the surface water (runoff) attenuation facilities for each platform*. Unfortunately, it does not mention what these facilities are, what their capacities are, or how they are modelled. We are therefore left with two questions of concern: (i) Why are water depths around the boundaries of the raised areas almost zero in figures 4.5-4.8? (ii) Does this mean that the rainwater falling on the raised areas is instantly moved to the drains? Because of the flat terrain and high groundwater levels, we believe that traditional sustainable urban drainage systems (SuDS) would have very limited effectiveness in compensating for covering over the natural ground level with houses, roads, pavements etc.

3.2.9. It is not clear from the report if the hydrodynamic model considered the influence of stagnant water on the site. In the wet autumn and winter months, it is highly likely that the filter drains, water storage facilities and other low-lying areas will be filled with water, bearing in mind the long empty time corresponding to the low infiltration rates of the West Melbury Marley Chalk (PBA, 2016). It would be incorrect to assume that the ground is all dry before a flood event. In particular, the southern excavated water storages facilities (Cannon Consulting Engineers, 2022) are no longer drained by any culvert, as compared with the 'Cow Lane Flood Basin' design in April 2021. It appears that the model does not take into account the subsurface flow dynamics, which would be expected to play an important role in collecting rainwater to the attenuation facilities and in the interaction between the one-dimensional ditch model and the two-dimensional floodplain model.

3.2.10. A close scrutiny of the predicted flood levels and inundation extents in the HR Wallingford 2020 report shows increased flood depths in the Cow Lane region as a result of the proposed development (e.g., compare the results for the existing conditions shown in figures 4.2-4.3 and the post-development conditions shown in figures 4.6-4.7 in the HR Wallingford 2020 report). The 2022 report, on the other hand, shows no difference in the off-site flood depths with and without the development in place, and hence the assertion that *the layout presented with the appeal scheme can be developed without increasing off-site flood risk to properties*. **However, the latest HR Wallingford report fails to show the correct flood depths outside the site. We are deeply concerned with the above conclusion drawn from the 2022 report, as it violates the basic physical principles.**

3.2.11. In the updated HR Wallingford report (2022), flood extents and depths owing to surface water flooding **on the site** are shown in figures 4.1 – 4.4 for the pre-development conditions, and in figures 4.5-4.8 for the post-development conditions. For rainfalls of the same return periods, the flood extents and depths outside the site are shown to be exactly the same in the pre- and post-development conditions, which is illogical. We suspect these figures do not show the correct flood extents and depths outside the site. The title of Section 3 is *Integrated Catchment Model (ICM) hydraulic of the Fulbourn catchment*. If the model indeed covered the whole Fulbourn catchment, then both the onsite and offsite flood extents and depths should be presented.

3.2.12. Figures 4.5-4.8 indicate serious onsite flooding at the south border of the development site, as shown by a dark-blue (indicating the 0.5 m – 1.0 m water depth band) strip north of 60 Cow Lane. However, no flooding is observed immediately outside this site boundary. Given that the ground elevations should be about the same on the two sides of the site boundary, the water depths should also be about the same. What prevents the onsite floodwater from flowing across the site boundary to flood 60 Cow Lane?

3.2.13. The HR Wallingford reports purport to demonstrate that the site development *avoids an increase in downstream flood risk*, which is on the north side of the development area, and *does not lead to an increase in flood risk i.e. an increase in flood depth where there are properties at risk*, which are on the south, west and east sides of the proposed development area. In fact, they show a slight decrease in the discharge leaving the site through the railway culvert in Section 4.4. As the mass of the rainwater needs to be conserved, the only way to avoid an increase in the flood risk at all site boundaries, as the report claims, is to store roughly equal amounts of rainwater within the site before and after the development. The fact that the land area available to store water will be reduced after the development means unreasonably large onsite water depths. Bearing in mind that the groundwater level is high, how can such large water depths be achieved?

3.2.14. The upper half of page 13 mentions a channel to be constructed to *convey flows from the south-eastern part of the site*, but this channel is not labelled in the revised development scheme shown in figure 3.1. It is also uncertain how floodwater will be guided to the channel inlet.

3.2.15. The Environment Agency surface water flood map for the site (figures 1.1) and the existing surface water flow paths on the site (figures 2.4) are inconsistent with the findings as shown in figures 4.9-4.12 in the HR Wallingford 2022 report. We understand that the inundation extents shown on the flood map are exaggerated because *the model does not include the drainage ditches or channels that run through the site or along-side roads*. However, it clearly shows a primary flow path through Poorwell Water and the central drainage channel, as well as a second flow path *across the site from the east towards the drainage channel in the centre of the site*. These flow paths will be hindered by bridges, culverts and development platforms. The water level drops required to drive the flow through these hydraulic structures means that the flood depths at Poorwell Water and the south-eastern corner of the site will rise. In extreme floods, the hydraulic structures may choke the flow, significantly increasing the upstream water levels. Has the modeller calculated the backwater curves along the channels and culverts? How can the post-development flood depths in Poorwell Water and some parts of the south-eastern corner of the site be reduced in figure 4.11?

3.2.16. The reports do not show any flow velocity information for the different scenarios. Velocity fields would need to be provided to examine whether the site development poses any blockage to the passage of floodwater northward through the site. If so, then more water will be held back south of the site to increase the flood risk to the properties adjacent to the site along the Cow Lane.

3.3 SURFACE WATER MANAGEMENT SYSTEM

3.3.1. Sub-catchment attenuation facilities have been proposed to manage surface water. The management relies on geocellular sub-base replacement crates, roadside filter drains and pipeline networks to collect and carry rainwater to shallow bio-retention basins, the pump house garden and the central ditch. Numerous amendments have been documented, making it a bit difficult to check the consistency of the hydrological calculations and the combined effect of the water management measures proposed in different times. In general, disposal of runoff to infiltration is ruled out and the scheme relies on a restricted discharge to the onsite watercourse.

3.3.2. Although the flow routes were labelled in the strategy drawing to indicate the accumulation of rainwater into different attenuation basins, the Cannon reports did not give any information about the hydraulic gradient and the conveyance of the channels, pipes and culverts. The operation of such a passive drainage system depends heavily on the slope of the terrain. If there is no hydraulic gradient to drive the flow, then the water on the site will be stagnant and will not drain to the designated locations. Detailed hydraulic computations are needed to test whether the volumes of the attenuation basins and the discharge rates in the pipeline and channel networks are sufficient.

3.3.3. In Cannon Consulting Engineers (2019), the proposed discharge rate to the onsite watercourse was 0.3 l/s/ha. The water depths of all the attenuation basins were chosen to be 0.6 m. *The attenuation facilities are sized to manage a long duration storm and the commonly quoted drain-down requirement of 24 to 48 hours is not therefore applicable (low runoff rates and short drain-down time being mutually exclusive)*. Such a design condition for the attenuation facilities is in sharp contrast to what is mentioned in the HR Wallingford reports, which only examined the flood risk posed by 'peaky' summer storms. The Micro Drainage calculations clearly show that the design was unsatisfactory for the Road Catchment, Catchments B, C and D, when the storm duration exceeded 1440 min, 720 min, 180 min and 360 min, respectively. The reason was that the *outflow is too low* or the *half drain time exceeds 7 days*. It is extremely disappointing that no consideration was given in the Cannon reports to address these unsatisfactory designs.

3.3.4. As mentioned before, the groundwater levels reported in Cannon Consulting Engineers (2019) are significantly lower than the values we measured using Cannon's borehole WS1a and the borehole located in the garden of 60 Cow Lane. In addition, none of the three boreholes used by Cannon Consulting Engineers lies close to attenuation basin D. Since the attenuation basin D is immediately north of 60 Cow Lane, we think our measured value in the garden is more suitable for the design of the invert level of attenuation basin D, which leads to a water depth of 0.4 m rather than the designed 0.6 m. Therefore, the area of the attenuation basin D should be increased. More importantly, WS6a recorded the highest groundwater levels among the three monitoring points in the Cannon reports, but only the data between 05/02/2015 and 05/06/2016 were reported and afterwards WS6a *could not be located during any of the recent monitoring visits* by Geosphere Environmental Ltd. We suggest that more groundwater level monitoring be undertaken before the development, so that the invert levels of the attenuation facilities can be correctly chosen. The monitoring boreholes should be located closer to the attenuation facilities.

3.3.5. The Cow Lane Flood Basin was introduced in April 2021 to alleviate the increased flood risk imposed on the existing properties along Cow Lane, as predicted by HR Wallingford 2020 report. To enable the floodwater to flow into the Basin, the southward slopes within the nearby development site are also introduced. This Basin was not mentioned in the subsequent plan in April 2022, although a similar sized isolated excavation remains. In addition, eight floodable gardens were introduced to increase onsite water storage capacities.

3.3.6. The capacity of the Cow Lane Flood Basin was designed to be 150 m^3, according to the volume of the onsite runoff. Onsite storage may have been increased in the April 2022 plans, but no figure was quoted. We think this capacity, together with the capacities of other retention basins, should be shown to accommodate both the onsite and necessary offsite runoffs. Because of the relatively low elevation of the site, some rainwater falling on adjacent houses will also end up flowing into the site in the natural situations. Failing to accept rainwater from outside the site after development will inevitably increase the flood risk to some adjacent houses, especially those to the southeast of the proposed southern excavated area.

3.3.7. We also doubt the efficacy of these excavated storage facilities in mitigating flood risk. Their effective capacity will depend highly on the groundwater level. It is unclear how the stored water will infiltrate and evaporate rapidly enough to free up the storage capacity before a subsequent storm, particularly during the wet autumn and winter months when consecutive storm events occur regularly. This is particularly true of the April 2022 plans, where drainage culverts are not provided for the southern excavated area. If the storage facilities are always filled with groundwater seeped out of their banks, then they will have little – if any – effect on reducing flood risk. Even if the overall storage capacity is sufficient, it still needs to be proved that rainwater can flow into these storage facilities in time before flooding occurs. We recommend incorporating the details of the storage facilities and other flood mitigation measures described in the April 2022 plans, together with the correct ground elevations around the development area, in the flood model, so that their effectiveness can be dynamically verified. Their reliable operation is crucial to limit the risk of flooding across the proposed development site and particularly to the existing properties adjacent to the site along Cow Lane.

4. CONCLUSIONS

4.1 According to the Environment Agency surface water flood map included in the HR Wallingford reports (2020, 2022), the proposed site for development is already affected by surface water flooding. It accepts rainwater from the surrounding area and the whole site effectively acts as a large retention basin to attenuate the flood hydrograph. The development proposal for the site involves significantly raising the ground elevations of the site, which will inevitably reduce space for water and thus reduce infiltration to the ground below and evaporation. It also has the potential to adversely affect the free passage of water through the site northwards, stopping rainwater falling outside the site from flowing to the site. We understand that some surface water management measures proposed in the Cannon reports (2019, 2020, 2022) can alleviate the flood risk within the site, such as building properties on raised platforms and creating water storage facilities. However, the surface water management strategies give no consideration of the extra attenuation capacity needed to receive the rainwater from outside the site. We believe that there is a lack of consideration of the increased flood risk to the existing properties along the Cow Lane. We have identified some key concerns in the HR Wallingford reports (2020, 2022), commissioned by Cannon Consulting Engineers, including a lack of investigating the risk of flooding during the prolonged wet weather conditions and high groundwater levels, the wrong ground elevations, nonphysical water depth distributions, as well as incorrect assumptions about Marly Chalk's permeability. We have also listed some problems with the surface water management calculations, such as the unsatisfactory designs for storms of long durations, insufficient groundwater level monitoring, lack of consideration of the flow dynamics in pipes, culverts, channels and water accumulation process.

4.2 We believe that these flaws make it misleading to claim that the proposed site development would not increase off-site flood risk to properties south of the site. In our professional opinion, the development will cause a marked increase in the risk of flooding to surrounding properties outside of, and adjacent to, the development site, such as 60 Cow Lane. More accurate knowledge on the ground permeability and groundwater level variations and more reliable hydrodynamic simulations would be needed to determine the degree of increased flood risk to the Cow Lane properties.

The current surface water management scheme relies on passive infiltration of floodwater into the ground. Most likely, the number of properties to be developed on the site will need to be significantly reduced to increase the area, and thus the volume, of the shallow flood attenuation basins. Moreover, the SuDS manual (Woods-Ballard et al., 2007) states that *the seasonally high groundwater table must be more than 1 m below the base of the facility* for the deployment of infiltration basins. If this criterion is to be complied with, then the development of this site will be extremely difficult as the groundwater levels on the site are generally within 1 m below the ground surface, even in the drier summer months.

5. REFERENCES

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6. APPENDIX

6.1 SHORT CV FOR PROF. FALCONER

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Water and Environmental Management Professional

Establishing and executing strategic water and environmental management plans to promote sustainable development

Award-winning and accomplished independent water consultant and water-environmental engineering professor with extensive experience in a wide range of water-environmental modelling and engineering projects. Instrumental in delivering effective advice to consulting environmental and engineering/water companies, and government and international agencies on a range of issues related to: water-environmental impact assessment (EIA) studies, flooding, river and tidal renewable energy, and global water security. Adept at building and leading multi-disciplinary teams.

Highlights of Expertise

- Water & Environmental Management
- Flood Risk Assessment & Mitigation
- Hydrodynamic & Water Quality Modelling
- Hydro-Environmental Impact Model Audits
- Hydro-power and Tidal Range Energy
- Global Water Security & Virtual Water
- Expert Witness & Due Diligence Advisor
- Strategic Research Assessment & Impact
- National & International Case Studies
- Education & Development Programmes

Career Experience

Roger Falconer Water Consultancy Ltd, Ilkley, UK

Deliver strategic leadership and guidance regarding flood risk modelling and management, tidal renewable energy, water and environmental engineering, water security and transfer, model audits and research impact.

DIRECTOR (2016 to Present)

Plan and oversee effective hydro-environmental modelling and audit studies, such as for: (i) Environmental Impact Assessment (EIA) studies, (ii) EU water framework bathing and shellfish water compliance studies, (iii) flood risk assessment projects etc. Audited studies for companies such as: Dwr Cymru, United Utilities, Mott MacDonald, Arup, Arcadis, Intertek etc. for Bathing Water compliance. Provided advice on flood modelling and resilience to organisations such as: Natural Resources Wales, Environment Agency, Thames Water, Arcus etc. Provided advice on tidal range energy projects to: UK Government Hendry Independent review of Tidal Lagoons, and for Severn, Mersey, Morecambe Bay barrages, and West Somerset and Liverpool Bay lagoons. Designed novel bi-directional turbine with Dragon River & Tidal Ltd. Prepared expert witness evidence for public inquiries and national and international court cases, and assessed publications and research impact for universities in UK and internationally.

- Provided advice on over 80 environmental impact assessment studies on computer modelling of water processes, such as: ITLOS international court case and Hinkley Point C Advisory Group to Welsh Government.
- Provided technical appraisal on range of flooding, water quality and tidal impoundment projects across the UK.

Cardiff University, Cardiff, UK

Provide research support on flood risk modelling and resilience; river and tidal renewable energy; modelling hydrodynamic, water quality and sediment transport processes; and global water security.

EMERITUS PROFESSOR OF WATER ENGINEERING (2018 to Present)

Collaborate on research, publish research papers, present research at international conferences, and deliver lectures to learned societies, universities, and global organisations, primarily on: flood and health risk modelling and assessment; tidal and river renewable energy; and global water security. Participated in TV and media interviews and provided expert advice to international and national learned societies etc.

- Support international activities of Hydro-environmental Research Centre (HRC) in the School of Engineering.
- Peer review research grants and papers for a range of funding agencies and international high impact journals.

Spearheaded and delivered research projects on modelling (computationally and experimentally) flow, water quality, and sediment transport processes in coastal and river basins, tidal and river renewable energy and global water security.

HYDER and CH2M PROFESSOR OF WATER MANAGEMENT (1997 to 2018)

Conducted research on wide range of projects in UK and internationally, lectured courses on environmental fluid mechanics and appointed external examiner on range of courses in UK and internationally. Founded internationally acclaimed Hydro-environmental Research Centre (income > £13M) and served on over 120 scientific conference committees and over 120 national external and learned society committees.

- Published > 400 journal and international conference papers > 11,000 cites and h-index 60 in Google Scholar.
- Delivered > 550 presentations on water management to universities and learned societies in 29 countries.

Continued...

Additional Key Experience (Current and Past)

Director ▪ Tidal Energy & Environmental Services Ltd., UK - company initially involved in developing the West Somerset Lagoon Tidal Range scheme, to be followed by development of other tidal range schemes.
Director ▪ Dragon River & Tidal Ltd., UK - company established to develop a hydro-kinetic turbine based on a twin set of contra-rotating blade arrays, for generating power in rivers and tidal basins, with minimal infrastructure.
Developer ▪ 1D, 2D and 3D computational models of hydro-environmental processes in river to coastal basins, mounted by over 40 companies and agencies, 2D model provides one of the engines for Jacobs' Flood Modeller
Auditor ▪ for numerous numerical modelling projects for bathing water compliance and flood risk assessment
Consultant ▪ on over 80 hydro-environmental impact assessment (EIA) studies, in the UK and internationally
Member ▪ Independent Expert Group (3) for Thames Water's independent review of London floods
Member ▪ Steering Committee for Affinity Water's Ofwat project on Water Neutrality at NAV Sites
Chair ▪ River Wharfe Partnership - working with stakeholders to improve water quality and ecological status
Co-Chair ▪ Group of (4) Experts, International Tribunal for Law of the Sea (ITLOS) Malaysia v. Singapore Case
Member ▪ Hinkley Point C Expert Group - reporting to First Minister of Wales on modelling impacts
Member ▪ Independent Expert Panel for Government Department Severn Tidal Power Feasibility Studies
Member ▪ National Flood Resilience Scientific Advisory Committee (UK Government Appointee)
Member ▪ Yorkshire Regional Flood and Coastal Committee (Environment Agency Appointee)
Member ▪ Flood Risk Management Wales Committee (Welsh Government Appointee)
Chair Professor ▪ Hohai University and Yangtse Institute for Conservation and Development, China – responsible for developing and supporting research young faculty in water engineering and promoting international activities.
President ▪ International Association for Hydro-Environment Engineering & Research (IAHR)
Vice President ▪ International Association for Coastal Reservoir Research (IACRR)
Professor of Water Engineering/Head of Civil & Environmental Engineering ▪ University of Bradford, UK
Lecturer in Hydraulic Engineering ▪ Department of Civil Engineering, University of Birmingham, UK
Honorary Professor ▪ universities of: Hohai, Hong Kong, Sichuan, Tianjin, Tongji and IWHR (China)
Chair ▪ UK REF 2014 Sub-Panel and Member RAE 2008 Panel for Civil and Construction Engineering
Member ▪ Trustee Board of Chartered Institution of Water and Environmental Management (CIWEM)
Elected Member ▪ councils of: Institution of Civil Engineers (ICE), CIWEM, IAHR and IACRR
Media ▪ regular interviews with press and media on: flooding, tidal energy, water quality and security

Education & Credentials

Academic Recognition

- **DSc(Eng)** ▪ Hydro-environmental Modelling, *Imperial College, London, UK*
- **DEng** ▪ Computational Fluid Dynamics, *University of Birmingham, UK*
- **PhD** and **DIC** ▪ Computational Hydraulics, *Imperial College, University of London, UK*
- **MSCE** ▪ Hydraulic Engineering, *University of Washington, Seattle, USA*
- **BSc(Hons)** ▪ Civil Engineering, *King's College, University of London, UK*

Professional Recognition

Fellowships (Academies and Learned Societies)

- **FREng** ▪ Fellow Royal Academy of Engineering
- **ForMemCAE** ▪ Foreign Member Chinese Academy of Engineering
- **FEurASc** ▪ Fellow European Academy of Sciences
- **FLSW** ▪ Fellow Learned Society of Wales
- **FCGI** ▪ Fellow City and Guilds Institute of London
- **FICE** ▪ Fellow Institution of Civil Engineers
- **FCIWEM** ▪ Fellow Chartered Institution of Water & Environmental Management
- **FASCE** ▪ Fellow American Society of Civil Engineers
- **Hon Mem** ▪ International Association for Hydro-Environment Engineering and Research

Charterships

- **CEng** ▪ Chartered Civil Engineer
- **CEnv** ▪ Chartered Environmentalist
- **C.WEM** ▪ Chartered Water and Environmental Manager

Key Awards

- Royal Academy of Engineering Silver Medal
- International Association for Hydraulic Research Ippen Award
- Hai He Award of Honour Tianjin Municipal Government (China)
- ICE Telford Premium and ICE Robert Carr Awards

Appendix 1 – Selected Key Consulting Projects

Independent Expert Group (of 3) Review of London Floods – Thames Water (2021-date):- Appointed to report on causes of London floods in July 2021 and recommend how such future extreme flood events can best be managed.

Arcus Consultancy Ltd (2021):- Provide third party review of Flood Risk Assessment for development in Glasgow.

Liverpool City Region Combined Authority (2019-date):- Provide technical advice and assessment reports of hydrodynamic and tidal power modelling for various lagoon and barrage options for energy generation.

Hinkley Point C Stakeholder Reference Group – Welsh Government (2020-date):- Provide technical assessment and report chapter on the impact of Hinkley Point C nuclear power station along the Welsh coastline and Severn Estuary.

Hendry Review of Tidal Lagoons – ITP Energised (2017):- Consultant to the independent review of the role of tidal lagoons around the UK coast. This project involved reviewing over 200 items of evidence and providing a report and assessment of the evidence submitted to the Hendry Review.

Coastal Water Quality Investigation, Wales – Welsh Water (2016-18):- Provide independent review of computational hydro-environmental modelling studies of Mott MacDonald, and 3 partners, as part of an £8+ million in investigation of 49 bathing sites around Welsh coastline. Project involved simulating coastal hydrodynamics and pollutant transport.

Regional Coastal Model Studies for Liverpool Bay and North West Coast of England – United Utilities plc (2014-18):- Audit of major hydro-environmental impact assessment studies for rivers and coastal receiving waters around the North West England coast. Studies involved extensive modelling calibration and application using DHI MIKE 21.

Jamaica Bay Wetland Creation Study, USA – Buro Happold (2013-15):- Oversee and advise on model set-up for hydrodynamic and tidal flushing studies for different bay configurations and topographies.

Three Rivers Environmental Impact Assessment, Wales – Metoc Consulting (2007-08):- Audit consultant's hydro-environmental impact assessment computational modelling studies of three rivers and Carmarthen Bay coastal zone.

Preston 7 Public Inquiry, England – Environment Agency (2007):- Provide and present Proof of Evidence to Public Inquiry on behalf of EA in defending against appeals by United Utilities Ltd. Centred on 7 key CSO impacts on the River Ribble and adjacent WFD protected bathing and shellfish waters.

Abingdon Bankside Storage Reservoir, England - Thames Water (2006-07):- Advise and oversee wide range of modelling studies undertaken by several companies for design of reservoir, inlet/outlet works and assess impact on range of water quality parameters in the river Thames.

Swansea Coastal Environmental Impact Study for Long-Sea Outfall, Wales – Hyder Consulting Ltd (2005):- Provide audit of hydrodynamic and faecal indicator organism model predictions, using Delft 3-D, for EIA of long-sea outfall.

International Tribunal for the Law of the Sea (ITLOS) Malaysia v. Singapore Land Reclamation Dispute (2004-05):- Co-Chair of Group of 4 International Experts overseeing and reporting to ITLOS on comprehensive environmental impact assessment study, undertaken by Danish Hydraulic Institute for both countries.

Straits of Johor, Malaysia – Department of Irrigation and Drainage (2003):- Provide expert review and evidence for modelling studies undertaken by DID for Malaysian Royal Navy to assess impact of Singapore land reclamations on coastal hydrodynamics, morphology and water quality.

Flood and Coastal Defence Research and Development Programme, UK – DEFRA/Environment Agency (2002):- Technical Advisor to EA on prioritizing research activities by consultants on flood and coastal erosion around the UK.

Bohai Bay and Sea Environmental Impact Assessment, China – Tianjin Municipal Government (2000-04):- Technical advice on hydro-environmental impact modelling studies to improve water quality of the Bay.

Al Khiran Pearl City, Kuwait – Buro Happold (1999):- Assist in setting up DIVAST model to predict hydrodynamic and flushing characteristics for design of new city layout with optimal waterfrontage.

Shannon Bridge Power Station, Eire – Electricity Supply Board Ireland (2000):- Provide technical assessment of computational studies of hydro-thermal environmental impact assessment of power station.

Anglian Region Flood Forecasting Modelling System, England – Environment Agency (1998):- Provide technical assessment of the tender submissions for a new EA Flood Forecasting System.

Point Mugu Lagoon, USA – US Navy, Environment Division (1995):- Provide technical support, training and setting up of DIVAST model for predicting hydro-morphological features of Point Mugu and the Tijuana Estuary.

Klang Port Dredging Studies, Malaysia – Intergroup and Bullen Consultants (1995):- Provide technical short course and assess model studies to predict sediment deposition and erosion.

Danish Agency for Trade and Development – Expert Evaluation of the Danish Hydraulic Institute (1995):- Responsible for reviewing a wide range of projects, departments and management across the global activities of DHI and reporting on the assessment to the main Danish funders.

British Nuclear Fuels plc, UK – Sellafield Cumbria (1993):- Review environmental impact assessment modelling studies for a nuclear generation feasibility study along the Cumbria coast.

Appendix 2 – Selected Recent Publications

(i) Flooding Risk Modelling

Dong, B., Xia, J., Zhou, M., Deng, S., Ahmadian, R., **Falconer R.A.** 2021. Experimental and numerical model studies on flash flood inundation processes over a typical urban street. *Advances in Water Resources,* 147, January, 1-15.

Musolino, G., Ahmadian, R., **Falconer, R.A.** 2020. Comparison of flood hazard assessment criteria for pedestrians with a refined mechanics-based method. *Journal of Hydrology X,* 9, December, 1-13.

Musolino, G., Ahmadian, R., Xia, J., **Falconer, R.A.** 2020. Mapping the danger to life in flash flood events adopting a mechanics-based methodology and planning evacuation routes. *Journal of Flood Risk Management,* 13(4), 1-19.

Chen, Q., Xia, J., **Falconer, R.A.,** Guo, P. 2018. Further improvement in a criterion for human stability in floodwaters. *Journal of Flood Risk Management,* 12(3), 1-9.

Ahmadian, R., **Falconer, R.A.,** Wicks, J. 2018. Benchmarking of flood inundation extent using various dynamically linked 1D-2D approaches. *Journal of Flood Risk Management,* 11(S1), S314-S328.

Kvocka, D., **Falconer, R.A.,** Bray, M. 2016. Flood hazard assessment for extreme flood events. *Natural Hazards,* 84(3), 1569-1599.

Xia, J., **Falconer, R.A.,** Wang, Y., Xiao, X. 2014. New criterion for the stability of a human body in floodwaters. *Journal of Hydraulic Research,* 52(1), 93-104.

Xia, J., **Falconer, R.A.,** Lin, B., Tan, G. 2011. Numerical assessment of flood hazard risk to people and vehicles in flash floods. *Environmental Modelling and Software,* 26(8), 987-998.

(ii) Tidal Renewable Energy

Guo, B., Ahmadian, R., **Falconer, R.A.** 2021. Refined hydro-environmental modelling for tidal energy generation: West Somerset Lagoon case study. *Renewable Energy,* 179, December, 2104-2123.

Xue, J., Ahmadian, R., Jones, O., **Falconer, R.A.** 2021. Design of tidal range energy generation schemes using a Genetic Algorithm model. *Applied Energy,* 286, 116056, 1-15.

Xue, J., Ahmadian, R., **Falconer, R.A,** 2019. Optimising the operation of tidal range schemes. *Energies.* 12(15), 2870, 1-23.

Falconer, R.A., Angeloudis, A., Ahmadian, R. 2018. Modelling hydro-environmental impacts of tidal range renewable energy projects in coastal waters. *World Scientific Series on Coastal Engineering Practice,* 2(10), Chap. 55, 1553-1574.

Angeloudis, A. and **Falconer, R.A.** 2017. Sensitivity of tidal lagoon and barrage hydrodynamic impacts and energy outputs to operational characteristics. *Renewable Energy,* 114, December, 337-351.

Angeloudis, A., Ahmadian, R., **Falconer, R.A.** and Bockelmann-Evans, B. 2016. Numerical model simulations for optimisation of tidal lagoon schemes. *Applied Energy,* 165, March, 522-536.9.

Zhou, J., Pan, S., **Falconer, R.A.** 2014. Optimization modelling of the impacts of a Severn Barrage for a two-way generation scheme using a Continental Shelf model. *Renewable Energy,* 72, December, 415-427.

Ahmadian, R. and **Falconer, R.A.** 2012. Assessment of array shape of tidal stream turbines on hydro-environmental impacts and power output. *Renewable Energy,* 44, August, 318-327.

(iii) Water Security and Quality

Falconer, R.A. 2021. Water security: Why we need global solutions. *Engineering,* 15(11), e2021WR030370, 1-5.

King, J., Ahmadian, R., **Falconer, R.A.** 2021. Hydro-epidemiological modelling of bacterial transport and decay in nearshore coastal waters. *Water Research,* 196, 117049, 1-14.

Huang, G., **Falconer, R.A.,** Lin, B. 2018. Evaluation of *E.coli* losses in a tidal river network using a refined 1-D numerical model. *Environmental Modelling and Software,* 108, October, 91-101.

Bakar, A. A., Ahmadian, R. and **Falconer, R.A.** 2017. Modelling the transport and decay processes of microbial tracers released in a macro-tidal estuary. *Water Research,* 123, October, 802-824.

Huang, G., **Falconer, R.A.** and Lin, B. 2017. Integrated hydro-bacterial modelling for predicting bathing water quality. *Estuarine, Coastal and Shelf Science,* 188, 145-155.

Gao, G., **Falconer, R.A.** and Lin, B. 2015. Modelling the fate and transport of faecal bacteria in estuarine and coastal waters. *Marine Pollution Bulletin,* 100(1), 162-168.

Huang, G., **Falconer, R.A.,** Boye, B. A. and Lin, B. 2015. Cloud to coast: integrated assessment of environmental exposure, health impacts and risk perceptions of faecal organisms in coastal waters. *International Journal of River Basin Management,* 13(1), 73-86.

Angeloudis, A., Stoesser, T. and **Falconer, R.A.** 2014. Predicting the disinfection efficiency range in chlorine contact tanks through a CFD-based approach. *Water Research,* 60, September, 118-129.

6.2 SHORT CV FOR DR LIANG

Dr. DONGFANG LIANG

Associate Professor in Civil Engineering Fluid Mechanics, University of Cambridge

Fellow and Director of Studies of Churchill College, Cambridge

ADDRESS Department of Engineering, University of Cambridge, Cambridge CB2 1PZ, U.K.
Tel: +44 1223 764829; Email: d.liang@eng.cam.ac.uk; Web: www.eng.cam.ac.uk/~dl359

HIGHER EDUCATION

Sep. 1998 – 8 Jan. 2003: PhD student, Department of Hydraulic Engineering, Tsinghua University, Beijing

Sep. 1994 – 26 Jun. 1998: BEng student, Department of Hydraulic Engineering, Tsinghua University, Beijing

WORK EXPERIENCE

Oct. 2006 – Present: University Lecturer, Senior Lecturer and then Associate Professor at *Department of Engineering, University of Cambridge, U.K.*

Feb. 2005 – Sept. 2006: Research Associate at *School of Engineering, Cardiff University, U.K.*

Apr. 2003 – Jan. 2005: Postdoctoral Researcher at *School of Civil & Resource Engineering, University of Western Australia*

FIELD OF SPECILIZATION: Hydrodynamics and Hydro-environment, in particular:

Computational fluid dynamics, Soil/Water interaction, Flood risk management, Sediment transport

MAIN FELLOWSHIPS AND AWARDS

- 2017, *Best Paper Award*, International Symposium on Meshfree Methods in Computational Hydraulics, Shanghai
- 2017, *Best Lecturer Prize*, Department of Engineering, University of Cambridge
- 2016, *Marie Curie Fellowship*, FP7 for Research and Technological Development, European Commission
- 2013, *Humboldt Research Fellowship for Experienced Researchers*, Alexander von Humboldt Foundation
- 2013, *OMAE Best Paper Award in Ocean Engineering Symposium*, American Society of Mechanical Engineers (ASME)
- 2012, *Research Fellowship*, The Matsumae International Foundation

MAIN PROFESSIONAL ACTIVITIES

1. 2019-present, Editor, Journal of safety science and resilience, Elsevier
2. 2019-present, Associate Editor, Maritime Engineering, Thomas Telford
3. 2019, Chair, 2nd international conference on MPM for modelling soil–water–structure interaction, 8–11 January 2019
4. 2018-present, Fellow of Higher Education Academy (FHEA)
5. 2018-present, Chartered Engineer (CEng)
6. 2016-present, Associate Editor, Journal of Hydrodynamics, Springer
7. 2015-present, Board Member, Anura3D MPM Research Community
8. 2016-present, Co-Chair of Institution of Civil Engineers (ICE) Cambridgeshire Branch
9. 2015-present, Technical Programming Committee, International Society of Offshore and Polar Engineers (ISOPE)

RECENT RESEARCH PROJECTS

1. 2020-2022, Royal Society-Newton Mobility Grant, International Exchanges Cost Share (NSFC), "Interaction among waves, integrated breakwater-WEC systems and seabed" (EC\NSFC\191369), £11,800
2. 2020, Cambridge Enterprise, "Hydrodynamic analyses of the AWP devices", £90,000
3. 2019-2020, Cambridge Centre for Smart Infrastructure and Construction, "Photogrammetric Study of Landslides and Rapid Ground Deformations", £25,000
4. 2018-2019, Laing O'Rourke Centre for Construction Engineering and Technology, "Monitoring slope stabilities with novel imaging techniques", £27,000
5. 2017-2018, Cambridge Centre for Smart Infrastructure and Construction, "A novel aerial sensing platform: Airship Drone", £30,000
6. 2017-2018, British Council, "Newton UK-China PhD Placement Programme: Hydro-environmental processes of Poyang Lake subject to climate change and engineering control", £29,123
7. 2015-2016, The Royal Academy of Engineering, "Industrial Secondments Scheme: Integrated dynamic modeling of surface and ground waters", £24,372
8. 2015, The Royal Academy of Engineering, "Newton Research Collaboration Programme: Hydrological and hydro-environmental responses of urban catchments to heavy rainfalls", £24,000
9. 2013-2017, EU Seventh Framework Programme (FP7) IAPP, "MPM modelling and simulation of soil-fluid interaction for dredging applications", €1,043,410.84 (€557,339.47 for Cambridge)

RECENT PUBLICATIONS

1. **Liang D**, Huang J, Zhang J, Shi S, Zhu N, Chen J. (2022). Three-Dimensional Simulations of Scour around Pipelines of Finite Lengths. Journal of Marine Science and Engineering, 10(1): Article No 106.
2. **Liang D**, Jia H, Xiao Y, Yuan S. (2022). Experimental investigation of turbulent flows around high-rise structure foundations and implications on scour. Water science and engineering, 15(1): 47-56.
3. Tsurudome C, **Liang D**, Shimizu Y, Khayyer A, Gotoh H. (2021). Study of beach permeability's influence on solitary wave runup with ISPH method. Applied Ocean Research, 117, Article No 102957.
4. Zhou Y, Ning D, **Liang D**, Cai S. (2021). Nonlinear hydrodynamic analysis of an offshore oscillating water column wave energy converter. Renewable and Sustainable Energy Reviews. 145, Article No 111086.
5. Zhang T, Xiao Y, **Liang D**, Tang H, Xu J, Yuan S, Wang N, Luan B. (2021). A Two-Layer Model for Studying 2D Dissolved Pollutant Runoff over Impermeable Surfaces. Hydrological Processes, 35, Article No e14152.
6. Harris L, **Liang D**, Shao S, Zhang T, Roberts G. (2021) MPM Simulation of Solitary Wave Run-up on Permeable Boundaries. Applied Ocean Research, 111, Article No 102602.
7. Yang F, **Liang D**. (2020). Random-walk simulation of non-conservative pollutant transport in shallow water flows. Environmental Modelling and Software, 134, Article No 104870.
8. Zhang T, Xiao Y, **Liang D**, Tang H, Xu J, Yuan S, Luan B. (2020). A physically-based model for dissolved pollutant transport over impervious surfaces. Journal of Hydrology, 590, Article No 125478.
9. **Liang D**, Zhao X, Soga K. (2020). Simulation of overtopping and seepage induced dike failure using two-point MPM. Soils and Foundations, 60: 978-988.

- **Published over 147 SCI papers, citation number = over 2212, H-index = 26 (www.researcherid.com/rid/D-2854-2011).**
- **Reviewer for over 100 journals; Supervised 6 Master's students and 17 PhD students to completion.**

7. STATEMENT OF TRUTH

7.1 The evidence which we have prepared and provide for this appeal reference APP/W0530/W/22/3291523 in this proof of evidence is true and we confirm that the opinions expressed are our true and professional opinions.

Professor Roger A. Falconer

Dr Dongfang Liang

Date 26th April 2022

Appendix G Poor maintenance led to a blocked culvert and severe flooding in St Ives in Cambridgeshire

A report on flooding that occurred in St Ives over Christmas 2020 can be found here[1]. In brief there was severe flooding, with a combination of surface water and sewage, of 96 properties, 32 of them internally, on Christmas Eve of 2020.

Two key factors played a role:

Firstly, 10 East Anglian towns and villages on 23rd – 24th December 2020 experienced widespread flooding, following a storm falling onto landmass which had already experienced sustained rainfall.

Secondly, there was blockage of one or more culverts (watercourses), with key parts of the Cambridgeshire County Council's report[2] into the situation reading as follows:

"Flooding began in St Ives on 23 December 2020 as a result of intense rainfall and existing ground conditions. The flooding was declared a major incident on 23 December 2020 and the tactical response was then co-ordinated by Cambridgeshire Police.

The duration of the flooding was reported to have been between 5 hours and two days, with predominantly surface water flooding on 23rd – 24th December 2020.

December was a very wet month with a total average rainfall of 108 mm (195% of the longterm average) across East Anglia as a whole and 180% of the long-term average for the rainfall catchment including St Ives.

96 flood reports were received by the LLFA from St Ives for December 2020. The duration of the flooding was reported to be between 5 hours and 2 days.

- *32 properties were reported by the community as having flooded internally.*

- *64 further properties reported external flooding of gardens, outbuildings, and roads.*

The combination of the above conditions resulted in rapid runoff on 23rd December 2020. This led to significant surface water flooding that in turn caused inundation of the foul drainage system. There are numerous watercourses throughout St Ives, many of which interact with each other before they reach the River Great Ouse. The maintenance condition of these watercourses is varied along their length, and it is understood that some may have been obstructed to such an extent that their capacity was adversely affected, and this may have also contributed to the flooding. The flooding of the watercourses also led to the overwhelming of a number of Anglian Water pumping stations. These pumping stations continued to function throughout the incident but were continually pumping flood water

[1] Flood Investigation Report | St Ives | December 2020[Folder ref. Doc_52]
[2] Flood Investigation Report | St Ives | December 2020[Folder ref. Doc_52]

which meant that foul water was not able to be pumped away, resulting in systems backing up into properties and a loss of toilet facilities.

The maintenance condition of these watercourses is varied along their length, and it is understood that some may have been obstructed to such an extent that their capacity was adversely affected, and this may have also contributed to the flooding. The flooding of the watercourses also led to the overwhelming of a number of Anglian Water pumping stations. These pumping stations continued to function throughout the incident but were continually pumping flood water which meant that foul water was not able to be pumped away, resulting in systems backing up into properties and a loss of toilet facilities."

Appendix H Psychological morbidity of flooding, a Public Health England study

Mulchandani et al. BMC Public Health (2020) 20:321
https://doi.org/10.1186/s12889-020-8424-3

BMC Public Health

RESEARCH ARTICLE Open Access

The English National Cohort Study of Flooding & Health: psychological morbidity at three years of follow up

Ranya Mulchandani[1,2*], Ben Armstrong[3], Charles R. Beck[1,2,4], Thomas David Waite[1,5], Richard Amlôt[6], Sari Kovats[3], Giovanni Leonardi[6], G. James Rubin[7] and Isabel Oliver[1,2,4]

Abstract

Background: Flooding is expected to increase due to climate change, population growth and urban development. The longer-term mental health impacts of flooding are not well understood. In 2015, the English National Study of Flooding and Health was established to improve understanding of the impact of flooding on health and inform future public health action.

Methods: We used 3 years of data from the English National Study of Flooding and Health. Participants who had consented to follow up were sent a questionnaire. Participants were classified into either "unaffected", "disrupted" or "flooded" according to their exposure. Logistic regression models were used to calculate adjusted odds ratios for probable depression, anxiety and post-traumatic stress disorder (PTSD) in each exposure group. The Wald test was used to assess the difference in probable mental health outcomes for those who did and did not experience "persistent damage" to their home. Conditional logistic regression was conducted to assess change in prevalence over the 3 years and to identify possible determinants of recovery.

Results: Eight hundred nineteen individuals were included in the final analysis – 119 were classified as unaffected, 421 disrupted and 279 flooded. Overall, 5.7% had probable depression, 8.1% had probable anxiety and 11.8% had probable PTSD, with higher prevalence in the flooded group compared with the unaffected group. After adjustment for potential confounders, probable mental health outcomes were higher in the flooded group compared to the unaffected group, significantly for probable depression (aOR 8.48, 95% CI 1.04–68.97) and PTSD (aOR 7.74, 95% CI 2.24–26.79). Seventy-seven (9.4%) participants reported experiencing persistent damage to their home, most commonly damp ($n = 40$) and visible mould ($n = 26$) in liveable rooms. Of the 569 participants who responded at all 3 years, a significant reduction in prevalence for all probable mental health outcomes was observed in the flooded group.

Conclusions: Flooding can have severe long-lasting consequences on mental health in affected populations. If these problems are not identified and treated early, they may persist for years. Further research is necessary to develop and evaluate interventions to increase resilience in at risk populations and to ensure timely access to support services following flooding.

Keywords: Post-traumatic stress disorder, Depression, Anxiety, Psychological morbidity, Flooding

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Full list of author information is available at the end of the article

Background

Flooding is the most common natural disaster worldwide and has been shown to have an adverse impact on both physical and psychological health [1]. In England, it is estimated that around 5.2 million properties are at risk of flooding [2]. Frequency and intensity of floods are anticipated to increase in the future due to population growth, urban development on flood plains, and climate change [3, 4].

In high-income countries such as the UK, the greatest burden of disease following flooding is adverse mental health outcomes [5]. In addition, displacement from homes can result in stress arising from dealing with household repairs and disruption to public services [6]. A number of factors have been found to increase vulnerability to experiencing psychological impacts following extreme weather, including older age, pre-existing medical conditions, inadequate insurance cover and social deprivation [7].

There is a paucity of studies quantifying the longer-term impacts of flooding on health, particularly beyond the first year post-flooding [8]. Following floods affecting England in 2013–2014, Public Health England (PHE) established the National Study of Flooding and Health (NSFH), to investigate the long-term impact of flooding and associated disruption on psychological health. The study aims to support preparedness and response activities to future flooding events.

The NSFH has previously identified a significant adverse impact on mental health, both at one and 2 years post-flooding, in those whose homes were flooded and whose lives were otherwise disrupted by flooding, compared with those unaffected [9, 10]. The NSFH also identified that adverse outcomes are associated with secondary stressors [11], such as insurance-related issues [12], and with displacement from home without warning [13]. In this study, we aim to assess mental health morbidity at 3 years post-flooding and the impact of persistent flood-related damage in the home. We also aim to assess the prevalence change over the three-year period, to identify possible predictors for psychological recovery.

Methods

Study design

This study is at year three of follow-up as part of the English NSFH, which was designed as a longitudinal observational open cohort. The participants are people affected by flooding between 1 December 2013 and 31 March 2014 (which are described in more detail elsewhere [9]).

Study population

The original cohort comprised of 2126 participants, with 1408 providing consent for follow-up [9]. At year two, of the 1408 contacted a total of 1064 responded [10]. 1361 participants were contacted at year three. This included all participants who had consented to follow-up at year one, irrespective of their response at year two, had not withdrawn consent subsequently and remained contactable.

Data collection

Participants were sent a 21-item bespoke questionnaire by either post or email. At year three, the questionnaire collected the following demographic information: marital status, educational level, employment status and presence of ongoing illness. Participant sex, ethnicity and age were collected at year one.

The participants had been classified in year one according to their exposure to flooding in the winter of 2013/14. The categories were either "unaffected", "disrupted" (life disrupted by flooding, but no entry of water into any liveable room of the home) or "flooded" (entry of water into at least one liveable room of the home).

The questionnaire included validated instruments to determine probable psychological outcomes based on self-reported symptoms. The instruments used were the Patient Health Questionnaire (PHQ-2) for depression [14], Generalized Anxiety Disorder Scale (GAD-2) for anxiety [15] and PTSD checklist (PCL-6) for PTSD [16]. Cut-off scores were ≥ 3 for PHQ-2 and GAD-2 and ≥ 14 for PCL-6, respectively.

The questionnaire also included questions to determine whether the participant's home had ongoing damage from the original floods ("persistent damage"), whether they had experienced any new episodes of flooding, status of any insurance re-payment and other potential secondary stressors (dealing with insurance-related issues, dealing with home repairs, concerns about own health, relationship problems, disagreements with neighbours and concerns about the value of the home).

"Persistent damage" was defined as ongoing flood-related issues in the home damp in liveable rooms, visible mould in liveable rooms, problems with damp or water in non-liveable rooms, sewage backing up, problems with septic tank and problems with other utilities (drinking water, gas, oil, electricity etc) attributed to the floods in the winter of 2013/2014.

Statistical analysis

We performed a descriptive analysis of the sociodemographic characteristics of respondents, their exposure to flooding and any experience of persistent damage, and mental health outcomes of probable depression, anxiety and PTSD.

It is important to note that the crude mental health prevalence presented are not exactly comparable to those presented at year two of this study, in the previously published paper by *Jermacane* et al. [10]. In *Jermacane* et al, *2018*, individuals who had responded to some, but not all mental health questions, were included in the denominator data, but in the present study those subjects were excluded, in line with the approach of *Waite* et al. [9] for year one data. In our paper, we have calculated prevalence according to the method used by *Waite* et al, *2017* at all 3 years, to allow for easier comparison across all 3 years.

Crude logistic regression models were run for all exposure groups to test for associations between exposure variables (flooding and disruption from flooding) and probable mental health outcomes, using those unaffected as the reference group.

Multivariable logistic regression models were run to adjust for a priori potential confounders, including age group, sex, ethnic group, pre-existing illness, deprivation score (Index of Multiple Deprivation, IMD), marital status, education and employment.

We used the Wald test to assess whether there was a significant difference in probable mental health outcomes between those who experienced persistent damage at year three and those who did not; for this analysis we only included disrupted and flooded respondents, with the disrupted group as the reference. Conditional logistic regression was conducted to test for significant changes in prevalence over the 3 years by each exposure group and to identify possible determinants of recovery for mental health outcomes. Only those who responded in all 3 years were included in the matched analyses. All data were merged, cleaned and analysed in R software version 3.5.0 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Of the 1361 participants contacted at year three, 896 responded with a questionnaire, however 29 questionnaires were blank and were not included in the analysis (63.7% valid response rate). A further 48 exclusions were made, including 9 duplicates, 3 who reported a new episode of flooding and 36 who had a missing exposure status at year one. Of the 819 included in the final analysis, 119 (14.5%) were classified as unaffected, 421 (51.4%) as disrupted and 279 (34.0%) as flooded. Of those, 569 had completed the questionnaire in all 3 years, with 93 (16.3%) classified as unaffected, 289 (50.8%) as disrupted and 187 (32.9%) as flooded.

Overall, approximately 5.7% reported symptoms of probable depression, 8.1% of probable anxiety and 11.8% of probable PTSD, with the prevalence of all adverse probable mental health outcomes higher in the flooded group than unaffected (Table 1).

The adjusted odds ratio (aOR) of probable depression and PTSD were significantly higher in the flooded group compared with the unaffected group, with aOR 8.48 (95% CI 1.04–68.97) and aOR 7.74 (95% CI 2.24–26.79), respectively. The aOR of probable anxiety was elevated in the flooded group, compared with the unaffected group but not significantly (aOR 2.68, 95% CI 0.88–8.20). Participants who were disrupted by flooding had increased odds of PTSD (aOR 4.33, 95% CI 1.26–14.92), compared with the unaffected group; no other probable mental health outcomes in the disrupted group were statistically significant (Table 2).

Seventy-seven (9.4%) participants reported persistent damage to their home because of the original flooding episode. The most commonly reported issues were damp in liveable rooms ($n = 40$), visible mould in liveable rooms ($n = 26$), problems with damp or water in non-liveable rooms such as garage, cellar or basement ($n = 12$) and drains backing up and flooding ($n = 10$). After adjusting for potential confounders, those who reported persistent home damage at year three were statistically more likely to suffer from depression and PTSD, compared with those who did not report persistent damage, however anxiety was not significantly elevated in this group (Table 3).

We observed a prevalence change of probable mental health outcomes over three consecutive years post-flooding, for the 569 participants who completed the questionnaire in all 3 years (Fig. 1, Supplementary Table 1). In the flooded group, we observed a significant reduction in prevalence across all three probable mental health outcomes: depression (year one 20.8%, year two 11.2%, year three 7.8%, $p = 0.0014$), anxiety (year one 27.6%, year two 12.3%, year three 11.8%, $p < 0.001$) and PTSD (year one 33.2%, year two 24.9%, year three 17.1%, $p = 0.001$). The reduction was suggestive in the disrupted group for depression (year one 8.3%, year two 4.8%, year three 5.1%, $p = 0.05$) and in the unaffected group for PTSD (year one 5.6%, year two 0%, year three 1.9%, $p = 0.045$), but not for anxiety in either the disrupted or unaffected group. No significant predictors were identified for the reductions in prevalence of adverse mental health outcomes.

Discussion

Few studies have focused on the long-term prevalence of mental health problems in those affected by flooding, with systematic mapping reviews by *Zhong* et al, *2018* and *Fernandez* et al, *2015* highlighting the lack of studies conducted on this topic two or more years post-flooding [1, 17]. Our paper assessed the prevalence of probable mental health outcomes 3 years after a flooding event.

We identified that the adverse impact of flooding on mental health persists for at least 3 years after the flooding event, with a higher prevalence of psychological morbidity (significantly for depression and PTSD) in flooded participants, compared with those unaffected. Many individuals reported persistent damage to their homes, which was a strong predictor for poorer mental health outcomes, compared with other people who were exposed (disrupted or flooded) but who did not report experiencing persistent damage issues.

Table 1 Crude prevalence of mental health outcomes by exposure group (year 3)

Outcome	Overall cohort	Exposure group		
		Unaffected	Disrupted	Flooded
Probable depression	42/733 (5.7%)	1/112 (0.9%)	22/380 (5.8%)	19/241 (7.9%)
Probable anxiety	59/731 (8.1%)	4/114 (3.5%)	27/378 (7.1%)	28/239 (11.7%)
Probable PTSD	91/771 (11.8%)	3/117 (2.6%)	43/397 (10.2%)	45/257 (17.5%)

Overall the data show a reduction in psychological morbidity over the 3 years in the flooded group, a suggestive decline in the disrupted group and no significant differences in the unaffected group. Unfortunately, we were unable to identify any predicators of this recovery in this cohort; previous studies has found factors such as availability of social support and personal coping style could influence recovery from PTSD post-flooding [18, 19]; however, these were conducted in China and more research is required on understanding the mechanisms for recovery in other contexts post-flooding.

We observed nearly half the prevalence of PTSD symptoms in the flooded group at year three post-flooding, compared with year one. This is in line with previous studies on PTSD related to natural disasters where one meta-analysis calculated a spontaneous remission rate of 60.0% [20], and may partly reflect the resolution of ongoing stressors that were helping to maintain distress in this group.

Within our study we observed 17.5% of flooded individuals with scores that indicated probable PTSD at 3 years after flooding, which is line with previous studies – 22% of individuals in South Korea at 18 months after flooding [21] and 8.6% of individuals 2.5 years after flooding in China [22] experienced probable PTSD. However, despite the decline in prevalence observed in people who have experienced flooding over the 3 years, there is still persistence of psychological morbidity, which may indicate a possible risk of chronic mental health problems if affected people do not receive suitable treatment.

Limitations

There are several limitations with our study. There were a low number of cases in the unaffected group, which impacts the precision and power of our study – particularly for probable depression in the unaffected group, which is only based on one case.

Our study was conducted in response to flooding that occurred in 2013–2014 in the south of England within a homogenous population in terms of income, age and ethnic group; it may not generalizable for all English populations or representative across other geographical contexts. As we excluded people who reported experiencing a further episode of flooding (since the original floods in 2013–2014), our data does not consider the impact of repeated flooding on the extent of mental health outcomes.

A strength of our paper is the use of conditional logistic regression, where we have matched the same individuals over the 3 years. This allowed us to understand the

Table 2 Crude and adjusted odds ratios (aOR) of mental health outcomes by exposure group

Outcome by exposure	Prevalence	Crude OR (95% CI)	aOR[a] (95%CI)	*P* value
Probable depression				
Unaffected	0.9%	ref	ref	
Disrupted	5.8%	6.82 (0.91–51.18)	5.89 (0.74–47.10)	0.094
Flooded	7.9%	9.50 (1.25–71.88)	8.48 (1.04–68.97)	0.046
Probable anxiety				
Unaffected	3.5%	ref	ref	
Disrupted	7.1%	2.12 (0.72–6.17)	1.59 (0.52–4.83)	0.412
Flooded	11.7%	3.65 (1.24–10.7)	2.68 (0.88–8.20)	0.084
Probable PTSD				
Unaffected	2.6%	ref	ref	
Disrupted	10.8%	4.62 (1.40–15.16)	4.33 (1.26–14.92)	0.020
Flooded	17.5%	8.07 (2.45–26.53)	7.74 (2.24–26.79)	0.001

[a]Adjusted odds ratios are adjusted for age, sex, pre-existing illness, deprivation score, marital status and education and employment

Table 3 Crude and adjusted odds ratios (aOR) of mental health outcomes of participants with and without persistent damage to year three

Outcome by exposure	Prevalence (n/N)	Crude OR (95% CI)	aOR[a] (95%CI)	*P* value
Probable depression				
Disrupted				
No persistent damage	4.8% (17/356)	ref	ref	
Persistent damage	20.8% (5/24)	5.20 (1.73–15.61)	19.30 (3.99–93.24)	< 0.001
Flooded				
No persistent damage	5.6% (11/197)	ref	ref	
Persistent damage	18.1% (8/44)	3.68 (1.38–9.78)	6.02 (1.61–22.5)	0.008
Probable anxiety				
Disrupted				
No persistent damage	6.5% (23/354)	ref	ref	
Persistent damage	16.7% (4/24)	2.85 (0.90–9.04)	5.53 (1.31–23.30)	0.019
Flooded				
No persistent damage	10.4% (20/196)	ref	ref	
Persistent damage	18.6% (8/43)	1.97 (0.80–4.82)	1.92 (0.67–5.54)	0.227
Probable PTSD				
Disrupted				
No persistent damage	9.7% (36/371)	ref	ref	
Persistent damage	24.0% (6/25)	2.91 (1.09–7.76)	3.85 (1.13–13.11)	0.031
Flooded				
No persistent damage	13.7% (29/211)	ref	ref	
Persistent damage	30.2% (13/43)	2.70 (1.26–5.78)	4.56 (1.73–11.99)	0.002

[a]Adjusted odds ratios are adjusted for age, sex, pre-existing illness, deprivation score, marital status and education and employment

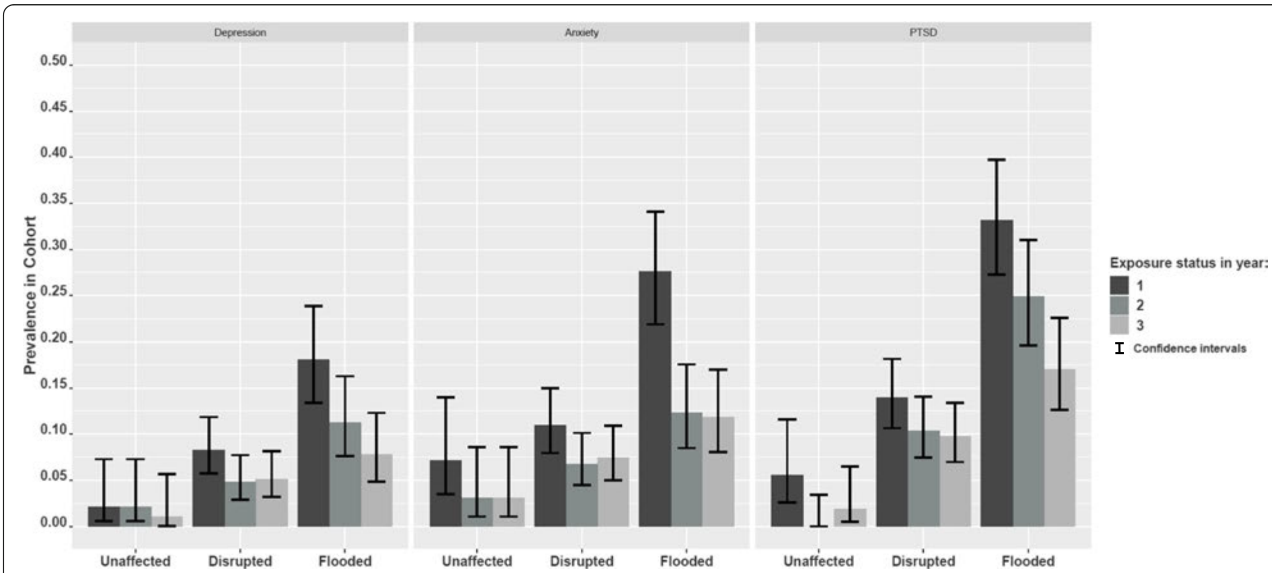

Fig. 1 Prevalence of mental health outcomes by exposure group over 3 years post-flooding of participants who responded all 3 years

change in mental health prevalence over time without having to control for potential confounders. This is particularly important, as the review by *Fernandez* et al, *2015* identified that most other studies had not taken confounding into account, limiting overall confidence in their study conclusions [1].

Further research

We have identified that experience of flooding followed by persistent damage to the home is a significant predictor for poorer mental health outcomes. It would be important to understand in more detail the types of damage experienced and how these impact on mental health, particularly in vulnerable groups who may experience and respond to damage differently, to guide appropriate public health action. Studies are also needed to develop and evaluate interventions, such as social support, to reduce the impact of flooding on mental health.

Conclusions

This study has shown that the adverse impact of flooding on mental health persists for at least 3 years after the event, and that persistent damage to liveable rooms in the home is associated with more severe mental health outcomes. Work is needed to develop and evaluate interventions to increase resilience within populations at risk of flooding and to ensure prompt access to appropriate services following a flooding event.

Supplementary information

Supplementary information accompanies this paper at https://doi.org/10.1186/s12889-020-8424-3.

Additional file 1: Supplementary Table 1. Prevalence of mental health outcomes by exposure group over 3 years post-flooding of participants who responded at all 3 years.

Abbreviations

aOR: Adjusted odds ratio; CI: Confidence interval; NSFH: National Study of Flooding and Health; OR: Odds ratio; PHE: Public Health England; PTSD: Post-traumatic stress disorder; UK: United Kingdom

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Authors' contributions

RM led on the analysis of the study as well as drafting of the work for publication. BA contributed to the design of the study, drafting and revision of the work for publication, and provided expert guidance on the statistical analysis. CRB contributed to the design, analysis and interpretation of the study and drafting and revision of the work for publication. TDW contributed to the design and analysis of the study and drafting and revision of the work for publication. TDW was the lead researcher at year one of the study. RA contributed to the design and analysis of the study and drafting and revision of the work for publication. SK contributed to the design and analysis of the study and drafting and revision of the work for publication. GL contributed to the design of the study. GJR contributed to the design, analysis and interpretation of the study, drafting and revision of the work for publication and is a primary investigator of the study. IO contributed to the design, analysis and interpretation of the study, drafting and revision of the work for publication and is a primary investigator of the study. All authors, external and internal, had full access to all of the data in the study and can take responsibility for the integrity and accuracy of the data analysis. The lead author (Isabel Oliver) affirms that the manuscript is an honest, accurate and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and if relevant, registered) have been explained. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and analysed during the study are available from Public Health England on reasonable request.

Ethics approval and consent to participate

The National Study on Flooding and Health was granted ethical approval by the Psychiatry, Nursing and Midwifery Research Ethics Subcommittee at King's College London [Reference PNM 1314 152]. All study respondents provided written consent to participate.

Consent for publication

This manuscript does not contain individual level data and thus is not relevant. All participants consented to the use of their aggregated data for publication as a journal article.

Competing interests

The authors declare that they have no competing interests.

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Publisher's Note

Appendix I Reference document list

All documents cited are being provided to HM Planning Inspector in a single folder, due to the difficulties in dealing with many different versions of amended plans.

Within this folder, we have divided these documents into 'Core', 'Non-Core', 'Admin', and 'Reference' folders. Where we believe with high confidence that document is a core document, we have indicated this in Table I1 and placed it in the 'Core' folder. Administrative documents (such as the Appellant's Appeal Statement and the Case Management minutes) are in the 'Admin' folder. The SuDS manual is in the 'Reference' folder.

We regret that it is possible that some documents in 'Non-Core' are actually core documents. This application is characterised by many versions and complex plans. Determining whether a document is core has been difficult thus far. We have received a Letter from SCDC stating that core documents will be available at https://www.scambs.gov.uk/Land-East-of-Teversham-Road-Fulbourn-Public-Inquiry-Code-Documents, however this URL is not available at present (26/4/2022).

When we (the Rule 6 Party) are able to download all core documents, we undertake to screen all our cited documents against the core documents.

Table of Contents

Table I1: Document titles and filenames in accompanying document folder

Folder	Core document reference	Filename in folder	Document Title
NonCore		Doc_1_Downloaded_c8e1a.pdf	Catchment Based Approach | Chalk Stream Restoration Strategy 2021 (Main report)
NonCore		Doc_2_TRF-CBA-1-GF-M2-L-3000__2__SITE_SECTIONS-5580258pdf_aa445.pdf	TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 November 2020)
Core	CDC1	Doc_3_S_0202_17_OL-Decision_Notice-4618041pdf_81819.pdf	Planning Permission subject to conditions S/0202/17/OL (26 October 2017)
NonCore		Doc_4_SITE_SECTIONS__AMENDED_-5695409pdf_f3b3d.pdf	TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 April 2021)
NonCore		Doc_5_PLANNING_UPDATE-5419461pdf_2a2d5.pdf	Planning Update Note (March 2020)
Core	CDE1	Doc_6_south-cambridgeshire-adopted-local-plan-270918_smlpdf_f3df1.pdf	South Cambridgeshire Local Plan (Adopted September 2018)
NonCore		Doc_7_LLFA_inaccuracies_26Sept2021pdf_46b5a.pdf	FR/19-000431 Comments on S/3290/19/RM (26 September 2021)
NonCore		Doc_8_CANNON_CONSULTING_ENGINEERS-5519523pdf_ded9c.pdf	B411 Teversham Road Fulbourn Cambridgeshire Reserved Matters Application Layout (12 August 2020)
Admin		Doc_9_APPEAL_STATEMENT-5881461pdf_5b939.pdf	Pre-Inquiry Statement of Case (January 2022)
NonCore		Doc_10_60_COW_LANE-5770328tif_303d1.tif	Submission to the Planning Committee (8 August 2021)
Core	CDA13	Doc_11_DECISION_NOTICE-5820553pdf_f0d9a.pdf	Application for Approval of Reserved Matters (20 October 2021)
NonCore		Doc_12_SUBMISSION%20TO%20THE%20PLANNING%20COMMITTEE%28compressed%2920210613pdf_09221.pdf	Submission to the Planning Committee (13 June 2021)
Core	CDG4	Doc_13_EXPERT_SURFACE_WATER_FLOOD_MANAGEMENT-5520040tif_18441.tif	Review of surface water management (August 2020)
NonCore		Doc_14_S_3209_19_DC-DRAINAGE_COMMENTS-5423116pdf_4a8c7.pdf	Planning Consultation Response | Sustainable Drainage Engineer (15 March 2020)
NonCore		Doc_15_CCE_B411_TEVERSHAM_ROAD_FULBOURN_SW_REVISED_STRATEGY_REDUCED_FILE_SIZE-5419460pdf_a322e.pdf	B411 Teversham Road Fulbourn Cambridgeshire Surface water management (27 February 2020)
Core	CDB6	Doc_16_Surface_water_management-5153492pdf_8b621.pdf	B411 Surface water management (12 September 2019)
Core	CDG10	Doc_17_FWM9010-RT001-R03-00pdf_7582d.pdf	Update to surface water flood management (1 April 2022)
Core	CDG9	Doc_18_CCE%20B411%20Teversham%20Road%20Fulbourn%20modelling%20and%20sw%20note%2002pdf_f17f0.pdf	B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)
Core	CDG8	Doc_19_COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426pdf_29f69.pdf	B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)
NonCore		Doc_20_LLFA-5746335pdf_cefc5.pdf	Comments from LLFA (5 July 2021)

NonCore		Doc_21_FLOOD_RISK_UPDATE_NOTE__AMENDED_-5695403pdf_c160d.pdf	B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)
Core	CDF1	Doc_22_NPPF_July_2021pdf_a6cbd.pdf	National Planning Policy Framework (2021)
NonCore		Doc_23_Drainage_comments-5356806pdf_9b210.pdf	Planning Consultation Response | Sustainable Drainage Engineer (14 December 2019)
Core	CDC12	Doc_24_Flood_Risk___Surface_Water_Management_Update-4631194pdf_f354d.pdf	B411 Flood Risk and Surface Water Management Update (January 2017)
NonCore		Doc_25_S_3209_19_DC-AGENT_EMAIL__WITHDRAW_CONDITIONS_8_AND_20_-5801816pdf_e9a4d.pdf	Request to withdraw Condition 8 From application S/3209/19/DC
Admin		Doc_26_3291523%20CMC%20Summary%20Noteasddoc_15921.html	Case management conference Summary Note (APP/W0530/W/22/3291523)
NonCore		Doc_27_DRAINAGE-5469940docx_e7481.docx	Planning Consultation Response (14/6/2020)
NonCore		Doc_28_3000_series_site_sections-5326244pdf_8c9d2.pdf	TRF-CBA-1-GF-M2-L-3000 Site Sections (August 2019)
NonCore		Doc_29_LLFA%20Response%20to%20Resident%20Letterpdf_12398.pdf	LLFA response to resident of 60 Cow Lane (29 September 2021) [FR/19-000431]
NonCore		Doc_30_Downloaded_fc51d.html	New strategy launched to protect chalk streams (15 October 2021)
NonCore		Doc_31_LLFA_comments-5123328pdf_f81fb.pdf	LLFA response to consultation (FR/19-000431; S/3290/19/RM)
NonCore		Doc_32_DRAINAGE_DETAILS-EMAIL-5536414pdf_1e847.pdf	Email from Barton Willmore to SCDC Planning Officer
NonCore		Doc_33_S_3290_19_RM-COVERING_LETTER-5462675%20%281%29pdf_f1525.pdf	Planning Application S/3290/19/RM [25542/A5/PD] (26 May 2020)
NonCore		Doc_34_SUSTAINABLE_DRAINAGE-5583022pdf_98acf.pdf	Sustainable drainage Engineer comments (19/11/2020)
NonCore		Doc_35_B411_-_PL_-_SK_-_320_-_P06_FLOOD_MANAGEMENT_-_19_11_20-5582637pdf_2eba6.pdf	B411-PL-SK-320 Flood Management Strategy
NonCore		Doc_36_SURFACE_WATER_DETAILS_ADDITIONAL_11_12_19-5102527pdf_a4ae9.pdf	B411 Surface water Management (3 December 2019)
NonCore		Doc_37_DRAINAGE-5555978pdf_44541.pdf	Sustainable drainage Engineer comments (9/10/2020)
NonCore		Doc_38_FINISHED_FLOOR_LEVEL_PLAN_DRAINAGE-5546486pdf_dfdb1.pdf	B411-PL-SK-320 Flood Management Strategy (16/9/2020)
NonCore		Doc_39_3_flood_modelling_drainage_strategy_reportpdf_e7b04.pdf	Evidence regarding land south of the Cambridge Biomedical Campus | Flood modelling and drainage strategy report
NonCore		Doc_40_FLOOD_MANAGEMENT_STRATEGY__AMENDED_-5695397pdf_17847.pdf	B411-PL-SK-320 Flood Management Strategy (14/4/2021)
NonCore		Doc_41_FULBOURN_GENERAL_TOPO_PLAN__ADDITIONAL_INFORMATION_-5759427pdf_1549d.pdf	Fulbourn General Topological Plan Additional Information (from file title; no date provided)
NonCore		Doc_42_17m_high_gardenpdf_4f35b.pdf	Letter from 60 Cow Lane resident to SCDC Planning Officer (9 August 2021)
Core	CDC5	Doc_43_Planning_statement-5243498pdf_308bc.pdf	Reserved Matters Planning Statement (September 2019)

Core	CDF1	Doc_44_NPPF%20old%20archived%20versionpdf_a33a9.pdf	National Planning Policy Framework (2012)
NonCore		Doc_45_Cow%20Lanepdf_61884.pdf	Topological survey of gardens of housing along Cow Lane (14 April 2022)
Core	Part of CDA3	Doc_46_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_2__AMENDED_-5695407pdf_30b5a.pdf	TRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)
NonCore		Doc_47_Permeability%20indicespdf_8cf2e.pdf	British Geological Survey. Guide To Permeability Indices. (2006; CR/06/160N)
NonCore		Doc_48_DRAINAGE-5437198docx_272f6.docx	Sustainable drainage Engineer comments (16 April 2020)
NonCore		Doc_49_DRAINAGE-5530414pdf_29d0f.pdf	Sustainable drainage Engineer comments (1 September 2020)
NonCore		Doc_50_LLFA_s_consultation_response-4574683pdf_a463d.pdf	LLFA response to consultation (FR/19-000431; S/3290/19/RM) (15 October 2019)
NonCore		Doc_51_LLFA-5792277pdf_a2053.pdf	LLFA response to consultation (FR/19-000431; S/3290/19/RM) (9 September 2021)
NonCore		Doc_52_St-Ives-December-2020-Flood-Investigationpdf_bcf96.pdf	Flood Investigation Report | St Ives | December 2020
Reference		Doc_53_The-SuDS-Manual-C697pdf_da2e5.pdf	The SuDS manual (2007)
NonCore		Doc_54_LEAD_FLOOD_AUTHORITY-5429069pdf_5e684.pdf	LLFA response to consultation (FR/19-000431; S/3290/19/RM) (20 March 2020)
NonCore		Rec_55_Jan2021_Planning_Meeting	Recording of 13 January 2021 Planning Meeting
NonCore		Doc_56_Downloaded_fc51d.html	Press Release | New Strategy Launched to protect chalk streams (15 October 2021)
Core	Part of CDA3	Doc_57_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_1__AMENDED_-5695406	TRF-CBA-1-GF-M2-L-1010 1000 Series Hard Landscaping Sheet 1 (12 April 2021)
NonCore		This is dynamic web site; data downloaded from it presented separately as a figure.	Cambridge Historic Weather
NonCore		This is dynamic web site; data downloaded from it presented separately as a figure.	Onshore Geoindex

Table I2: Document authors, versions and filenames in accompanying document folder

Folder / Filename in folder	Author	Version
NonCore / Doc_1_Downloaded_c8e1a.pdf	CaBA CSRG Panel	N/A
NonCore / Doc_2_TRF-CBA-1-GF-M2-L-3000__2__SITE_SECTIONS-5580258pdf_aa445.pdf	Chris Blandford Associates	P3
Core / Doc_3_S_0202_17_OL-Decision_Notice-4618041pdf_81819.pdf	S J Kelly Director for Planning SCDC	N/A
NonCore / Doc_4_SITE_SECTIONS__AMENDED_-5695409pdf_f3b3d.pdf	Chris Blandford Associates	P4
NonCore / Doc_5_PLANNING_UPDATE-5419461pdf_2a2d5.pdf	Barton Willmore	02 [25542/A5/P10/PD/SO]
Core / Doc_6_south-cambridgeshire-adopted-local-plan-270918_smlpdf_f3df1.pdf	SCDC	SCDC/LP/27.09.2018
NonCore / Doc_7_LLFA_inaccuracies_26Sept2021pdf_46b5a.pdf	Residents, 60 Cow Lane	N/A
NonCore / Doc_8_CANNON_CONSULTING_ENGINEERS-5519523pdf_ded9c.pdf	Cannon Consulting Engineers	N/A
Admin / Doc_9_APPEAL_STATEMENT-5881461pdf_5b939.pdf	Castlefield International Ltd	02 [25542/A5/P11/PD/SO]
NonCore / Doc_10_60_COW_LANE-5770328tif_303d1.tif	Residents, 60 Cow Lane	N/A
Core / Doc_11_DECISION_NOTICE-5820553pdf_f0d9a.pdf	SCDC	N/A
NonCore / Doc_12_SUBMISSION%20TO%20THE%20PLANNING%20COMMITTEE%28compressed%2920210613pdf_09221.pdf	Residents, 60 Cow Lane	N/A
Core / Doc_13_EXPERT_SURFACE_WATER_FLOOD_MANAGEMENT-5520040tif_18441.tif	HR Wallingford Ltd	FWM8709-RT-01-R01-00
NonCore / Doc_14_S_3209_19_DC-DRAINAGE_COMMENTS-5423116pdf_4a8c7.pdf	Sustainable Drainage Engineer SCDC	N/A
NonCore / Doc_15_CCE_B411_TEVERSHAM_ROAD_FULBOURN_SW_REVISED_STRATEGY_REDUCED_FILE_SIZE-5419460pdf_a322e.pdf	Cannon Consulting Engineers	N/A
Core / Doc_16_Surface_water_management-5153492pdf_8b621.pdf	Cannon Consulting Engineers	N/A
Core / Doc_17_FWM9010-RT001-R03-00pdf_7582d.pdf	HR Wallingford Ltd	FWM9010-RT001-R3-00
Core / Doc_18_CCE%20B411%20Teversham%20Road%20Fulbourn%20modelling%20and%20sw%20note%2002pdf_f17f0.pdf	Cannon Consulting Engineers	N/A
Core / Doc_19_COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426pdf_29f69.pdf	Cannon Consulting Engineers	P02
NonCore / Doc_20_LLFA-5746335pdf_cefc5.pdf	SCDC LLFA	N/A
NonCore / Doc_21_FLOOD_RISK_UPDATE_NOTE__AMENDED_-5695403pdf_c160d.pdf	Cannon Consulting Engineers	N/A
Core / Doc_22_NPPF_July_2021pdf_a6cbd.pdf	HM Government	N/A

NonCore / Doc_23_Drainage_comments-5356806pdf_9b210.pdf	Sustainable Drainage Engineer SCDC	N/A
NonCore / Doc_24_Flood_Risk___Surface_Water_Management_Update-4631194pdf_f354d.pdf	Cannon Consulting Engineers	N/A
NonCore / Doc_25_S_3209_19_DC-AGENT_EMAIL__WITHDRAW_CONDITIONS_8_AND_20_-5801816pdf_e9a4d.pdf	Barton Willmore	N/A
Admin / Doc_26__3291523%20CMC%20Summary%20NoteasdNonCore / Doc_15921.html	HM Planning Inspector	N/A
NonCore / Doc_27_DRAINAGE-5469940docx_e7481.docx	Sustainable Drainage Engineer SCDC	N/A
NonCore / Doc_28_3000_series_site_sections-5326244pdf_8c9d2.pdf	Chris Blandford Associates	P1
NonCore / Doc_29_LLFA%20Response%20to%20Resident%20Letterpdf_12398.pdf	SCDC LLFA	N/A
NonCore / Doc_30_Downloaded_fc51d.html	Environment Agency	N/A
NonCore / Doc_31_LLFA_comments-5123328pdf_f81fb.pdf	SCDC LLFA	N/A
NonCore / Doc_32_DRAINAGE_DETAILS-EMAIL-5536414pdf_1e847.pdf	Barton Willmore	N/A
NonCore / Doc_33_S_3290_19_RM-COVERING_LETTER-5462675%20%281%29pdf_f1525.pdf	Barton Willmore	N/A
NonCore / Doc_34_SUSTAINABLE_DRAINAGE-5583022pdf_98acf.pdf	Sustainable Drainage Engineer SCDC	N/A
NonCore / Doc_35_B411_-_PL_-_SK_-_320_-_P06_FLOOD_MANAGEMENT_-_19_11_20-5582637pdf_2eba6.pdf	Cannon Consulting Engineers	P06
NonCore / Doc_36_SURFACE_WATER_DETAILS_ADDITIONAL_11_12_19-5102527pdf_a4ae9.pdf	Cannon Consulting Engineers	N/A
NonCore / Doc_37_DRAINAGE-5555978pdf_44541.pdf	Sustainable Drainage Engineer SCDC	N/A
NonCore / Doc_38_FINISHED_FLOOR_LEVEL_PLAN_DRAINAGE-5546486pdf_dfdb1.pdf	Cannon Consulting Engineers	P01
NonCore / Doc_39_3_flood_modelling_drainage_strategy_reportpdf_e7b04.pdf	Peter Brett Associates	36873/2001 | Rev: D
NonCore / Doc_40_FLOOD_MANAGEMENT_STRATEGY__AMENDED_-5695397pdf_17847.pdf	Cannon Consulting Engineers	P09
NonCore / Doc_41_FULBOURN_GENERAL_TOPO_PLAN__ADDITIONAL_INFORMATION_-5759427pdf_1549d.pdf	Cannon Consulting Engineers	Not stated
NonCore / Doc_42_17m_high_gardenpdf_4f35b.pdf	Resident, 60 Cow Lane	N/A
Core / Doc_43_Planning_statement-5243498pdf_308bc.pdf	Barton Willmore	N/A
Core / Doc_44_NPPF%20old%20archived%20versionpdf_a33a9.pdf	HM Government	N/A
NonCore / Doc_45_Cow%20Lanepdf_61884.pdf	Resident, 60 Cow Lane; MIJA Survey (Geospatial Surveying Engineering)	--
Core / Doc_46_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_2__AMENDED_-5695407pdf_30b5a.pdf	Chris Blandford Associates	P6

NonCore / Doc_47_Permeability%20indicespdf_8cf2e.pdf	LEWIS M A, CHENEY C S AND ODOCHARTAIGH BE	N/A
NonCore / Doc_48_DRAINAGE-5437198docx_272f6.docx	Sustainable Drainage Engineer SCDC	N/A
NonCore / Doc_49_DRAINAGE-5530414pdf_29d0f.pdf	Sustainable Drainage Engineer SCDC	N/A
NonCore / Doc_50_LLFA_s_consultation_response-4574683pdf_a463d.pdf	SCDC LLFA	N/A
NonCore / Doc_51_LLFA-5792277pdf_a2053.pdf	SCDC LLFA	N/A
NonCore / Doc_52_St-Ives-December-2020-Flood-Investigationpdf_bcf96.pdf	Cambridgeshire County Council	1.0
Reference / Doc_53_The-SuDS-Manual-C697pdf_da2e5.pdf	CIRIA	N/A
NonCore / Doc_54_LEAD_FLOOD_AUTHORITY-5429069pdf_5e684.pdf	SCDC LLFA	N/A
NonCore / Rec_55_Jan2021_Planning_Meeting	Recorded by SCDC	N/A
NonCore / Doc_56_Downloaded_fc51d.html	UK Government	N/A
Core / Doc_57_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_1__AMENDED_-5695406	Chris Blandford Associates	P6
This is dynamic web site; data downloaded from it presented separately as a figure.	www.worldweatheronline.co m	N/A
This is dynamic web site; data downloaded from it presented separately as a figure.	British Geological Survey	N/A

Table I3: Document online version availability and filenames in accompanying document folder

Folder / Filename in folder	Original website or dropbox url
NonCore / Doc_1_Downloaded_c8e1a.pdf	https://catchmentbasedapproach.org/wp-content/uploads/2021/10/CaBA-CSRG-Strategy-MAIN-REPORT-FINAL-12.10.21-Low-Res.pdf
NonCore / Doc_2_TRF-CBA-1-GF-M2-L-3000__2__SITE_SECTIONS-5580258pdf_aa445.pdf	https://www.dropbox.com/s/1292h7maut99rvf/TRF-CBA-1-GF-M2-L-3000__2__SITE_SECTIONS-5580258.pdf?dl=0
Core / Doc_3_S_0202_17_OL-Decision_Notice-4618041pdf_81819.pdf	https://www.dropbox.com/s/1dyq5jyr1hkpq9q/S_0202_17_OL-Decision_Notice-4618041.pdf?dl=0
NonCore / Doc_4_SITE_SECTIONS__AMENDED_-5695409pdf_f3b3d.pdf	https://www.dropbox.com/s/268xzezq9825em1/SITE_SECTIONS__AMENDED_-5695409.pdf?dl=0
NonCore / Doc_5_PLANNING_UPDATE-5419461pdf_2a2d5.pdf	https://www.dropbox.com/s/3e6cf1ns7ob9peg/PLANNING_UPDATE-5419461.pdf?dl=0
Core / Doc_6_south-cambridgeshire-adopted-local-plan-270918_smlpdf_f3df1.pdf	https://www.dropbox.com/s/61aha987ebbhphr/south-cambridgeshire-adopted-local-plan-270918_sml.pdf?dl=0
NonCore / Doc_7_LLFA_inaccuracies_26Sept2021pdf_46b5a.pdf	https://www.dropbox.com/s/69q8jt94po2n9k9/LLFA_inaccuracies_26Sept2021.pdf?dl=0
NonCore / Doc_8_CANNON_CONSULTING_ENGINEERS-5519523pdf_ded9c.pdf	https://www.dropbox.com/s/77zk5wc2ngatrek/CANNON_CONSULTING_ENGINEERS-5519523.pdf?dl=0
Admin / Doc_9_APPEAL_STATEMENT-5881461pdf_5b939.pdf	https://www.dropbox.com/s/8ah77mpvkenlom3/APPEAL_STATEMENT-5881461.pdf?dl=0
NonCore / Doc_10_60_COW_LANE-5770328tif_303d1.tif	https://www.dropbox.com/s/96qoa9bqjcr9hjy/60_COW_LANE-5770328.tif?dl=0
Core / Doc_11_DECISION_NOTICE-5820553pdf_f0d9a.pdf	https://www.dropbox.com/s/98p9gu2kfjkettc/DECISION_NOTICE-5820553.pdf?dl=0
NonCore / Doc_12_SUBMISSION%20TO%20THE%20PLANNING%20COMMITTEE%28compressed%2920210613pdf_09221.pdf	https://www.dropbox.com/s/a2mrmmhqw24u578/SUBMISSION%20TO%20THE%20PLANNING%20COMMITTEE%28compressed%2920210613.pdf?dl=0
Core / Doc_13_EXPERT_SURFACE_WATER_FLOOD_MANAGEMENT-5520040tif_18441.tif	https://www.dropbox.com/s/c0in254gx2vw6zm/EXPERT_SURFACE_WATER_FLOOD_MANAGEMENT-5520040.tif?dl=0
NonCore / Doc_14_S_3209_19_DC-DRAINAGE_COMMENTS-5423116pdf_4a8c7.pdf	https://www.dropbox.com/s/cptymsupvyhk87r/S_3209_19_DC-DRAINAGE_COMMENTS-5423116.pdf?dl=0
NonCore / Doc_15_CCE_B411_TEVERSHAM_ROAD_FULBOURN_SW_REVISED_STRATEGY_REDUCED_FILE_SIZE-5419460pdf_a322e.pdf	https://www.dropbox.com/s/d4399szjge6uxuf/CCE_B411_TEVERSHAM_ROAD_FULBOURN_SW_REVISED_STRATEGY_REDUCED_FILE_SIZE-5419460.pdf?dl=0
Core / Doc_16_Surface_water_management-5153492pdf_8b621.pdf	https://www.dropbox.com/s/zxpoaze15uw8dok/Surface_water_management-5153492.pdf?dl=0
Core / Doc_17_FWM9010-RT001-R03-00pdf_7582d.pdf	https://www.dropbox.com/s/d450hqs5e2aq2zi/FWM9010-RT001-R03-00.pdf?dl=0
Core / Doc_18_CCE%20B411%20Teversham%20Road%20Fulbourn%20modelling%20and%20sw%20note%2002pdf_f17f0.pdf	https://www.dropbox.com/s/dhm2iwfl167tnds/CCE%20B411%20Teversham%20Road%20Fulbourn%20modelling%20and%20sw%20note%2002.pdf?dl=0
Core / Doc_19_COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426pdf_29f69.pdf	https://www.dropbox.com/s/dhqa6cdz7xbnrw0/COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426.pdf?dl=0
NonCore / Doc_20_LLFA-5746335pdf_cefc5.pdf	https://www.dropbox.com/s/dra4ducf7g6eaj0/LLFA-5746335.pdf?dl=0
NonCore / Doc_21_FLOOD_RISK_UPDATE_NOTE__AMENDED_-5695403pdf_c160d.pdf	https://www.dropbox.com/s/dukwl01z1c5xyns/FLOOD_RISK_UPDATE_NOTE__AMENDED_-5695403.pdf?dl=0

Core / Doc_22_NPPF_July_2021pdf_a6cbd.pdf	https://www.dropbox.com/s/effpgattzln8nro/NPPF_July_2021.pdf?dl=0
NonCore / Doc_23_Drainage_comments-5356806pdf_9b210.pdf	https://www.dropbox.com/s/ehmp502sqt8w9ho/Drainage_comments-5356806.pdf?dl=0
NonCore / Doc_24_Flood_Risk___Surface_Water_Management_Update-4631194pdf_f354d.pdf	https://www.dropbox.com/s/f1h0r8gr7vm8c8v/Flood_Risk___Surface_Water_Management_Update-4631194.pdf?dl=0
NonCore / Doc_25_S_3209_19_DC-AGENT_EMAIL__WITHDRAW_CONDITIONS_8_AND_20_-5801816pdf_e9a4d.pdf	https://www.dropbox.com/s/f3qy44zaxlc7ivy/S_3209_19_DC-AGENT_EMAIL__WITHDRAW_CONDITIONS_8_AND_20_-5801816.pdf?dl=0
Admin / Doc_26__3291523%20CMC%20Summary%20NoteasdNonCore / Doc_15921.html	https://www.dropbox.com/s/fyf5nz4djlbojmx/3291523%20CMC%20Summary%20Note.asd.doc?dl=0
NonCore / Doc_27_DRAINAGE-5469940docx_e7481.docx	https://www.dropbox.com/s/g6hsd6g5dyt86so/DRAINAGE-5469940.docx?dl=0
NonCore / Doc_28_3000_series_site_sections-5326244pdf_8c9d2.pdf	https://www.dropbox.com/s/i9no6jsayj9ckoq/3000_series_site_sections-5326244.pdf?dl=0
NonCore / Doc_29_LLFA%20Response%20to%20Resident%20Letterpdf_12398.pdf	https://www.dropbox.com/s/jmu9yykechoin5s/LLFA%20Response%20to%20Resident%20Letter.pdf?dl=0
NonCore / Doc_30_Downloaded_fc51d.html	https://www.gov.uk/government/news/new-strategy-launched-to-protect-chalk-streams
NonCore / Doc_31_LLFA_comments-5123328pdf_f81fb.pdf	https://www.dropbox.com/s/khxartrzcjdkprg/LLFA_comments-5123328.pdf?dl=0
NonCore / Doc_32_DRAINAGE_DETAILS-EMAIL-5536414pdf_1e847.pdf	https://www.dropbox.com/s/m754p1o29vpde1l/DRAINAGE_DETAILS-EMAIL-5536414.pdf?dl=0
NonCore / Doc_33_S_3290_19_RM-COVERING_LETTER-5462675%20%281%29pdf_f1525.pdf	https://www.dropbox.com/s/m82yrhtjmqcli19/S_3290_19_RM-COVERING_LETTER-5462675%20%281%29.pdf?dl=0
NonCore / Doc_34_SUSTAINABLE_DRAINAGE-5583022pdf_98acf.pdf	https://www.dropbox.com/s/mj1nylbzgnrmrq2/SUSTAINABLE_DRAINAGE-5583022.pdf?dl=0
NonCore / Doc_35_B411_-_PL_-_SK_-_320_-_P06_FLOOD_MANAGEMENT_-_19_11_20-5582637pdf_2eba6.pdf	https://www.dropbox.com/s/mnrtqwt2p31btao/B411_-_PL_-_SK_-_320_-_P06_FLOOD_MANAGEMENT_-_19_11_20-5582637.pdf?dl=0
NonCore / Doc_36_SURFACE_WATER_DETAILS_ADDITIONAL_11_12_19-5102527pdf_a4ae9.pdf	https://www.dropbox.com/s/o3c2ig63vdvj0xm/SURFACE_WATER_DETAILS_ADDITIONAL_11_12_19-5102527.pdf?dl=0
NonCore / Doc_37_DRAINAGE-5555978pdf_44541.pdf	https://www.dropbox.com/s/ocj2zcwd0h67bzs/DRAINAGE-5555978.pdf?dl=0
NonCore / Doc_38_FINISHED_FLOOR_LEVEL_PLAN_DRAINAGE-5546486pdf_dfdb1.pdf	https://www.dropbox.com/s/psu9uufu9q7i2yj/FINISHED_FLOOR_LEVEL_PLAN_DRAINAGE-5546486.pdf?dl=0
NonCore / Doc_39_3_flood_modelling_drainage_strategy_reportpdf_e7b04.pdf	https://www.dropbox.com/s/pwaa5hwz6sqvwae/3_flood_modelling_drainage_strategy_report.pdf?dl=0
NonCore / Doc_40_FLOOD_MANAGEMENT_STRATEGY__AMENDED_-5695397pdf_17847.pdf	https://www.dropbox.com/s/qzevkldfk3yy4fs/FLOOD_MANAGEMENT_STRATEGY__AMENDED_-5695397.pdf?dl=0
NonCore / Doc_41_FULBOURN_GENERAL_TOPO_PLAN__ADDITIONAL_INFORMATION_-5759427pdf_1549d.pdf	https://www.dropbox.com/s/r1oqf8lbtt4sx5u/FULBOURN_GENERAL_TOPO_PLAN__ADDITIONAL_INFORMATION_-5759427.pdf?dl=0
NonCore / Doc_42_17m_high_gardenpdf_4f35b.pdf	https://www.dropbox.com/s/sup1ymwl9f2wwg1/17m_high_garden.pdf?dl=0
Core / Doc_43_Planning_statement-5243498pdf_308bc.pdf	https://www.dropbox.com/s/t2io3krtyz7kxln/Planning_statement-5243498.pdf?dl=0
Core / Doc_44_NPPF%20old%20archived%20versionpdf_a33a9.pdf	https://www.dropbox.com/s/ty0eccgvw45512t/NPPF%20old%20archived%20version.pdf?dl=0
NonCore / Doc_45_Cow%20Lanepdf_61884.pdf	https://www.dropbox.com/s/obbkfa5wfx40xje/Cow%20Lane.pdfvfldlevel3.pdf?dl=0

Core / Doc_46_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_2__AMENDED_-5695407pdf_30b5a.pdf	https://www.dropbox.com/s/uprh4ug0ikeg67c/S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_2__AMENDED_-5695407.pdf?dl=0
NonCore / Doc_47_Permeability%20indicespdf_8cf2e.pdf	https://www.dropbox.com/s/v91ku617j9qpto9/Permeability%20indices.pdf?dl=0
NonCore / Doc_48_DRAINAGE-5437198docx_272f6.docx	https://www.dropbox.com/s/v9pms38u02crkzc/DRAINAGE-5437198.docx?dl=0
NonCore / Doc_49_DRAINAGE-5530414pdf_29d0f.pdf	https://www.dropbox.com/s/vyocku31gn7j0uq/DRAINAGE-5530414.pdf?dl=0
NonCore / Doc_50_LLFA_s_consultation_response-4574683pdf_a463d.pdf	https://www.dropbox.com/s/wbflaxhek440ivz/LLFA_s_consultation_response-4574683.pdf?dl=0
NonCore / Doc_51_LLFA-5792277pdf_a2053.pdf	https://www.dropbox.com/s/xxph3cevi7hvmir/LLFA-5792277.pdf?dl=0
NonCore / Doc_52_St-Ives-December-2020-Flood-Investigationpdf_bcf96.pdf	https://www.dropbox.com/s/xyq9vhval60pzzr/St-Ives-December-2020-Flood-Investigation.pdf?dl=0
Reference / Doc_53_The-SuDS-Manual-C697pdf_da2e5.pdf	https://www.dropbox.com/s/ze36rfo7o919o75/The-SuDS-Manual-C697.pdf?dl=0
NonCore / Doc_54_LEAD_FLOOD_AUTHORITY-5429069pdf_5e684.pdf	https://www.dropbox.com/s/zh7p4x5in2i29rb/LEAD_FLOOD_AUTHORITY-5429069.pdf?dl=0
NonCore / Rec_55_Jan2021_Planning_Meeting	https://www.dropbox.com/sh/tk9rnj3ykild6xi/AAAS8mZ3IVgWs9qUFLZfSkD9a?dl=0
NonCore / Doc_56_Downloaded_fc51d.html	https://www.gov.uk/government/news/new-strategy-launched-to-protect-chalk-streams
Core / Doc_57_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_1__AMENDED_-5695406	https://www.dropbox.com/s/5965qzs2mru14g7/S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_1__AMENDED_-5695406.pdf?dl=0
This is dynamic web site; data downloaded from it presented separately as a figure.	https://www.worldweatheronline.com/cambridge-weather-history/cambridgeshire/gb.aspx
This is dynamic web site; data downloaded from it presented separately as a figure.	https://mapapps2.bgs.ac.uk/geoindex/home.html?_ga=2.259952778.1090462005.1649927734-771910022.1649927734

Table I4: Document file names on SCDC planning portal (where applicable) and filenames in accompanying document folder

Folder / Filename in folder	Filename on SCDC planning portal
NonCore / Doc_1_Downloaded_c8e1a.pdf	N/A
NonCore / Doc_2_TRF-CBA-1-GF-M2-L-3000__2__SITE_SECTIONS-5580258pdf_aa445.pdf	TRF-CBA-1-GF-M2-L-3000__2__SITE_SECTIONS-5580258.pdf
Core / Doc_3_S_0202_17_OL-Decision_Notice-4618041pdf_81819.pdf	S_0202_17_OL-Decision_Notice-4618041.pdf
NonCore / Doc_4_SITE_SECTIONS__AMENDED_-5695409pdf_f3b3d.pdf	SITE_SECTIONS__AMENDED_-5695409.pdf
NonCore / Doc_5_PLANNING_UPDATE-5419461pdf_2a2d5.pdf	PLANNING_UPDATE-5419461.pdf
Core / Doc_6_south-cambridgeshire-adopted-local-plan-270918_smlpdf_f3df1.pdf	south-cambridgeshire-adopted-local-plan-270918_sml.pdf
NonCore / Doc_7_LLFA_inaccuracies_26Sept2021pdf_46b5a.pdf	LLFA_inaccuracies_26Sept2021.pdf
NonCore / Doc_8_CANNON_CONSULTING_ENGINEERS-5519523pdf_ded9c.pdf	CANNON_CONSULTING_ENGINEERS-5519523.pdf
Admin / Doc_9_APPEAL_STATEMENT-5881461pdf_5b939.pdf	APPEAL_STATEMENT-5881461.pdf
NonCore / Doc_10_60_COW_LANE-5770328tif_303d1.tif	60_COW_LANE-5770328.tif
Core / Doc_11_DECISION_NOTICE-5820553pdf_f0d9a.pdf	DECISION_NOTICE-5820553.pdf
NonCore / Doc_12_SUBMISSION%20TO%20THE%20PLANNING%20COMMITTEE%28compressed%2920210613pdf_09221.pdf	SUBMISSION%20TO%20THE%20PLANNING%20COMMITTEE%28compressed%2920210613.pdf
Core / Doc_13_EXPERT_SURFACE_WATER_FLOOD_MANAGEMENT-5520040tif_18441.tif	EXPERT_SURFACE_WATER_FLOOD_MANAGEMENT-5520040.tif
NonCore / Doc_14_S_3209_19_DC-DRAINAGE_COMMENTS-5423116pdf_4a8c7.pdf	S_3209_19_DC-DRAINAGE_COMMENTS-5423116.pdf
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Core / Doc_17_FWM9010-RT001-R03-00pdf_7582d.pdf	FWM9010-RT001-R03-00.pdf
Core / Doc_18_CCE%20B411%20Teversham%20Road%20Fulbourn%20modelling%20and%20sw%20note%2002pdf_f17f0.pdf	CCE%20B411%20Teversham%20Road%20Fulbourn%20modelling%20and%20sw%20note%2002.pdf
Core / Doc_19_COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426pdf_29f69.pdf	COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426.pdf
NonCore / Doc_20_LLFA-5746335pdf_cefc5.pdf	LLFA-5746335.pdf
NonCore / Doc_21_FLOOD_RISK_UPDATE_NOTE__AMENDED_-5695403pdf_c160d.pdf	FLOOD_RISK_UPDATE_NOTE__AMENDED_-5695403.pdf

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NonCore / Doc_23_Drainage_comments-5356806pdf_9b210.pdf	Drainage_comments-5356806.pdf
NonCore / Doc_24_Flood_Risk___Surface_Water_Management_Update-4631194pdf_f354d.pdf	Flood_Risk___Surface_Water_Management_Update-4631194.pdf
NonCore / Doc_25_S_3209_19_DC-AGENT_EMAIL__WITHDRAW_CONDITIONS_8_AND_20_-5801816pdf_e9a4d.pdf	S_3209_19_DC-AGENT_EMAIL__WITHDRAW_CONDITIONS_8_AND_20_-5801816.pdf
Admin / Doc_26__3291523%20CMC%20Summary%20NoteasdNonCore / Doc_15921.html	3291523%20CMC%20Summary%20Note.asd.doc
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NonCore / Doc_28_3000_series_site_sections-5326244pdf_8c9d2.pdf	3000_series_site_sections-5326244.pdf
NonCore / Doc_29_LLFA%20Response%20to%20Resident%20Letterpdf_12398.pdf	LLFA%20Response%20to%20Resident%20Letter.pdf
NonCore / Doc_30_Downloaded_fc51d.html	N/A
NonCore / Doc_31_LLFA_comments-5123328pdf_f81fb.pdf	LLFA_comments-5123328.pdf
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NonCore / Doc_36_SURFACE_WATER_DETAILS_ADDITIONAL_11_12_19-5102527pdf_a4ae9.pdf	SURFACE_WATER_DETAILS_ADDITIONAL_11_12_19-5102527.pdf
NonCore / Doc_37_DRAINAGE-5555978pdf_44541.pdf	DRAINAGE-5555978.pdf
NonCore / Doc_38_FINISHED_FLOOR_LEVEL_PLAN_DRAINAGE-5546486pdf_dfdb1.pdf	FINISHED_FLOOR_LEVEL_PLAN_DRAINAGE-5546486.pdf
NonCore / Doc_39_3_flood_modelling_drainage_strategy_reportpdf_e7b04.pdf	3_flood_modelling_drainage_strategy_report.pdf
NonCore / Doc_40_FLOOD_MANAGEMENT_STRATEGY__AMENDED_-5695397pdf_17847.pdf	FLOOD_MANAGEMENT_STRATEGY__AMENDED_-5695397.pdf
NonCore / Doc_41_FULBOURN_GENERAL_TOPO_PLAN__ADDITIONAL_INFORMATION_-5759427pdf_1549d.pdf	FULBOURN_GENERAL_TOPO_PLAN__ADDITIONAL_INFORMATION_-5759427.pdf
NonCore / Doc_42_17m_high_gardenpdf_4f35b.pdf	17m_high_garden.pdf
Core / Doc_43_Planning_statement-5243498pdf_308bc.pdf	Planning_statement-5243498.pdf
Core / Doc_44_NPPF%20old%20archived%20versionpdf_a33a9.pdf	NPPF%20old%20archived%20version.pdf
NonCore / Doc_45_Cow%20Lanepdf_61884.pdf	N/A
Core / Doc_46_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_2__AMENDED_-5695407pdf_30b5a.pdf	S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_2__AMENDED_-5695407.pdf

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NonCore / Doc_49_DRAINAGE-5530414pdf_29d0f.pdf	DRAINAGE-5530414.pdf
NonCore / Doc_50_LLFA_s_consultation_response-4574683pdf_a463d.pdf	LLFA_s_consultation_response-4574683.pdf
NonCore / Doc_51_LLFA-5792277pdf_a2053.pdf	LLFA-5792277.pdf
NonCore / Doc_52_St-Ives-December-2020-Flood-Investigationpdf_bcf96.pdf	St-Ives-December-2020-Flood-Investigation.pdf
Reference / Doc_53_The-SuDS-Manual-C697pdf_da2e5.pdf	The-SuDS-Manual-C697.pdf
NonCore / Doc_54_LEAD_FLOOD_AUTHORITY-5429069pdf_5e684.pdf	LEAD_FLOOD_AUTHORITY-5429069.pdf
NonCore / Rec_55_Jan2021_Planning_Meeting	Several. Please see folder
NonCore / Doc_56_Downloaded_fc51d.html	N/A
Core / Doc_57_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_1__AMENDED_-5695406	S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_1__AMENDED_-5695406.pdf
This is dynamic web site; data downloaded from it presented separately as a figure.	N/A
This is dynamic web site; data downloaded from it presented separately as a figure.	N/A

Table I5: Document hyperlinks to available online versions and filenames in accompanying document folder

Folder / Filename in folder	Hyperlink
NonCore / Doc_1_Downloaded_c8e1a.pdf	Catchment Based Approach | Chalk Stream Restoration Strategy 2021 (Main report)[Folder ref. NonCore / Doc_1_]
NonCore / Doc_2_TRF-CBA-1-GF-M2-L-3000__2__SITE_SECTIONS-5580258pdf_aa445.pdf	TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 November 2020)[Folder ref. NonCore / Doc_2_]
Core / Doc_3_S_0202_17_OL-Decision_Notice-4618041pdf_81819.pdf	Planning Permission subject to conditions S/0202/17/OL (26 October 2017)[Folder ref. Core / Doc_3_]
NonCore / Doc_4_SITE_SECTIONS__AMENDED_-5695409pdf_f3b3d.pdf	TRF-CBA-1-GF-M2-L-3000 3000 Series Site Sections (12 April 2021)[Folder ref. NonCore / Doc_4_]
NonCore / Doc_5_PLANNING_UPDATE-5419461pdf_2a2d5.pdf	Planning Update Note (March 2020) [Folder ref. NonCore / Doc_5_]
Core / Doc_6_south-cambridgeshire-adopted-local-plan-270918_smlpdf_f3df1.pdf	South Cambridgeshire Local Plan (Adopted September 2018)[Folder ref. Core / Doc_6_]
NonCore / Doc_7_LLFA_inaccuracies_26Sept2021pdf_46b5a.pdf	FR/19-000431 Comments on S/3290/19/RM (26 September 2021)[Folder ref. NonCore / Doc_7_]
NonCore / Doc_8_CANNON_CONSULTING_ENGINEERS-5519523pdf_ded9c.pdf	B411 Teversham Road Fulbourn Cambridgeshire Reserved Matters Application Layout (12 August 2020)[Folder ref. NonCore / Doc_8_]
Admin / Doc_9_APPEAL_STATEMENT-5881461pdf_5b939.pdf	Pre-Inquiry Statement of Case (January 2022)[Folder ref. Admin / Doc_9_]
NonCore / Doc_10_60_COW_LANE-5770328tif_303d1.tif	Submission to the Planning Committee (8 August 2021)[Folder ref. NonCore / Doc_10]
Core / Doc_11_DECISION_NOTICE-5820553pdf_f0d9a.pdf	Application for Approval of Reserved Matters (20 October 2021)[Folder ref. NonCore / Doc_11]
NonCore / Doc_12_SUBMISSION%20TO%20THE%20PLANNING%20COMMITTEE%28compressed%2920210613pdf_09221.pdf	Submission to the Planning Committee (13 June 2021)[Folder ref. NonCore / Doc_12]
Core / Doc_13_EXPERT_SURFACE_WATER_FLOOD_MANAGEMENT-5520040tif_18441.tif	Review of surface water management (August 2020)[Folder ref. NonCore / Doc_13]
NonCore / Doc_14_S_3209_19_DC-DRAINAGE_COMMENTS-5423116pdf_4a8c7.pdf	Planning Consultation Response | Sustainable Drainage Engineer (15 March 2020)[Folder ref. NonCore / Doc_14]
NonCore / Doc_15_CCE_B411_TEVERSHAM_ROAD_FULBOURN_SW_REVISED_STRATEGY_REDUCED_FILE_SIZE-5419460pdf_a322e.pdf	B411 Teversham Road Fulbourn Cambridgeshire Surface water management (27 February 2020)[Folder ref. NonCore / Doc_15]
Core / Doc_16_Surface_water_management-5153492pdf_8b621.pdf	B411 Surface water management (12 September 2019)[Folder ref. NonCore / Doc_16]
Core / Doc_17_FWM9010-RT001-R03-00pdf_7582d.pdf	Update to surface water flood management (1 April 2022)[Folder ref. NonCore / Doc_17]
Core / Doc_18_CCE%20B411%20Teversham%20Road%20Fulbourn%20modelling%20and%20sw%20note%2002pdf_f17f0.pdf	B411 Teversham Road Fulbourn Cambridgeshire RM Appeal Flood modelling and surface water management update (4 April 2022)[Folder ref. NonCore / Doc_18]
Core / Doc_19_COW_LANE_FLOOD_BASIN__ADDITIONAL_INFORMATION_-5759426pdf_29f69.pdf	B411-Pl-SK-321 Cow Lane Flood Basin (12 April 2021)[Folder ref. NonCore / Doc_19]
NonCore / Doc_20_LLFA-5746335pdf_cefc5.pdf	Comments from LLFA (5 July 2021)[Folder ref. NonCore / Doc_20]

NonCore / Doc_21_FLOOD_RISK_UPDATE_NOTE__AMENDED_-5695403pdf_c160d.pdf	B411 Teversham Road Fulbourn Cambridgeshire RM Application - Layout Update (13 April 2021)[Folder ref. NonCore / Doc_21]
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NonCore / Doc_23_Drainage_comments-5356806pdf_9b210.pdf	Planning Consultation Response | Sustainable Drainage Engineer (14 December 2019)[Folder ref. NonCore / Doc_23]
NonCore / Doc_24_Flood_Risk___Surface_Water_Management_Update-4631194pdf_f354d.pdf	B411 Flood Risk and Surface Water Management Update (January 2017)[Folder ref. NonCore / Doc_24]
NonCore / Doc_25_S_3209_19_DC-AGENT_EMAIL__WITHDRAW_CONDITIONS_8_AND_20_-5801816pdf_e9a4d.pdf	Request to withdraw Condition 8 From application S/3209/19/DC[Folder ref. NonCore / Doc_25]
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NonCore / Doc_27_DRAINAGE-5469940docx_e7481.docx	Planning Consultation Response (14/6/2020)[Folder ref. NonCore / Doc_27]
NonCore / Doc_28_3000_series_site_sections-5326244pdf_8c9d2.pdf	TRF-CBA-1-GF-M2-L-3000 Site Sections (August 2019)[Folder ref. NonCore / Doc_28]
NonCore / Doc_29_LLFA%20Response%20to%20Resident%20Letterpdf_12398.pdf	LLFA response to resident of 60 Cow Lane (29 September 2021) [FR/19-000431][Folder ref. NonCore / Doc_29]
NonCore / Doc_30_Downloaded_fc51d.html	New strategy launched to protect chalk streams (15 October 2021)[Folder ref. NonCore / Doc_30]
NonCore / Doc_31_LLFA_comments-5123328pdf_f81fb.pdf	LLFA response to consultation (FR/19-000431; S/3290/19/RM)[Folder ref. NonCore / Doc_31]
NonCore / Doc_32_DRAINAGE_DETAILS-EMAIL-5536414pdf_1e847.pdf	Email from Barton Willmore to SCDC Planning Officer[Folder ref. NonCore / Doc_32]
NonCore / Doc_33_S_3290_19_RM-COVERING_LETTER-5462675%20%281%29pdf_f1525.pdf	Planning Application S/3290/19/RM [25542/A5/PD] (26 May 2020)[Folder ref. NonCore / Doc_33]
NonCore / Doc_34_SUSTAINABLE_DRAINAGE-5583022pdf_98acf.pdf	Sustainable drainage Engineer comments (19/11/2020)[Folder ref. NonCore / Doc_34]
NonCore / Doc_35_B411_-_PL_-_SK_-_320_-_P06_FLOOD_MANAGEMENT_-_19_11_20-5582637pdf_2eba6.pdf	B411-PL-SK-320 Flood Management Strategy[Folder ref. NonCore / Doc_35]
NonCore / Doc_36_SURFACE_WATER_DETAILS_ADDITIONAL_11_12_19-5102527pdf_a4ae9.pdf	B411 Surface water Management (3 December 2019)[Folder ref. NonCore / Doc_36]
NonCore / Doc_37_DRAINAGE-5555978pdf_44541.pdf	Sustainable drainage Engineer comments (9/10/2020)[Folder ref. NonCore / Doc_37]
NonCore / Doc_38_FINISHED_FLOOR_LEVEL_PLAN_DRAINAGE-5546486pdf_dfdb1.pdf	B411-PL-SK-320 Flood Management Strategy (16/9/2020)[Folder ref. NonCore / Doc_38]
NonCore / Doc_39_3_flood_modelling_drainage_strategy_reportpdf_e7b04.pdf	Evidence regarding land south of the Cambridge Biomedical Campus | Flood modelling and drainage strategy report [Folder ref. NonCore / Doc_39]
NonCore / Doc_40_FLOOD_MANAGEMENT_STRATEGY__AMENDED_-5695397pdf_17847.pdf	B411-PL-SK-320 Flood Management Strategy (14/4/2021)[Folder ref. NonCore / Doc_40]
NonCore / Doc_41_FULBOURN_GENERAL_TOPO_PLAN__ADDITIONAL_INFORMATION_-5759427pdf_1549d.pdf	Fulbourn General Topological Plan Additional Information (from file title; no date provided)[Folder ref. NonCore / Doc_41]
NonCore / Doc_42_17m_high_gardenpdf_4f35b.pdf	Letter from 60 Cow Lane resident to SCDC Planning Officer (9 August 2021)[Folder ref. NonCore / Doc_42]
Core / Doc_43_Planning_statement-5243498pdf_308bc.pdf	Reserved Matters Planning Statement (September 2019)[Folder ref. NonCore / Doc_43]

Core / Doc_44_NPPF%20old%20archived%20versionpdf_a33a9.pdf	National Planning Policy Framework (2012)[Folder ref. NonCore / Doc_44]
NonCore / Doc_45_Cow%20Lanepdf_61884.pdf	Topological survey of gardens of housing along Cow Lane (14 April 2022)[Folder ref. NonCore / Doc_45]
Core / Doc_46_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_2__AMENDED_-5695407pdf_30b5a.pdf	TRF-CBA-1-GF-M2-L-1011 100 Series Hard Landscaping Strategy Sheet 2 (12 April 2021)[Folder ref. NonCore / Doc_46]
NonCore / Doc_47_Permeability%20indicespdf_8cf2e.pdf	British Geological Survey. Guide To Permeability Indices. (2006; CR/06/160N)[Folder ref. NonCore / Doc_47]
NonCore / Doc_48_DRAINAGE-5437198docx_272f6.docx	Sustainable drainage Engineer comments (16 April 2020)[Folder ref. NonCore / Doc_48]
NonCore / Doc_49_DRAINAGE-5530414pdf_29d0f.pdf	Sustainable drainage Engineer comments (1 September 2020)[Folder ref. NonCore / Doc_49]
NonCore / Doc_50_LLFA_s_consultation_response-4574683pdf_a463d.pdf	LLFA response to consultation (FR/19-000431; S/3290/19/RM) (15 October 2019)[Folder ref. NonCore / Doc_50]
NonCore / Doc_51_LLFA-5792277pdf_a2053.pdf	LLFA response to consultation (FR/19-000431; S/3290/19/RM) (9 September 2021)[Folder ref. NonCore / Doc_51]
NonCore / Doc_52_St-Ives-December-2020-Flood-Investigationpdf_bcf96.pdf	Flood Investigation Report | St Ives | December 2020[Folder ref. NonCore / Doc_52]
Reference / Doc_53_The-SuDS-Manual-C697pdf_da2e5.pdf	The SuDS manual (2007)[Folder ref. NonCore / Doc_53]
NonCore / Doc_54_LEAD_FLOOD_AUTHORITY-5429069pdf_5e684.pdf	LLFA response to consultation (FR/19-000431; S/3290/19/RM) (20 March 2020)[Folder ref. NonCore / Doc_54]
NonCore / Rec_55_Jan2021_Planning_Meeting	Recording of 13 January 2021 Planning Meeting[Folder ref. NonCore / Rec_55]
NonCore / Doc_56_Downloaded_fc51d.html	Press Release | New Strategy Launched to protect chalk streams (15 October 2021)[Folder ref. NonCore / Doc_56]
Core / Doc_57_S_3290_19_RM-HARD_LANDSCAPE_STRATEGY_SHEET_1__AMENDED_-5695406	TRF-CBA-1-GF-M2-L-1010 1000 Series Hard Landscaping Sheet 1 (12 April 2021)[Folder ref. NonCore / Doc_57]
This is dynamic web site; data downloaded from it presented separately as a figure.	Cambridge Historic Weather website at https://www.worldweatheronline.com/cambridge-weather-history/cambridgeshire/gb.aspx accessed 23 April 2022
This is dynamic web site; data downloaded from it presented separately as a figure.	Onshore Geoindex website at https://mapapps2.bgs.ac.uk/geoindex/home.html?_ga=2.259952778.1090462005.1649927734-771910022.1649927734 accessed 23 April 2022