framed sash and casement windows; and slate and stone tile roofs, all of which contributes to the architectural and artistic interest of the Conservation Area;

- The sense of enclosure in many parts of the Conservation Area, experienced as a result of buildings which front directly onto the streets and tall stone boundary walls, and the contrasting sense of openness in the marketplace and around areas of green space;

- Important areas of green space within and on the outskirts of Fairford (but included within the Conservation Area boundary), such as the grounds of Farmor's School to the north, the recreation ground, the formal grounds and parkland of Morgan Hall to the east, and agricultural land to the west, which are of historic interest in illustrating the development and rural context of Fairford; and

- Key views within, towards and out from the Conservation Area, as described above, which contribute to the historic and architectural interest of the asset.

27. The setting of the Fairford Conservation Area largely comprises the surrounding agricultural land of the Coln Valley, with this landscape making some contribution to the historic interest of the Conservation Area by further illustrating its rural context. Other important elements of setting include the Fairford Saxon Cemetery, a Scheduled Monument *c.* 200m north-west of the designation boundary, which contributes to the archaeological and historic interest of the Conservation Area; and Fairford Park to the north, which contributes in terms of historic interest.

The contribution of the Site

28. The Site is located within the south-easternmost part of the Conservation Area, with public rights of way running along its north and east boundaries.

29. The majority of the Site is open land. This land is now fallow and, when traversing the public right of way in a westerly direction, views across the Site are set against the backdrop of modern residential development (specifically Beaumoor Place and dwellings to the north of East End). The latter has eroded the rural character of the Site and diminished its contribution to the heritage significance of the Conservation Area. Overall, the site is considered to make a very small contribution to the rural character of the Conservation Area as it is possible to experience this land while traversing the public rights of way that pass through the Site, albeit in a currently fallow state and seen in conjunction with modern dwellings.

Plate 3: Satellite image showing the Site (outlined in red) in relation to the Fairford Conservation Area (shaded yellow).
Source: Bing.

Plate 4: South-west-facing view across the Site from the public right of way that runs along the northern boundary. Modern residential development at Beaumoor Place (right of frame) and to the north of East End (left of frame) is visible in the background.

30. The derelict bungalow within the southernmost part of the Site is clearly visible from East End (within the Conservation Area) and is incongruous with the stone dwellings and agricultural buildings within this part of the Conservation Area. This element of the Site therefore detracts from the character and appearance of the Conservation Area.

Plate 5: Derelict bungalow ('Pengerric') within the southernmost part of the Site, viewed from East End.

Assessment of potential impacts

31. Whilst the proposed dwellings will respect the local architectural vernacular and follow the Cotswold Design Code, the residential development of the Site will change its character, resulting in a very small level of harm to the Conservation Area.

32. The demolition of the derelict bungalow within the southernmost part of the Site presents an opportunity to enhance the character and appearance of the Conservation Area (as previously identified by the Neighbourhood Plan Examiner), especially if the new access road proposed for this part of the Site is designed with appropriate boundary treatments.

Grade II Listed Morgan Hall

33. Morgan Hall is a large, detached house of late 16th-century origins which stands approximately 75m north of the Site. It was added to the National List on 4th June 1952 and is described as follows:

> *"Large detached house set back from road. Late C16 (recorded as Bakers in 1590), refaced in C18 and enlarged to east. Rubble stone, faced in roughcast to north west, and in render on late C18 wing, with raised alternating quoins, hipped stone slate roof both ranges, large ashlar stacks. Long E-shape range of 2 storeys and attic, with single C18 wing on north east end of 2 storeys. West front has 2-light C18 casements in moulded stone architraves, to both floors along whole of west side, occasionally with timber lintel and no architrave. Stone doorcase in northernmost arm of E with pilasters, plain frieze, and moulded cornice, and recessed 6- panel door, 4 fielded, lower 2 flush, in 2 leaves, with sundial over. Southernmost arm appears to have been altered or is possibly later. East side of original range has similar casement fenestration, 4 windows, some 3-light, and 3 hipped dormers. C18 range on plinth has 4 large 12-pane sashes in moulded architraves matching earlier ones, 3 on ground floor with door in bay 2 from left formed by adding solid piece of wood to lower sash. Internal shutters remain and some panelling in this wing, panelling also intact in ground floor room in north west corner of original range. Interior otherwise inaccessible. Reputed to have been a Cromwellian stronghold during the Civil War."*

34. The First Edition (1877) Ordnance Survey map (Plate 5) records the house as 'Fairford Lodge' and shows the building set within its formal grounds and gardens, with a carriageway approach from the north. To the east (separated from the house by an embankment or ha-ha) was a large area of parkland. The house was evidently orientated to provide designed east-facing views across this parkland. Today, the gardens and parkland are still extant, and with curtilage boundary being tightly defined by a tall stone wall.

Statement of Significance

35. As a Grade II Listed building, Morgan Hall is a heritage asset of less than the highest significance as defined by the NPPF. This heritage significance is principally embodied in the physical fabric of the building, which possesses archaeological, historic, architectural and artistic interest as a good example of an elite residence dating from the 16th century with various period features and possible connections to the English Civil War.

36. The setting of the Listed building also contributes to its heritage significance, although the significance derived from the setting is less than that from its historic fabric. The principal elements of setting which contribute to the heritage significance of the asset comprise the historic ancillary buildings; the immediate formal grounds and gardens; the driveway approach from the north; the parkland to the east; and the perimeter stone boundary walling.

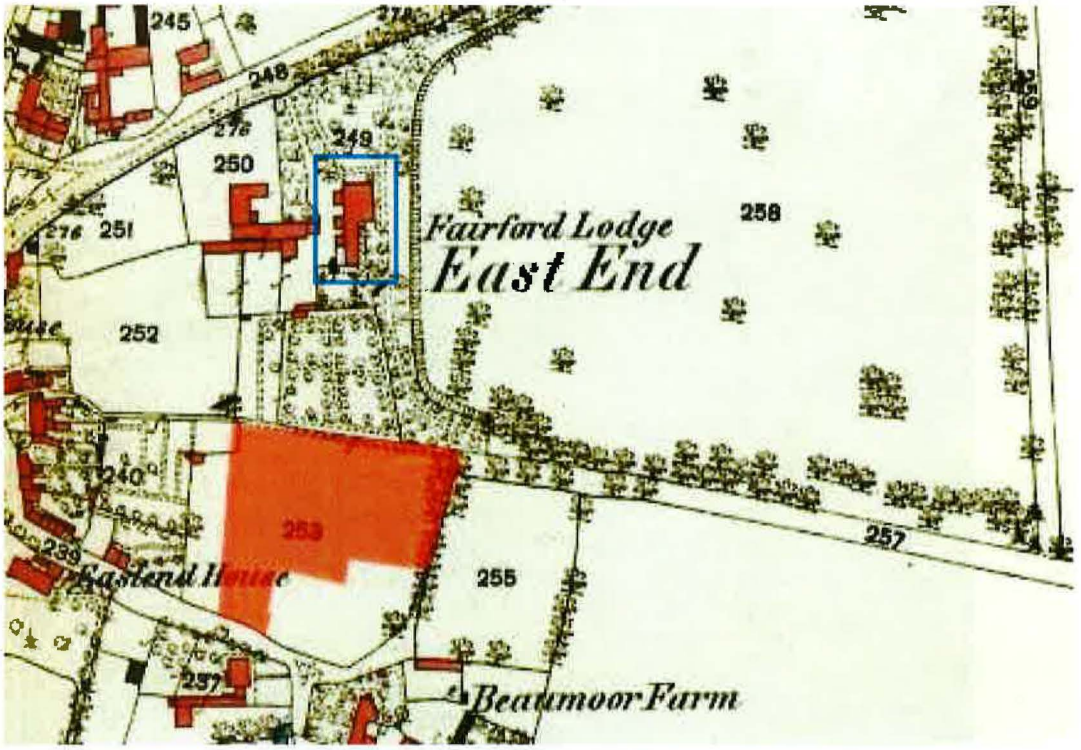


Plate 6: First Edition (1877) Ordnance Survey map showing Morgan Hall (labelled as 'Fairford Lodge' and outlined in blue) and its surrounding gardens and parkland. The Site,

The contribution of the Site

37. The 1841 tithe map and apportionment for Fairford records that both the Site and Morgan Hall were owned by John Raymond Baker Esquire, however they were in separate use and not functionally associated. The First Edition Ordnance Survey map (illustrated above) shows a boundary between the curtilage of the hall and the Site, and this appears to correspond with the tall stone wall that currently marks the northern boundary of the Site (Plate 6).

38. From within the Site, there are only incidental glimpsed views to the roof and upper south flank of Morgan Hall, with visibility of the Listed building being heavily restricted by the intervening perimeter wall and a mixture of coniferous and deciduous trees and vegetation (Plate 7). There are no views to the principal, east façade of the hall from within the Site.

39. From within the hall, there are no designed views in the direction of the Site. Owing to the position of the hall and the presence of the tall perimeter wall and vegetation, the Site will not be visible in any key views to the Listed building from within its curtilage.

40. For these reasons, the Site makes no contribution to the heritage significance of Grade II Listed Morgan Hall through setting.

Plate 7: Tall stone wall marking the perimeter of the curtilage of Morgan Hall, viewed from the public right of way running through the northern part of the Site.

Plate 8: Glimpsed, long-range view to the roof and upper south flank of Morgan Hall (circled yellow) from within the centre of the Site.

Assessment of potential impacts

41. The proposed dwellings within the Site are not anticipated to be visible from within Morgan Hall or from its curtilage, owing to the intervening wall and vegetation, the proposed green buffer, and development within the Site being limited to 1½ storeys.

42. Therefore, no harm to the heritage significance of Morgan Hall through change to its setting is anticipated.

Grade II Moor Farmhouse

43. Moor Farmhouse is a Grade II Listed building of early to mid-18th century origins that stands approximately 50m south of the Site. It was added to the National List on 17th June 1986 with the following description:

> *"Farmhouse. Early/mid C18, enlarged to south in later C18 or early C19, and with C20 front porch and additions to rear. Coursed rubble stone, stone slate roof, stone external stack to left, end stack to right and former end now ridge stack. Single main range with probable rear stair turret, originally symmetrical of 2 storeys and attic with additional section to south linking with small cottage of single storey and attic on south end. Three windows, 3-light casements with timber lintel, renewed to right. Three restored gabled dormers above, on eaves with plain paired casements. Ground floor has 2 similar 3-light, originally flanking central doorway now blocked at base with paired casement and timber lintel. Renewed paired casement to far right and single storey porch extension of C20. Cottage end has 2 gabled dormers, C20 door and windows to ground floor, and small gabled extension to far right."*

Plate 9: Principal west façade of Moor Farmhouse.

44. Historic mapping records that Moor Farmhouse was previously known as 'Beaumoor Farm' and was surrounded by its associated agricultural land. This surrounding agricultural land has since been truncated, especially by modern residential development to the north, and the Listed building no longer serves a working farm.

45. The principal façade of the farmhouse is its west elevation, which is readily appreciable from the road (East End) and from which there are views across the front garden.

Statement of significance

46. As a Grade II Listed building, Moor Farmhouse is a heritage asset of less than the highest significance as defined by the NPPF. This heritage significance is principally embodied in the physical fabric of the building, which possesses historic, architectural and artistic interest as a good example of a vernacular farm dwelling of 18th-century origins.

47. The setting of the Listed building also contributes to its heritage significance, although the significance derived from the setting is less than that from its historic fabric. The principal elements of setting which contribute to the heritage significance of the asset comprise its garden curtilage and the former ancillary farm buildings to the east.

Contribution of the Site

48. The 1841 tithe map and apportionment records that Moor Farmhouse and the Site were under the same ownership and occupation, with the Site serving as pastureland for the farm.

49. This historic functional association has since been severed, with the Site now fallow agricultural land and Moor Farmhouse no longer being part of a working farm. Additionally, there has been modern residential development between Moor Farmhouse and the Site, on land that formerly belonged to the farm.

50. There is no designed intervisibility between the Site and the farmhouse, with the Listed building being orientated such that primary views are focused over the front garden to the west. From within the Site, there are only incidental, long-range, glimpsed views to the roof and chimneys of Moor Farmhouse, with these glimpsed being heavily restricted by intervening trees and built form.

51. The Site no longer gives legibility to Moor Farmhouse as a former agricultural dwelling, therefore it makes no contribution to the heritage significance of the Grade II Listed building through setting.

Plate 10: Long-range south-facing view in the direction of Moor Farmhouse from within the Site. There are only glimpses of the chimneys and roof of the Listed building (outlined in yellow) owing to intervening trees and modern built form.

Assessment of potential impacts

52. The proposed dwellings within the Site will not be visible from Moor Farmhouse, nor are they anticipated to be visible from the curtilage of the Listed building owing to their restricted 1½ storey elevations.

53. The proposed new access road to the Site from East End will not be readily perceptible from the Listed building owing to intervening vegetation and built form, and distance.

54. It is therefore anticipated that the residential development of the Site will cause no harm to Grade II Listed Moor Farmhouse through change to its setting.

Summary Conclusions

55. The undeveloped areas of the Site make a very small contribution to the character and appearance of the Fairford Conservation Area in terms of its open agricultural character; however, this contribution has been reduced by neighbouring modern residential development (which is clearly visible from the Site). The derelict bungalow in the southernmost part of the Site which is incongruous with the local architectural vernacular and detracts from the character and appearance of the area.

56. The proposed illustrative layout combines with sensitively designed plots and dwellings that respect the local architectural vernacular.

57. Overall, the proposals would result in a very small amount of harm to the character and appearance of the Conservation Area, through the change of the parts of the site which have a rural character, but also deliver an enhancement to the area through the removal of the bungalow. In this regard, the very small amount of heritage harm to the character and appearance of the Conservation can be outweighed by the heritage benefits associated with the development of the site.

58. Based on desk-based research and observations made during a site visit, the Site makes no demonstrable contribution to the heritage significance of Grade II Listed Morgan Hall or Grade II Listed Moor Farmhouse through setting. The proposed

development is not anticipated to be visible or perceptible from either Listed building. Based on the illustrative masterplan, it is anticipated that the residential development of the Site will cause no harm to the heritage significance of either Listed building through change to setting.

GHBullard & Associates LLP
Civil and Traffic Engineering Consultants

Proposed Residential Development
Land to East of Beaumoor Place, East End
Fairford, Gloucestershire

FLOOD RISK ASSESSMENT
AND
OUTLINE DRAINAGE STRATEGY

Date:
March 2022

GHB Reference:
229/2020/FRADS

Revision: P4

Status: Draft

Prepared By:
Elizabeth Rahim, M.Eng (Hons.) CEng MICE
Associate, G.H. Bullard & Associates LLP

Checked By:
Jeff Horner, B.Eng (Hons.)
Partner, G.H. Bullard & Associates LLP

Flood Risk Assessment (FRA) Checklist	
This document should be attached to the front of the Floor Risk Assessment (FRA) issued to Local Planning Authorities (LPA) in support of a development proposal which may be at risk of flooding. This document is not a substitute for a FRA. Please note, under our responsibilities as a statutory consultee we will review any submitted FRA only in respect to fluvial and tidal risk. Your FRA should also consider other sources of flooding such as surface water, drainage, and ground water flooding.	
1.Development Proposal	
Site name	Land to East of Beaumoor Place, East End, Fairford, Gloucestershire GL7 4AP
National Grid Reference (NGR)	SP 157008
Flood Risk Assessment	Reference/Title: 229/2020/FRA P4 Date: March 2022
Existing site use & vulnerability classification	Less Vulnerable (Greenfield)
Proposed site use & vulnerability classification	More Vulnerable (Residential)
2. Flood Risk	
Flood Zone(s) affecting the site/property	Flood Zone 1
Sources of flooding affecting the site	Groundwater Flooding
Have you considered flood storage compensation?	No
3. Please provide a node map and accompanying table in the Flood Risk Assessment similar to the example given (see Appendix A). You should clearly demonstrate the highest and most representative flood levels for your proposed development. For example, if it is a small extension (< 250 square metres) then approximately 5-10 nodes would be sufficient. For larger sites, approximately 10 to 20 nodes would be appropriate. Refer to Appendix B and D.	
4. Mitigation	
Finished floor levels (in m AOD) for each proposed floor. Have you considered a freeboard for these Finished Floor Levels?***	300mm above surrounding ground level.
Drawing reference showing Finished Floor Levels for proposed development	-
Have you considered suitable internal and external access for safe refuge above the flood level?	-
5. Proximity to the watercourse/ flood defence/ culvert	
Are the proposed developments on, over, under or within 8 metres of a fluvial main river or 16 metres of a tidal main river or flood defence?	No If yes, please provide a cross section drawing in your planning application showing the distance of the proposed development in relation to the watercourse/flood defence/culvert. If yes, this will require a Flood Risk Activity Permit.
Map Many of our flood datasets are available online: Flood Map For Planning (Flood Zone 2, Flood Zone 3 ,Flood Storage Areas, Flood Defences, Areas Benefiting from Defences, , Risk of Flooding from Rivers and Sea, Historic Flood Map, Current Flood Warnings	

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071

1.0 INTRODUCTION

1.1. This flood risk assessment and outline drainage strategy is being submitted to support a proposal for a residential development at a site off East End, Fairford, Gloucester. Site location plans are shown in **Appendix A**.

1.2. The purpose of this report is to demonstrate that development of the site will not pose an unacceptable flood risk to the proposed site users or to others off site, and that there is a feasible drainage strategy for the development.

1.3. An illustrative site layout plan (refer to **Appendix B**) showing how this quantum of development can be accommodated on the site is submitted with the application but is an indicative layout only and does not form part of the application as such. However, this flood risk assessment and drainage strategy has been prepared on the basis of the illustrative site layout to demonstrate that this quantum of development can be undertaken without it being at risk from flooding or from increasing flood risk off site.

1.4. The report is produced for the sole use by Earlswood Homes (Southwest).

1.5. The report includes a thorough review of commercially available flood risk and Environment Agency (EA) supplied data indicating potential sources of flood risk to the site.

1.6. The information provided within this report is based on the best available data currently recorded or provided by a third party. The accuracy of this report is therefore not guaranteed and does not obviate the need to make additional appropriate searches, inspections and enquiries.

1.7. The National Planning Policy Framework (NPPF, July 2021), Section 14 (Meeting the challenge of climate change, flooding and coastal change), Paragraph 159 states that:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere."

1.8. The NPPF recommends the Environment Agency (EA) Flood Maps as a starting point for Flood Risk Assessment. An extract from the EA Flood maps is reproduced in Figure 1.1.

1.9. The Environment Agency has produced standing guidance for developments dependent on their size and location. As can be seen from Figure 1.1, the site is located within Flood Zone 1, within an area with a low probability of flooding.

1.10. Industry best practice requires assessment of all flooding sources to be carried out. Despite this document having now been superseded by the NPPF, Figure 3.2 of the "PPS25: Development and Flood Risk" (PPS25) Practice Guide, lists five key sources of flooding:

i. Fluvial (refer to Section 6);

ii. Tidal (refer to Section 7);

iii. Pluvial (refer to Section 8);

iv. Groundwater (refer to Section 9); and

v. Infrastructure Failure (refer to Section 10).

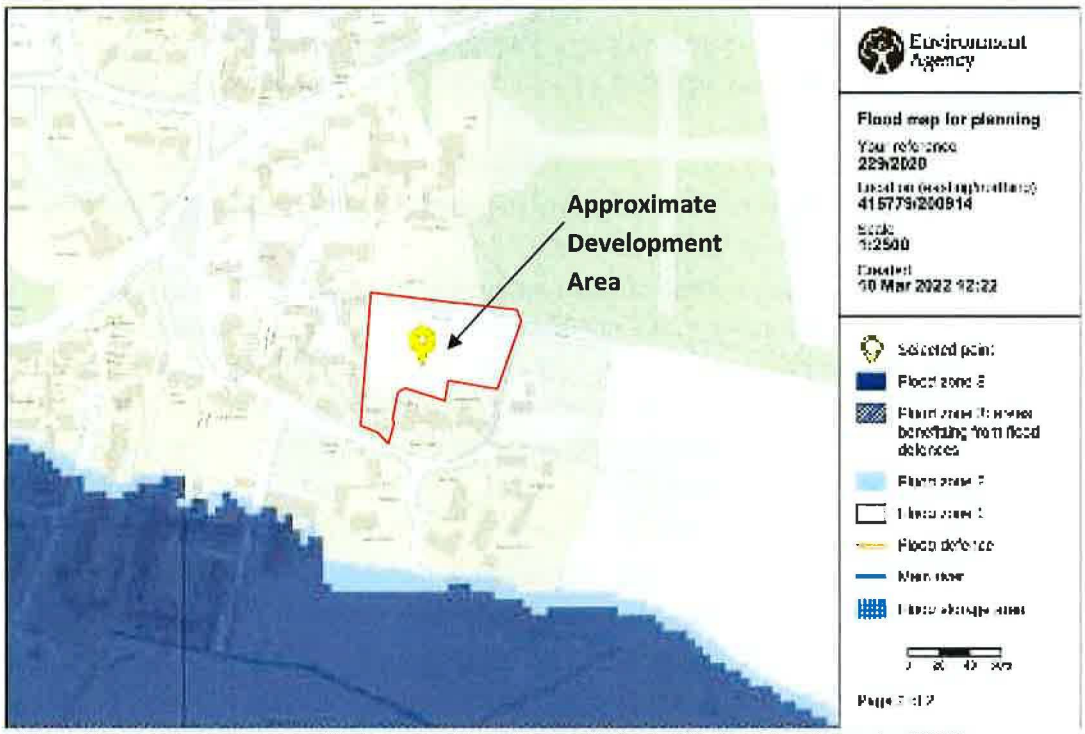


Figure 1.1 – Environment Agency Flood Map (Rivers and Seas)

2. POLICY CONTEXT

2.1. The purpose of the planning system is to contribute to the achievement of sustainable development – *NPPF, Paragraph 7.*

2.2. At the heart of the National Planning Policy Framework is a presumption in favour of sustainable development which does not change the statutory status of the development plan as the starting point for decision making – *NPPF, Paragraph 12.*

2.3. Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere– *NPPF, Paragraph 159.*

2.4. The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding – *NPPF, Paragraph 162.*

2.5. Following the Sequential Test, both elements of the Exception Test will have to be passed for development to be allocated or permitted – *NPPF, Paragraph 165.*

2.6. The Local Planning Authority Documents;

- Cotswold District Local Plan 2011-2031 (Adopted 3 August 2018).
- Cotswold District Council Strategic Flood Risk Assessment for Local Development Framework; Level 1 September 2008.
- Cotswold District Council Strategic Flood Risk Assessment Updated Final Report May 2016.

2.7. Gloucestershire County Council, as lead local flood authority, advises on the standards to be used at a local level:

- Standing Advice and Development Guidance (March 2015)
- Gloucestershire County Council Strategic Flood Risk Assessment Level 1 Executive Summary (September 2008)
- Gloucestershire SuDS Design and Maintenance Guide (November 2015)
- Guidance to Local Planning Authorities on Development and Flood Risk

  document (March 2015)

2.8. Fairford Town Council document Groundwater Monitoring and Review of Flood Risk Flood Risk at Fairford prepared by WRA (November 2018).

2.9. Fairford Town Council's Neighbourhood Plan Site Assessment Report dated February 2019.

2.10. The Environment Agency provide standing advice guidance.

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071

3. EXISTING SITE INFORMATION

3.1. The site is located within the eastern fringes of Fairford, off East End and comprises an area of approximately 0.56Ha. It is bound by residential dwellings and gardens to the west, East End (road) to the south, residential dwellings and farm buildings to the east and open fields and Morgan Hall gardens to the north. Refer to the site location plans in **Appendix A**.

3.2. The site is predominantly greenfield (Fallow) with an existing single storey dwelling with an associated driveway and garden to the south. A drawing showing the existing site layout and topographical survey is attached in **Appendix C**.

3.3. The site can be located from the following information:

i. Postcode: GL7 4AP

ii. NG Reference: SP 157008

iii. The ground levels range from 83.9m AOD (at the north-west corner) to 82.8m AOD at the site entrance. The site slopes from the north boundary to the south at an approximate gradient of 1:80 with two localised depressions in the site area to the north, at a level of 83.17m AOD.

3.4. The site is located near a Main River, the River Coln, which is 425m south-west of the site. There is also a watercourse located 160m south of the site, which flows east and discharges into the River Coln, 480m downstream. These watercourses are shown on the site location plan in **Appendix A**.

3.5. The BGS records describe the geology as:

i. Superficial: Northmoor Sand and Gravel Member - Lower Facet Sand and Gravel

ii. Bedrock: Cornbrash Formation - Limestone

3.6. The BGS 1:50,000 scale drift maps (Figure 3.1) show the form of the superficial deposits.

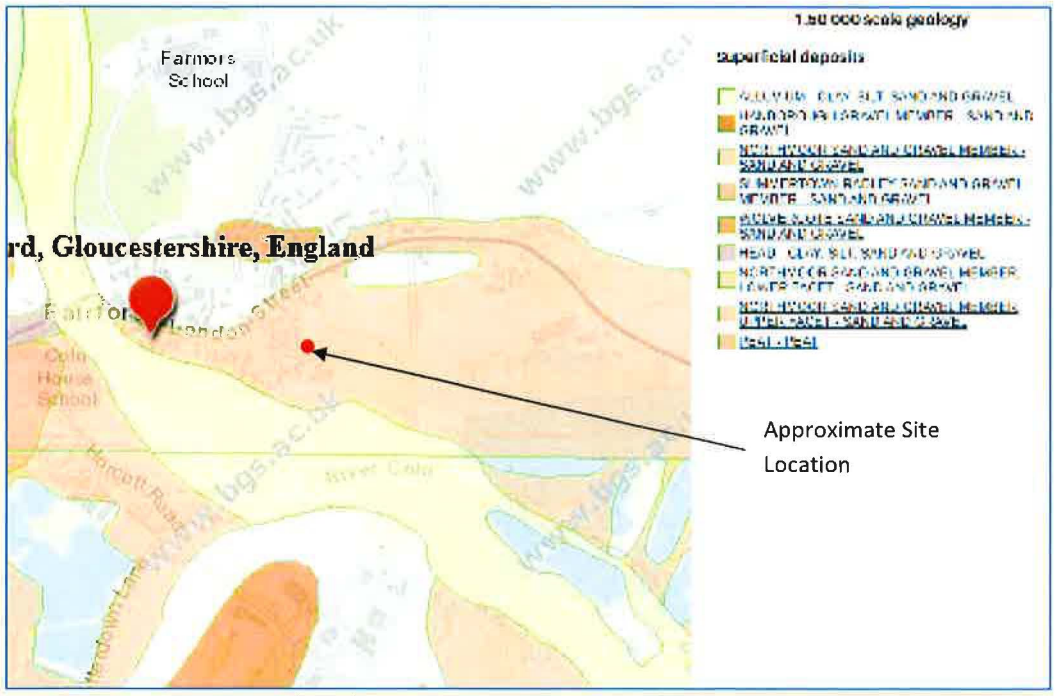


Figure 3.1: BGS 1:50,000 Scale Drift Map

3.7. Micro-Drainage has been used to assess the existing greenfield runoff rate from the whole site area using the ICP SuDS methodology which has shown; Q_{bar} = **3.6l/s/ha**. Refer to **Appendix D** for the calculations.

3.8. The Environment Agency has mapped Source Protection Zones (Figure 3.2), and this shows that the south-east part of the site is located over a Zone III Total Catchment Source Protection Zone. This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source. The remaining area of the site is not located over a source protection zone.

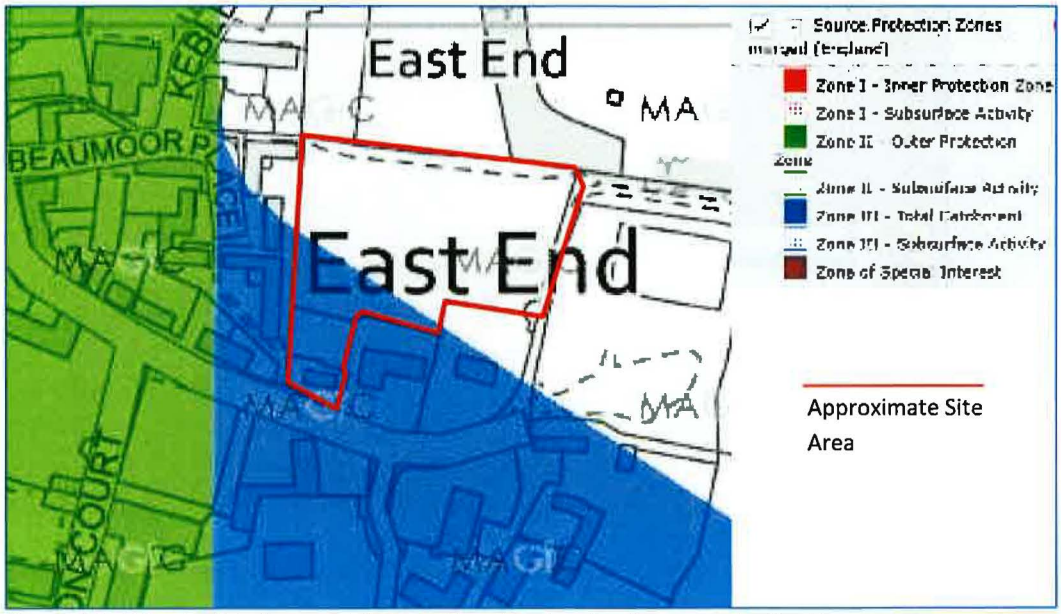


Figure 3.2: Extract of Environment Agency Mapping showing Source protection Zones

3.9. The Environment Agency has produced data sets that identify the different types of aquifer which are underground layers of water-bearing permeable rock or drift deposits from which groundwater can be extracted. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The designations vary from Principal, Secondary (subdivided into Secondary A, Secondary B and Secondary (Undifferentiated)) or Unproductive. The maps are split into two different type of aquifer designation: superficial - permeable unconsolidated (loose) deposits (for example, sands and gravels), and bedrock - solid permeable formations e.g. sandstone, chalk and limestone.

3.10. The Environment Agency Aquifer Bedrock Geology mapping shows that the site is located over a Secondary A Aquifer. Secondary A aquifers comprise permeable layers that can support local water supplies and may form an important source of base flow to rivers.

3.11. The Environment Agency Superficial Drift Geology Aquifer Designations mapping information also shows that the site is over a Secondary A Aquifer.

3.12. The Environment Agency has mapped groundwater vulnerability which identifies the groundwater susceptibility to pollution and not flooding. Figure 3.3 below shows the site is located over a Medium to High zone within an area at Soluble Rock Risk.

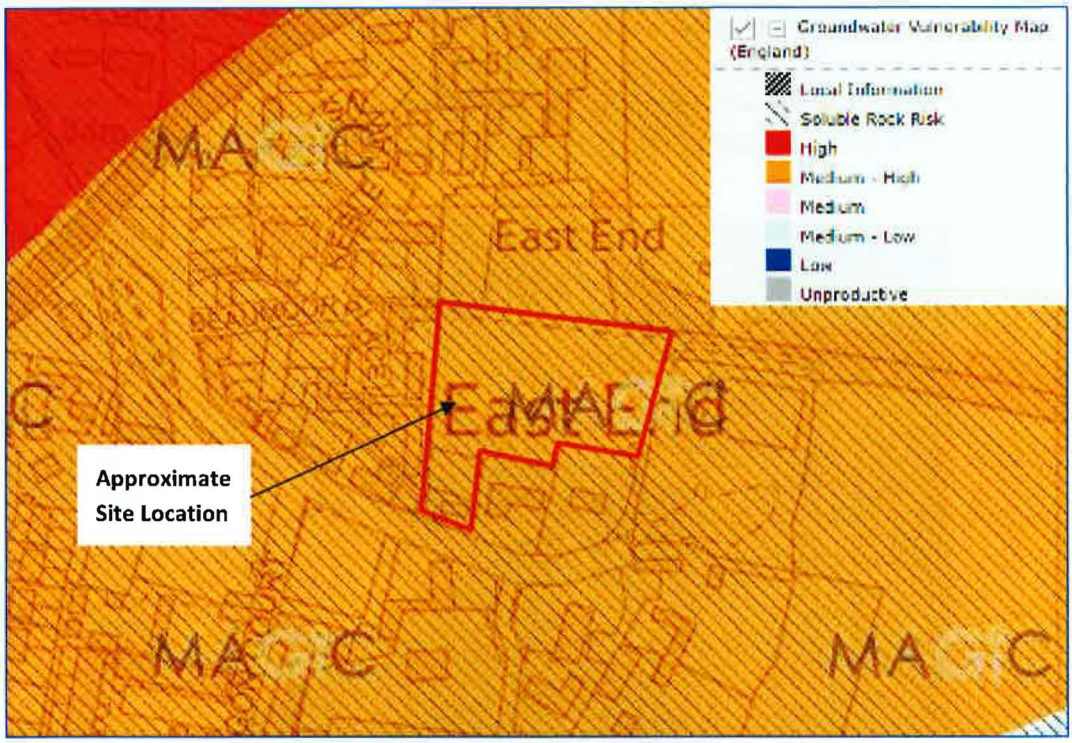


Figure 3.3: Environment Agency Groundwater Vulnerability Zones

3.13. A Thames Water Drainage and Water Search for the site (Pengeric) was undertaken during June 2020 which advised that the existing dwelling is connected to both a Foul and Surface Water public sewer, with a surface water charge payable. The search also advises that there is a public sewer within 30.48m of the existing building. A copy of the search report is attached in **Appendix E.**

3.14. A Pre-Planning Enquiry was made to Thames Water during October 2020 and copies of their responses to date are attached in **Appendix E**. This response indicates that the existing site surface water runoff does not discharge to a Thames Water Sewer.

3.15. The correspondence from Thames Water advises that the foul flows from the site discharge to a Thames Water sewer. Refer to **Appendix E** for a copy of the response.

3.16. The greenfield site area currently drains via infiltration, and via an existing surface water sewer as outlined above. The existing site drainage and overland flow paths are shown on the drawing in **Appendix C.**

3.17. The potential for groundwater emergence flooding is related to the geology and hydrology of Fairford which is complex and varies across the town as indicated in Figure 3.1. A Groundwater Monitoring and Review of the Groundwater Flood Risk at Fairford was undertaken during November 2018 and a copy of the report is attached in **Appendix F**. The report advises that the maximum 1 in 200 year event groundwater level, 280m east of the site at Cinder Lane, is 82.1m AOD and at Riverdale, London Road 190m west of the site, is 84.1m AOD. The flood risk relating to the site is discussed further in Section 9 of this report.

4. HISTORICAL FLOODING

4.1. Historic flooding from Fluvial, Groundwater, Surface Water sources and Sewers has been experienced at the town of Fairford. However, there are no public records of historic flooding relating to the development site.

4.2. The Thames Water Drainage and Water Search Report attached in **Appendix E** advises that the existing dwelling is not at risk of flooding due to overloaded public sewers.

4.3. The Strategic Flood Risk Assessment recognises flooding within Fairford, but not for this site.

4.4. The Lead Local Flood Authority do not have any Section 19 investigations for this and neighbouring sites suggesting there is not a current flood issue.

4.5. The landowner who has lived in Fairford for 70+ years has never seen the site flooded, only on occasion to be waterlogged in places.

5. PROPOSED DEVELOPMENT

5.1. The proposal comprises the development of 10 dwellings with associated access roads, garages, driveways and gardens, and also a car park for the local Surgery. The development and car park would be accessed off East End. An illustrative site layout plan is attached in **Appendix B** which shows how this quantum of development can be accommodated on the site is submitted with the application but is an indicative layout only and does not form part of the application as such.

5.2. The development is classified as **More vulnerable**; Buildings used for **dwelling houses**, student halls of residence, drinking establishments, nightclubs and hotels.

5.3. The Environment Agency table below (Table 5.1) shows that development is appropriate at the site based on the vulnerability classification and Flood Zone.

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓ *

Key:

✓ Development is appropriate

✗ Development should not be permitted.

Table 5.1: Environment Agency Flood Zone/ Classification Table

5.4. Design life of the development is 100 years.

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071

6. FLUVIAL FLOODING

6.1. Fluvial flooding is the flooding associated with rivers. This can take the form of:

i. Inundation of floodplains from rivers and watercourses
ii. Inundation of areas outside the floodplain due to influence of bridges, embankments and other features that artificially raise water levels
iii. Overtopping of defences
iv. Breaching of defences
v. Blockages of culverts
vi. Blockages of flood channels or corridors

6.2. The nearest significant watercourse is the Main River Colne located 425m south-west of the site.

6.3. Figure 1.1 shows that the site is located within Flood Zone 1 where the risk is less than 1 in 1000 (0.1% AEP).

7. TIDAL FLOODING

7.1. Tidal flooding is a risk of water levels from the sea or an estuary exceeding the normal tidal range. This can take the form of:

i. Overtopping of defences
ii. Breaching of defences
iii. Other flows (fluvial surface water) that could pond due to tide locking
iv. Wave action

7.2. As mentioned in 6.3, the Environment Agency Flood Map for Rivers and Seas shows the site is located within Flood Zone 1; the site is located too far from the sea to be affected by tidal flooding.

8. PLUVIAL FLOODING

8.1. Pluvial flooding is a risk of overland flows and ponding associated with extreme rainfall events. This can take the form of:

i. Sheet run-off from adjacent land (urban or rural)
ii. Surcharged sewers

8.2. As rain falls everywhere within the United Kingdom, there will always be a residual risk of flooding from extreme rainfall events.

8.3. The Environment Agency has produced maps with risk classifications that show the risk of flooding from surface water run-off and an extract for the area showing the extent of flooding is reproduced in Figure 8.1. The map shows that the site is at Very Low risk of surface water flooding (<0.1% AEP) with the exception of two localised areas within the northern part of the site which are at a Low risk of flooding. These areas correlate to localised depressions in the ground levels identified by the site topography in **Appendix C** (refer to section 3.3).

8.4. An extract for the area showing the extent of flooding in the Medium Risk Scenario is reproduced in Figure 8.2, which shows the site is not at risk of flooding during this scenario.

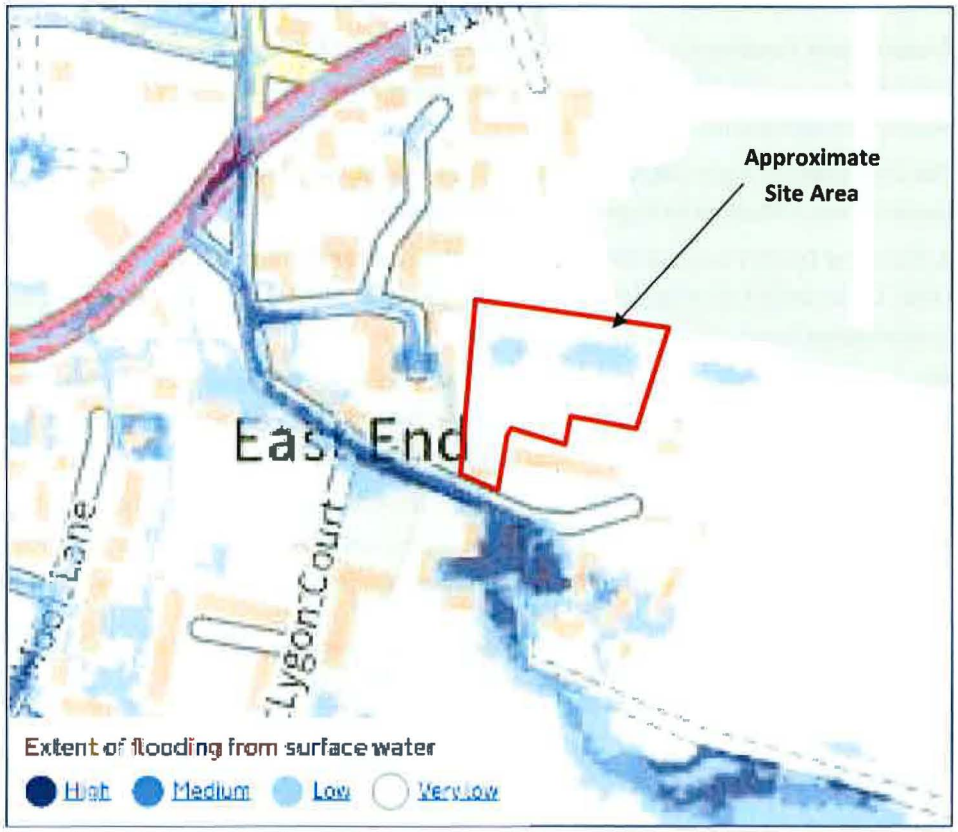


Figure 8.1 – Surface water flood risk

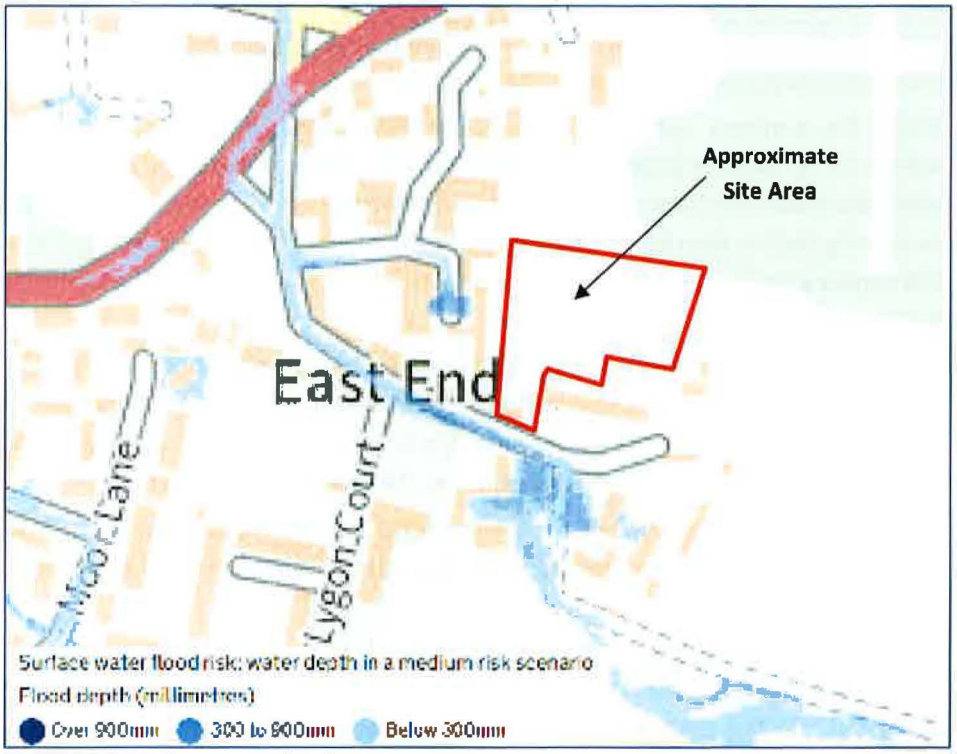


Figure 8.2 – Surface water flooding extents 1% to 3.33%

9. GROUNDWATER FLOODING

9.1. Groundwater flooding is a risk of the water table rising after prolonged rainfall to emerge above ground level remote from a watercourse. It is most likely to occur in low lying areas underlain by aquifers of high vulnerability.

9.2. The Environment Agency has mapped groundwater vulnerability and Figure 3.3 shows the site is located over a Medium to High vulnerability aquifer.

9.3. A Cotswold District Council Strategic Flood Risk Assessment for Local Development Framework Level 1 was undertaken by Halcrow during September 2008 which did not identify any historical groundwater flood events within Fairford.

9.4. The Fairford Neighbourhood Development Plan Steering Group commissioned a Groundwater Monitoring and Review (GMR) of the Groundwater Flood Risk at Fairford, and a copy of the report (dated November 2018) is attached in **Appendix F**.

9.5. The above GMR undertook extreme value frequency analysis using available records to estimate maximum groundwater levels at the various study locations across Fairford. The following table summarises the assessed groundwater levels at two locations; to the east and west of the site location.

Monitoring Location	Max m AOD	T2	T100	T200
Cinder Lane (280m east of the site)	81.45	80.88	81.90	82.07
Riverdale, London Road (190m west of the site)	83.75	83.00	83.90	84.05

Table 9.1: Summary of Maximum Predicted Groundwater Levels (mAOD) taken from the Monitoring and Review of the Groundwater Flood Risk at Fairford Report

9.6. Within the summary and conclusions of the GMR report, it states that the site (F38) is a Northmoor terrace site located east of the river and may be represented by data for Cinder Lane which showed a freeboard of 1.2m under T200 conditions. It then states that F38 is closer to the monitoring well at Riverdale which showed a risk of groundwater flooding in T200 conditions. BGS mapping for the two monitoring site locations shows the same Superficial and Bedrock strata as is shown for the site.

9.7. The GMR report has referred to the 1 in 200 year return period groundwater levels in assessing the flood risk to the site. The Environment Agency requires the 1 in 100 year risk to be assessed when considering fluvial and surface water flood risk and so it may be considered onerous to use the 1 in 200 year flood event when considering the groundwater flood risk.

9.8. The site ground levels vary between 83.9-82.8m AOD, which implies that the groundwater would rise above the ground level during the Riverdale 1 in 200 year event, and during the lower return period events summarised in Table 9.1.

9.9. Interpolation between the estimated groundwater levels assuming a linear hydraulic gradient between the two locations in Table 9.1, indicates a 1 in 200 year groundwater level of 83.3m AOD at the site, implying a depth to groundwater of 0.6m bgl at the north boundary to -0.5m (above ground level) at the south boundary, during this scenario. The interpolated T2 level is 82.1m AOD and the interpolated T100 level is 83.1m AOD.

9.10. A site visit was carried out by Earlswood Homes. They met with the site owner who provided information relating to historic flooding and groundwater levels at and around the site and who stated that he has never known the site to flood. A summary of the information provided during the site visit is provided below and a copy of annotated maps and photographs to accompany this is attached in **Appendix G**.

Summary of Site Visit on 15th October 2020 by Earlswood Homes:

- *I also went to site myself yesterday and met the owner who talked me through the history. We spoke at length about flooding and groundwater. He is a 77 year old ex farmer who has lived in Fairford all his life and the land has been in his family since he was born. He tells me that he has never seen the field flood and has only seen small areas of water logging in a couple of parts of the field when there is major flooding in the rest of the town. He says he has never had any problems with groundwater (as a farmer who ploughs the land I think he probably knows what he is talking about!).*
- *He then took me to his sister's house next door who has a well and sent me the attached photo of him standing in it. The natural groundwater level in the well is at least 3.5-4m deep from what he says and looking at the photo.*
- *There are also two monitoring wells in the site which apparently a previous developer installed in 2017. We put a 4.5 metre long pole down into the one on the southern side which is at a lower level than the north side to see where the water came up to. It went down to about 3m deep and only the final 30 cm of the pole was damp, and even that looked like it was just mud rather than water. On that basis, it seems that the groundwater level is probably at least 3 metres lower than the ground level in the southern end of the field.*
- *He took me across to another field next door and pointed out that our site is higher than the adjoining field abutting the river Coln, with a ditch in between. He told me that the field next to the river floods but he has never seen the field next to it flood.*
- *The access to the site where the mobile home is has a higher ground level than the road.*
- *The owner said that the front gardens of Bridham and Moor Farm flooded in the 50s and 60s but then had their garden levels raised and have not flooded since. None of the other neighbouring houses have flooded in his lifetime.*

9.11. Given that October 2020 was the wettest October on record and the groundwater dips were taken on the 15th October 2020, according to the GMR report it would be expected to see the groundwater at the surface, but it was actually more than 3m below ground. This suggests caution with the prediction of the GMR and that monitoring should be undertaken on site.

9.12. The groundwater level at the site has been monitored monthly over a year (January 2021 to January 2022) at three locations within the site. A copy of the groundwater monitoring results, associated location plan and borehole logs is attached in **Appendix G**. The borehole logs show the ground conditions comprise Sand to depths of up to 0.95m bgl over Limestone. The monitoring shows that the highest groundwater levels at the site were recorded during January 2021, February 2021 and January 2022, at levels of 82.25 (1.4m bgl) at the north to 81.91m (1.69m bgl) AOD at the south. The groundwater level falls across the site (north to south) by approximately 0.41 to 0.46m. Table 9.2 summarises these results.

Borehole reference (approximate ground level)	Monitored groundwater depth (m bgl) and associated groundwater level (m AOD)		
	17/01/2021	18/02/21	15/01/22
WS1 (83.65m AOD)	1.49 (82.16)	**1.40 (82.25)**	1.44 (82.21)
WS2 (83.65m AOD)	1.90 (81.75)	1.93 (81.72)	**1.89 (81.76)**
WS3 (83.60m AOD)	1.75 (81.85)	1.76 (81.84)	**1.69 (81.91)**

Table 9.2: Groundwater Level Monitoring Summary showing the highest recorded groundwater levels at the site. ***Highest level recorded***

9.13. If groundwater flooding was to occur it would present as wet areas on the ground which would develop into overland flow following the contours of the site. The rate of emergence is dependant on the point of issue and will be restricted to the rate of flow through the soil beneath. It is likely at this site given the contours, that any groundwater flooding would initially emerge at the south of the site and as the groundwater level rose, it would be observed as wet ground across the site area. The emerging water would then flow overland from north to south to East End. The existing overland flow paths are shown on the drawing in **Appendix C**.

9.14. Given the site geology and the groundwater levels outlined in 9.5 to 9.9, the risk of water coming up to the surface through the ground is considered to be High, varying in severity across the site. Any water that does come up through the surface would drain to East End to the south of the site, and based on available information, would then continue to flow south and then east towards existing watercourses. This would occur with or without the development. There are no records of historic groundwater flooding at the site.

9.15. Based on the 1 in 200 year predicted groundwater levels to the west of the site of 84.1m AOD, the development will be at risk of groundwater flooding which will potentially impact on the proposed dwellings and will flood the access and egress to the development and parking areas. Based on the existing ground levels, this groundwater level implies flood depths of 0.2m at the north of the site to 1.3m at the south of the site, although the water is unlikely to reach this depth as it will emerge slowly and flow south towards the existing watercourses. These depths also do not take into account the variation of the groundwater level across the site observed during the site monitoring.

9.16. Safe access to and from the site during a groundwater flood scenario is available at the north of the site within the area retained for Public Open Space which is linked by a new path to the Surgery to the west and to the east via a track. The ground level in this location is approximately 84.0m AOD, with any groundwater emergence to the north being shallow in depth and slowly flowing south.

9.17. Setting the proposed floor levels a minimum of 300mm above surrounding ground levels will reduce the risk of flooding to the dwellings during a flood event and provide a freeboard. It will be necessary to maintain the flow paths through the site to East End, utilising the proposed roads and localised contouring to achieve this.

9.18. It should be noted that the dwellings in East End would be flooded before the proposed site floods, as they are sited on lower land and the groundwater would appear more frequently in these lower areas.

9.19. The groundwater flood risk will not alter due to development on the site and may reduce with a sustainable surface water drainage system.

9.20. The design of the development should consider the design of structural features below ground due to the impact of groundwater.

10. INFRASTRUCTURE FAILURE FLOODING

10.1. Infrastructure failure flooding is a risk of collapse, failure or surcharging of man-made structures and drainage systems. This could take the form of:

i. Reservoirs
ii. Canals
iii. Burst water mains
iv. Blocked sewers
v. Failed pumping stations

10.2. The Environment Agency have mapped failure of reservoirs and this indicates there are no near effects of reservoir failure, therefore the risk to the site is low.

10.3. The risk of flooding from blocked sewers is considered to be very low as any flood water would flow to East End to the south of the site.

10.4. Thames water have stated in their response dated 22/6/2020, that the existing building is not at risk of internal flooding due to overloaded public sewers.

11. CLIMATE CHANGE

11.1. The National Planning Policy Framework (NPPF) sets out how the planning system should help to minimise vulnerability and provide resilience to the impacts of climate change.

11.2. The climate change allowances are predictions of anticipated change for:

i. Peak river flow by river basin district

ii. Peak rainfall intensity

iii. Sea level rise

iv. Offshore wind speed and extreme wave height.

11.3. The climate change allowances relevant to this site are predictions of anticipated change for peak rainfall intensity as follows;

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

11.4. For the peak rainfall intensity, the design will allow for 40% increase due to climate change; based on an assessment of both the central and upper end allowances to understand the range of impact in accordance with Environment Agency requirements.

12. FINISHED FLOOR LEVELS

12.1. As outlined in Section 9, an effective way to protect the building from groundwater flooding is to set the habitable floor level to a minimum of 300mm above surrounding ground level to allow for a depth of overland flow during a flood event.

13. SAFE ACCESS

13.1. During a flood, the journey to safe, dry areas will need to be maintained. A safe access route via the north area of the site is indicated on the layout drawing in **Appendix G,** which links to the town to the west. The ground level in this location is approximately 84.0m AOD, with any groundwater emergence to the north being shallow in depth and slowly flowing south.

13.2. The provision of a safe access could also be used by those residents from the lower land, East End, to aid their route to safe dry higher land.

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071

14. FLOOD EMERGENCY EVACUATION PLAN

14.1. As a safe access is required during a groundwater flood event then an emergency flood plan is required which deals with matters of evacuation and refuge and demonstrates that people will not be exposed to flood hazards. The developer should prepare an emergency flood plan that includes receiving flood warnings and preparing for the flood event. Given that the flood risk is from groundwater emergence, this will follow in the days after extreme rainfall has occurred and will be relatively slow to emerge (and subsequently subside) providing ample warning and time to prepare.

14.2. During a flood event, safe access/egress will be available to the north of the site via the access route outlined in Section 13.

14.3. The site owner should sign up with the Environment Agency to receive 24-hour Flood Warnings/Alerts to enable safe evacuation or preparation before a flood event occurs (either by visiting the Environment Agency website or calling Floodline- 0345 988 1188).

15. FLOOD RESILIENCE AND RESISTANCE MEASURES

15.1. To minimise the disruption and cost implications of a groundwater flood event, flood resilience/resistance measures up to the extreme (1 in 200 year) event are to be encouraged.

15.2. Floor levels will be set at minimum **300mm** above surrounding ground levels, to allow for a depth of overland flow around the dwellings.

15.3. The buildings should be constructed using materials of low permeability below finished floor level (subject to structural assessment).

15.4. The sills of the proposed dwellings within the groundwater flood risk area should be set at a minimum of **300mm** above surrounding ground level, to prevent the ingress of flood water.

15.5. All electrical services within the dwellings in the groundwater flood risk area should be located at a minimum **600mm** above surrounding ground level.

15.6. Site ground levels will be locally contoured to deflect water away from building thresholds. The exceedance flow path will be directed around the building and towards the existing watercourses, mimicking the current flow path.

DRAINAGE STRATEGY

16. PROPOSED DRAINAGE

16.1. The proposal comprises the development of 10 dwellings with associated access roads, garages, driveways and gardens, and also a car park for the local Surgery. The development and car park would be accessed off East End. An illustrative site layout plan is attached in **Appendix B** which shows how this quantum of development can be accommodated on the site is submitted with the application but is an indicative layout only and does not form part of the application as such.

16.2. Site characteristics:

- Total development area is 0.56ha
- Proposed impermeable area is 0.202ha (excluding creep)
- The greenfield rate based on the proposed impermeable area is Q_{bar} = 0.7l/s, Q_1 = 0.6l/s, Q_{30} = 1.6 l/s, Q_{100} = 2.3 l/s. Refer to the Micro-Drainage calculations in **Appendix D**.

16.3. There are no existing surface water features within the site or within its vicinity.

16.4. Based on the Pre-planning enquiry responses received from Thames Water (refer to **Appendix E**), it appears that the surface water runoff from the existing dwelling and the adjacent dwellings either discharges to soakaway or to the surface water highway sewer located in East End. The existing dwelling does not drain to a Thames Water Surface Water sewer.

16.5. Thames Water has advised in their Pre-planning Enquiry response that there is sufficient capacity in the clean water network to serve the development, though they have not advised a suitable connection location to their system.

Surface Water Disposal

16.6. In accordance with Government and Local Plan Policies and the requirements of the Building Regulations, surface water runoff from the development will be drained at source in a sustainable way by making full use of Sustainable Drainage Systems (SuDS) where possible.

16.7. The SuDS hierarchy dictates that infiltration at source is considered first. After infiltrating at source has been considered, the next stage is to deal with run-off in individual catchments, followed finally by site wide drainage solutions. Runoff from the development should not adversely impact upon drainage systems outside of the site boundary.

16.8. Detailed surface water drainage design should take into account all three key SuDS principles in equal measure:

i. Reducing peak quantity;
ii. Improving quality; and
iii. Providing amenity and biodiversity value.

16.9. Given the potential shallow depth to groundwater in the area, infiltration is not considered a viable drainage option at this stage. There are no nearby surface water features at the site and so discharge via this method is not possible to protect the groundwater from pollution. It is therefore proposed to discharge surface water to the existing Surface Water sewer within East End, based on the understanding at this stage, that this is where the existing dwelling and the neighbouring properties currently discharge to.

16.10. In accordance with the Lead Local Flood Authority drainage policy, the discharge to the existing sewer will be restricted to the existing greenfield runoff rate, attenuating the runoff on-site to achieve this.

16.11. Attenuation in the form of storage below the car parking and road areas within the sub-base can be used, which will be lined. The runoff from the roof areas will use conventional gutters and pipework prior to discharge to the sub-base and the runoff from the external surfaced area will discharge to the sub-base via permeable paving. The proposed drainage layout is attached in **Appendix H**.

Quantity

16.12. Micro-Drainage has been used to design the storage, assessing the volumes associated with the 1 in 30 year event and the 1 in 100 year event plus an allowance for 40% climate change and 10% urban creep. The calculations are attached in **Appendix I**.

16.13. A storage volume of 168m^3 to attenuate for the 1 in 100 year event plus an allowance of 40% for climate change. Refer to **Appendix H** for the layout drawing.

Quality

16.14. The water discharging to the watercourse (assumed to be the final outfall for the existing surface water sewer) must be cleansed and therefore treatment processes are introduced through the drainage network. These have been assessed using the simple qualitative method and index approach in accordance with Chapter 26 of the Ciria SuDS Manual C753, where the hazard of low to medium is mitigated with the various SuDS components to equal or exceed the hazard indices. Refer to Tables 26.2 and 26.3 which show the hazard and mitigation indices associated with the proposed drainage scheme.

16.15. It can be seen from the above tables, the mitigation indices associated with the permeable paving exceed the hazard indices for the residential access road and car parking areas and also the Surgery car park if this is to be a frequent use car park for patients to use. A car park associated with Surgery Staff use only would more likely fall into the Low hazard category, demonstrating mitigation in excess of the hazard indices associated with this scenario.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) i.e. < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured, industrial sites, trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.6	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.6	0.5	0.6
Pond[4]	0.7[3]	0.7	0.6
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[2,5]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Exceedance

16.16. In an exceedance event in which rainfall surpasses the design capacity, there should be no vulnerable buildings at risk of flooding; any excess runoff will be directed away from vulnerable buildings and infrastructure to the lowest part of the site via the development access roads.

16.17. Site ground levels will be locally contoured to deflect water away from building thresholds, with floor levels being set at least 300mm above surrounding ground levels. The exceedance flow path will be directed around the buildings and towards East End as currently occurs.

16.18. The exceedance paths have been shown on the layout plan in **Appendix G**.

Foul Water Disposal

16.19. Part H of the Building Regulations (2015) states that "Foul drainage should be connected to a public foul or combined sewer wherever this is reasonably practicable".

16.20. There is a Thames Water sewer located within East End which is a gravity system flowing east. A copy of the Thames Water Enquiry response is attached in **Appendix E**. It is proposed that the foul discharge from the site will discharge to the existing sewer in East End as shown on the drawing in **Appendix G**.

16.21. The foul connection from the development will be subject to Thames Water consent and Infrastructure Charging.

17. ADOPTION & MAINTENANCE

17.1. It is important to establish the adopting authorities at an early stage to define the requirement and how these meet the standards.

17.2. Maintenance of the system will include for frequent inspections and regular intervals of cleansing.

17.3. Filter chambers and catch pits prior to inlet pipework should be routinely inspected and cleaned out to minimise debris reaching the attenuation storage. It is also important to prevent construction silt from entering the pipework and storage system.

17.4. The local council could designate flood features if they so wish in accordance with 'Flood & Water Management Act 2010 Section 30 and Schedule 1, designation of features', to protect from future change.

17.5. Maintenance of the permeable pavement should be undertaken in accordance with Table 20.15.

TABLE 20.15 Operation and maintenance requirements for pervious pavements

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site specific observations of clogging or manufacturer's recommendations - pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Strimming and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remedial any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

18. SUMMARY

18.1. It has been demonstrated that the site is located within Flood Zone 1, in an area at low probability of flooding.

18.2. Table 18.1 summarises the probability of the site flooding from the five key sources as listed in PPS25.

Source	Description	Risk	
Fluvial	Rivers	Flood Zone 1	**(<0.1%)**
Tidal	Seas		
Pluvial	Surface Water	Very Low-Low	**(<0.1%-1%)**
Groundwater	Aquifers	High	-
Infrastructure failure	Reservoirs Blocked Sewers	Outside maximum extent of flooding Very Low	**(Very Low)**

Table 18.1 – Flood Risk Summary

18.3. The assessment of groundwater flood risk has been based on an estimated 1 in 200 year groundwater level provided in the 'Groundwater Monitoring and Review of the Groundwater Flood Risk at Fairford' Report prepared by WRA. The estimated groundwater level is for the Riverdale monitoring point located, with a level of 84.1m AOD. This is considered to be a conservative level given the return period (which is greater than 1 in 100) and the distance of the monitoring location from the site. It should be noted that there are no records of groundwater flooding at the site, either within the Strategic FRA for the site area or from the site owner.

18.4. It should be noted that the Groundwater Monitoring and Review of the Groundwater Flood Risk at Fairford' Report prepared by WRA appears to have concluded that the site is unsuitable for development based on the predicted groundwater level for the Riverdale site located 190m west, whilst recognising that the site is also represented by the Cinder Lane monitoring point (280m east) which has a 2m lower groundwater level.

18.5. Groundwater monitoring has been undertaken at the site over a 12 month period which has shown a highest groundwater level at the north of the site of 82.25m AOD (1.4m bgl) and 81.91m AOD (1.69m bgl) at the south of the site. It is not known what return period this water level relates to.

18.6. Using a conservative approach based on the predicted 1 in 200 year groundwater level of 84.1m AOD, the development will be at risk of flooding. It is therefore recommended that the ground floor levels are set 300mm above the surrounding ground levels to allow for a depth of overland flow during a flood event, which also accords with Environment Agency guidance with regards to setting of floor levels above flood levels.

18.7. Groundwater flooding would likely emerge, with or without the development, in the south part of the site initially, and then emerge further north within the site as groundwater levels rose. The emerging water would then flow overland from north to south to East End. Safe access and egress will be available to the north of the site area, linking to the town to the west via a footpath or to the east via a track. Any groundwater emergence to the north would be shallow in depth and slowly flowing south.

18.8. The groundwater flood risk can be mitigated and managed by the proposed development with minimal impact to those on site and provides another form of escape for existing residents in East End.

18.9. The developer should prepare an emergency flood plan that includes receiving flood warnings and preparing for the flood event. Given that the flood risk is from groundwater emergence, this will follow in the days after extreme rainfall has occurred and will be relatively slow to emerge (and subsequently subside) providing time to prepare.

18.10. Flood resilience and resistance measures are recommended for the proposed dwelling construction and floor levels, including for the below ground services.

18.11. Following the standing advice from the Environment Agency, the development will be safe for its lifetime without increasing flood risk elsewhere.

18.12. Runoff from this development will be discharged to an existing Surface Water sewer in East End at the existing greenfield rate, utilising below ground on-site attenuation storage for rainfall events up to the 1 in 100 year return period plus an allowance for 40% climate change and 10% urban creep. This discharge connection and rate is subject to approval and consent.

18.13. The exceedance flow is directed away from vulnerable buildings and infrastructure and outflows along its original path to East End and ultimately to the watercourses to the south-east of the site.

18.14. In accordance with government policy, SuDS will be used on site, where possible, and surface water drainage of the site will be carried out in a sustainable way.

18.15. As long as maintenance of the new drainage systems are correctly carried out, the risk of flooding and the subsequent risks from infrastructure failure or pluvial means, is very low.

18.16. The Environment Agency accepts that extreme floods will occur and it will never be possible to eliminate flood risk altogether.

18.17. It is considered that the risk of flooding to the site has been adequately considered and therefore development of the site with the proposed drainage system does not pose an unacceptable flood risk either to occupants of the site or to others off site.

19. LIST OF APPENDICES

Appendix A - Site Location Plans
Appendix B - Proposed Layout Plan
Appendix C - Existing Site Drainage Layout -Drawing No. 229/2020/02
Appendix D - Greenfield Runoff Calculations
Appendix E - Thames Water Drainage and Water Search report
Thames Water Pre-planning Enquiry Response
Appendix F - Groundwater Monitoring and Review of Flood Risk at Fairford Report
Appendix G - Historical Information relating to Flooding and Groundwater Levels
Appendix H - Proposed Drainage Strategy and Flood Resilience Measures – Drawing No. 229/2020/03
Appendix I - Micro-Drainage Design Calculations

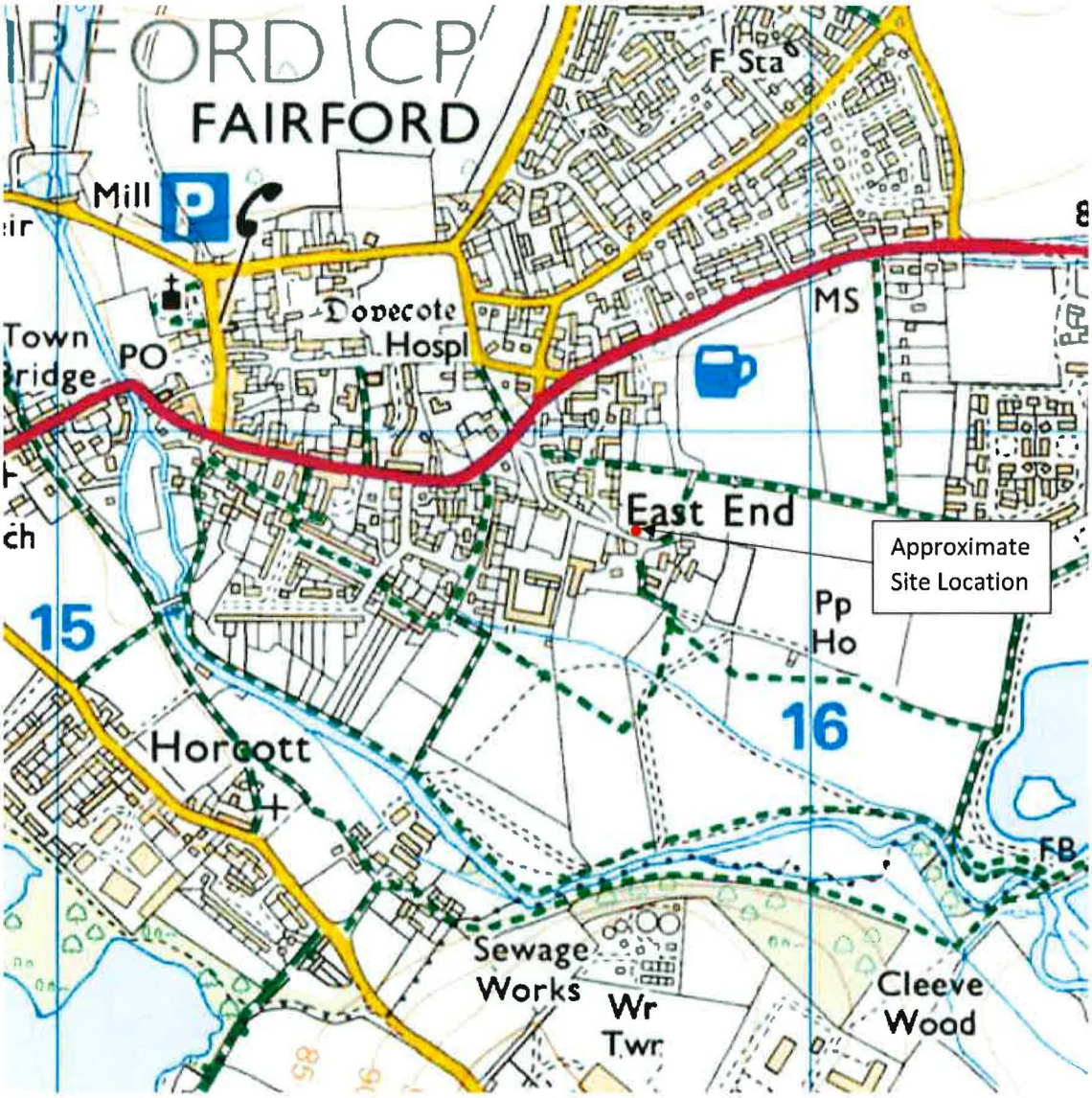
APPENDIX A

Site Location Plans

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071

229/2020

Site Location Plan 1 of 2: Site off Beaumoor Place, Fairford, Gloucestershire



LAND AT EAST END, FAIRFORD, GLOUCESTERHIRE, GL7 4AP

APPENDIX B

Proposed Layout Plan

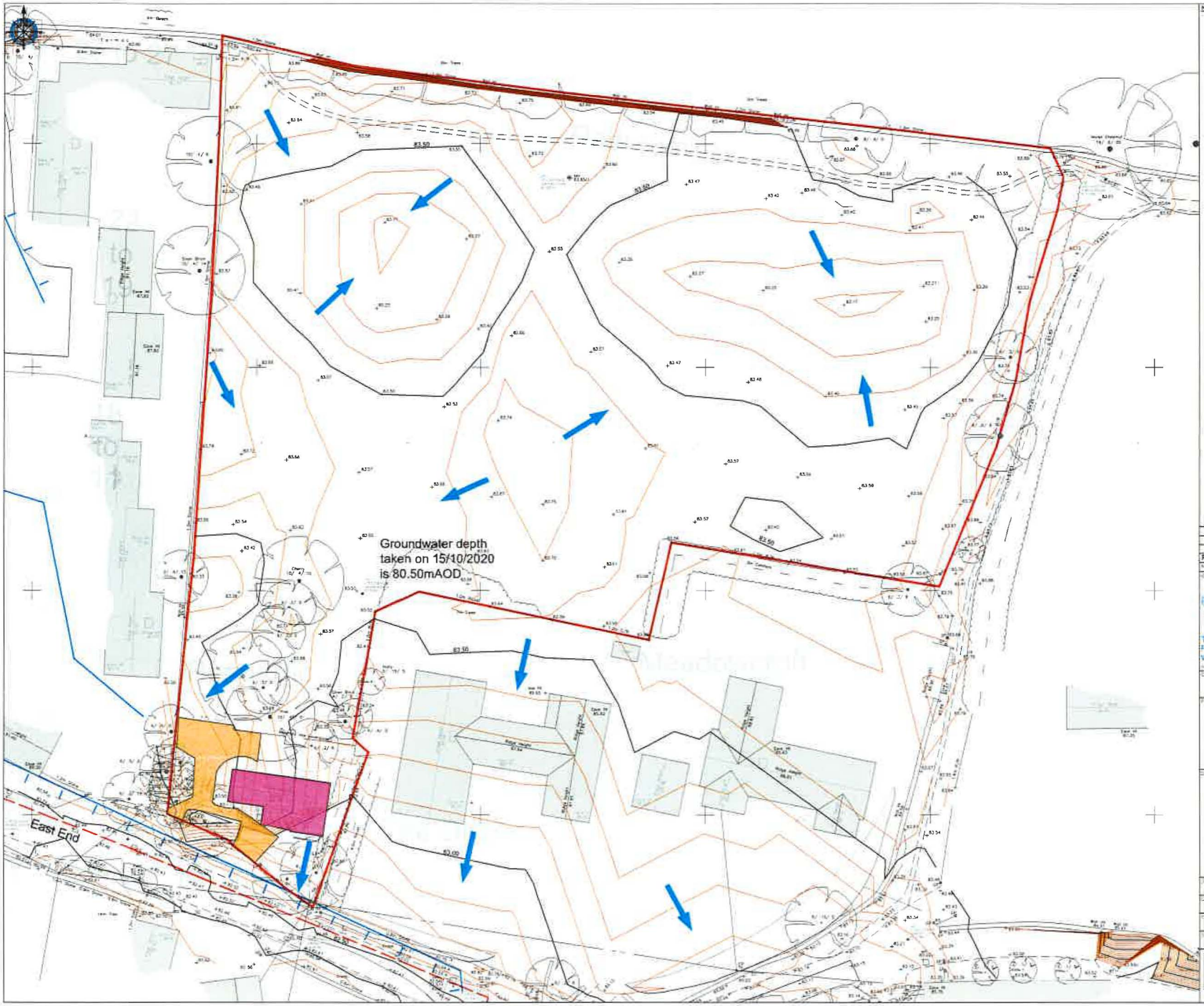
G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071


Path to surgery
Beaumoor Place
23 - 27
1 - 4
5 - 8
19 - 22
9 - 10
11 - 18
Cherry Tree Cottage
Acorn Cottage
East End
Surgery Car Park
Right of Way
Public Open Space
Track
10
9
8
3
4
2
5
(in roofspace)
6
7
Retirement Complex
1
The Divot
Meadowcroft
Moor Farm
Bridham
Schedule of Accommodation
Retirement Complex - 1 & 1.5 storey
Unit 1 - 61sqm 2 bed bungalow
Unit 2 - 61sqm 2 bed flat
Unit 3 - 50sqm 1 bed flat
Unit 4 - 61sqm 2 bed flat
Unit 5 - 61sqm 2 bed flat
Market Housing - 1.5 storey
Unit 6 - 93sqm 3 bed house
Unit 7 - 93sqm 3 bed house
Unit 8 - 110sqm 4 bed house
Unit 9 - 93sqm 3 bed house
Unit 10 - 130sqm 4 bed house
Earlswood
Job Title
East End, Fairford, Glos., GL7 4AP
Drawing Name
Sketch Scheme
5 Retirement Homes & 5 Market Houses
Client
Earlswood Homes Ltd
Drawing Scale
NTS
Layout ID
0509/01
Status
SK
Revision

APPENDIX C

Existing Site Drainage Layout – Drawing No. 229/2020/02

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071



NOTES:
1. This drawing is to be read in conjunction with GHB series 229/2020 drawings and documents and any other relevant project team documents.
2. Preliminary Issue - Any work undertaken before approvals are received (in writing) are at risk of abortive works
3. This drawing has been prepared solely for the purpose of obtaining a Planning Consent based on information available and planning requirements at the date of issue only.
4. This drawing is not to be used for construction or detailed pricing purposes
5. Drawing Based on a Topographical survey undertaken by D&H Surveys on OCT 2020

Legend-

- Site Boundary: 5 554m²
- Overland Flowpath
- Contour (0.1m)
- Contour (0.5m)
- Existing Impermeable Roof Area: 56m²
- Approximate Area of Impermeable Surfacing: 70m²
- Gulley- Highway Authority Surface Water Sewer
- Combined Sewer not owned by Thames Water
- Thames Water Foul Sewer

P2	03/11/2020	Title change

GHBullard & Associates LLP
27 Barton Road, Thurston, Suffolk, IP31 3PA
T: (01359) 235071
F: (01359) 231138
W: http://www.ghbullard.co.uk

Client: Earlswood Homes Ltd.

Project: Land Off East End, Fairford

Drawing Title: Existing Site Layout

Scale:	1:200 @ A1		
Date:	OCT 2020	Drawn: JWT	Checked: JAH
Drwg Reference:	229-2020.DWG		
Status:	FOR INFORMATION		
Drawing Number:	229/2020/02	Revision:	P2

APPENDIX D

Greenfield Runoff Calculations

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	1.000	Urban	0.000
SAAR (mm)	727	Region Number	Region 6

Results 1/s

QBAR Rural	3.6
QBAR Urban	3.6
Q100 years	11.3
Q1 year	3.0
Q30 years	8.1
Q100 years	11.3

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	0.202	Urban	0.000
SAAR (mm)	729	Region Number	Region 6

Results l/s

QBAR Rural	0.7
QBAR Urban	0.7
Q100 years	2.3
Q1 year	0.6
Q30 years	1.6
Q100 years	2.3

APPENDIX E

Thames Water Drainage and Water Search Report and Pre-planning Enquiry response

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071

Clean Water

Your reference: DS6078006

Your site address: Land off East End, Fairford, GL7 4AP.

Customer: Mrs Elizabeth Rahim

Clean water capacity report

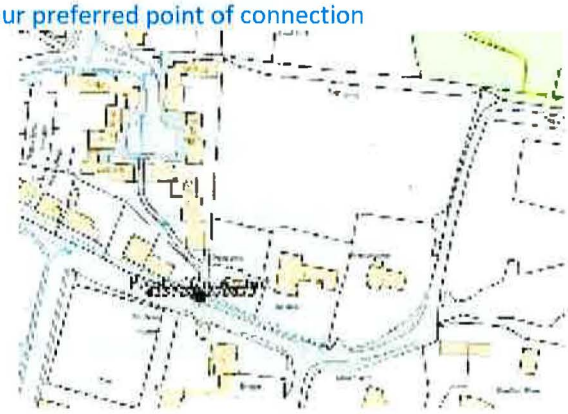
Status: Capacity confirmed
Date: 15.10.20
Validity: Valid until 15.04.21 or for the duration of your Local Authority planning permission when this report is used to support your application.

We confirm that there will be sufficient capacity in our clean water network to serve all properties of your development.

Please be aware that this report is based upon the details and drawings provided. If there are any subsequent changes to these, then the contents of this report will become invalid and a new assessment will be needed.

Please note that the below POC is based on desktop study and it might change after capacity check study or site-specific survey.

Nearest point of connection / Your preferred point of connection



Contaminated land

If your site is on contaminated land, any new water pipes laid should be barrier pipe which is more expensive. If you think this is not the case you will need to provide a soil report when applying for new mains and services.

Building water

It's important that you apply for a building water supply before you start using water on site even if you believe your supply is already metered. We need to ensure your account is properly set up and you have the correct meter for your supply or fines maybe imposed. Apply here.

Asset location search

If you need help in identifying the location of existing water mains and sewers, you can get this information from any property search provider. We have a Property Searches team who will carry out an asset location search, which provides information on the location of known Thames Water clean and/or wastewater assets, including details of pipe sizes, direction of flow and depth (for which a fee is payable). You can find out more online or by calling us on 0845 070 9148.

Quotation process

Please use links below to find out more information about water main and services connections, including application process. Click here for our home improvements website, or click here to apply for clean water services.

Mrs Elizabeth Rahim
By email
elizabeth@ghbullard.co.uk

Wastewater pre-planning
Our ref DS6078005-DTS **67261**

19 October 2020

Pre-planning enquiry: Confirmation of sufficient capacity- Land of East End, Fairford, Gloucestershire, GL7 4AP

Dear Elizabeth,

Thank you for providing information on your development 10 New houses and demolition of 1 existing. Foul discharging by gravity into FWM SP15007801, surface water to discharge into highway drainage.

We're pleased to confirm that there will be sufficient foul water capacity in our sewerage network to serve your development, so long as your phasing follows the timescale you've suggested.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

You'll need to keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient capacity.

What happens next?

Please make sure you submit your connection application, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me on the numbers below.

Yours sincerely

Jose Varela

Developer Services – Adoptions Engineer Mobile 07747 640250 Landline 02035 778753
jose.varela@thameswater.co.uk Clearwater Court, Vastern Road, Reading, RG1 8DB

Find us online at developers.thameswater.co.uk

Elizabeth Rahim

From: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Sent: 12 October 2020 11:52
To: Elizabeth Rahim
Subject: RE: COURTESY DS6078005
Attachments: pastedImage1

Good morning Elizabeth,

Many thanks for your Pre Planning application. Before we can check with our Asset Planner we need some comments on the following points please:

1) How many flats or houses are already (before development) inside the red boundary (are to be developed)

2) For information: Please note the surface water sewer to the south of the development is maintained by the Highways Authority according to our records. We recommend you to discuss your surface water draiange strategy with the Lead Local Flooding Authority ahead of designing the draiange strategy.

Kind regards

Jose Varela
Developer Services – Adoptions Engineer
Mobile 0756 424 7625 – Landline 0800 009 3921
jose.varela@thameswater.co.uk

Original Text

From: "DEVELOPER.SERVICES@THAMESWATER.CO.U" <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
To: elizabeth@ghbullard.co.uk
CC:
Sent: 10.10.20 15:06:25
Subject: COURTESY DS6078005

DS reference DS6078005

developer.services@thameswater.co.uk

0800 009 3921
Mon – Fri 8am – 5pm

thameswater.co.uk/developerservices

r email about?	Acknowledgement of application
ı need to do next?	Note your reference number
;	Land off East End Fairford GL7 4AP

m,

· your waste pre-development application at the above address. This has been passed to our technical team for assessment. ' ıss your application within 14 days.

ote of your reference number which is DS6078005. Should you need to contact us please quote this reference number.

questions, please call us on 0800 009 3921 between 8am and 5pm, Monday to Friday, or email developer.services@thamesw

rvices

naking your sewer connection correctly at connectright.org.uk

ing to this email, please note that we are unable to accept emails which are larger than our 15MB email size limit. If tiple or large files, please use a compression software, such as WINZIP to group your files together prior to sending ɔe in ZIP, RAR, 7Z, JPEG, PDF or PNG format. Thank you.'

: Thames Water Utilities Limited, Clearwater Court, Vastern Road, Reading RG1 8DB
2366661 Thames Water Utilities Limited is part of the Thames Water Plc group. VAT registration no GB 537-4569-15

Elizabeth Rahim

From: DEVELOPER.SERVICES@THAMESWATER.CO.U <DEVELOPER.SERVICES@THAMESWATER.CO.UK>
Sent: 15 October 2020 11:30
To: Elizabeth Rahim
Subject: Clean water capacity confirmed – DS6078006
Attachments: Land off East End Fairford GL7 4AP Clean Water Capacity Report.pdf

Your reference: DS6078006

Your site address: Land off East End, Fairford, GL7 4AP.

Our clean water network has capacity

Dear Mrs Elizabeth Rahim

We've completed the clean water capacity check on our network and we're happy to say that we have sufficient capacity for all of your development.

What do I need to do?

We've attached your **capacity report**. You can include this when making your local authority (LA) planning application to reduce the likelihood of planning conditions being applied.

Please note the validity period indicated on your capacity report. Don't forget to let us know if your plan changes, such as an increase in the number of properties, as we'll need to check that our network still has the necessary capacity.

What happens next?

When you're ready to move ahead with a water supply for your new development you can:

1. Engage an independent installer or supplier, known as a self-lay provider or NAV
2. Apply to us

Can I speak to someone?

As your dedicated contact for your clean water pre-planning enquiry, I'm here if you need a hand.

Just call me on the number below.

Yours sincerely,

Miguel Villar
Developer Services – CAD & Network Coordinator
Phone 0203 577 8737

Miguel.Villar@thameswater.co.uk

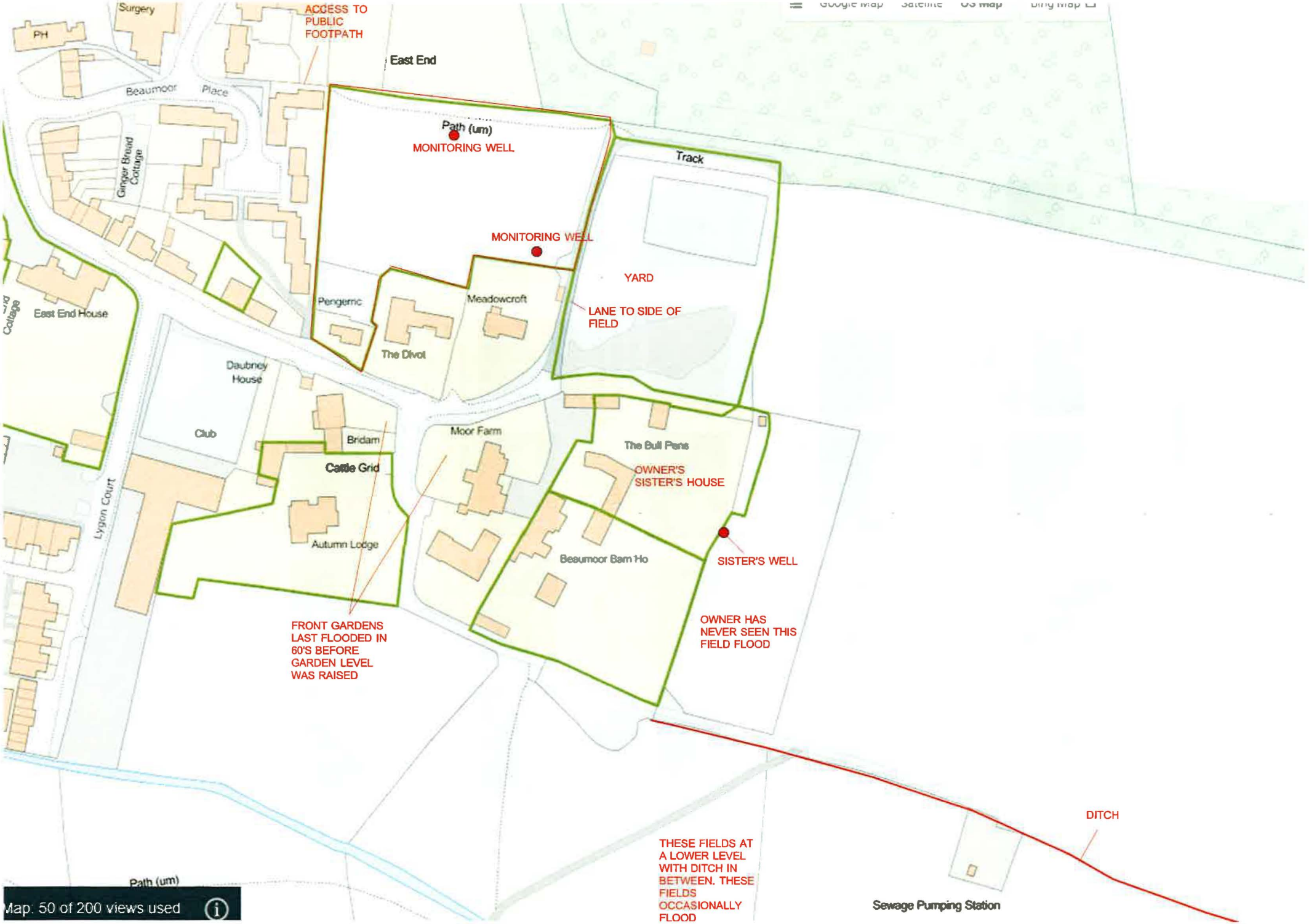
Visit us online www.thameswater.co.uk , follow us on twitter www.twitter.com/thameswater or find us on www.facebook.com/thameswater. We're happy to help you 24/7.

APPENDIX G

Historical Information relating to Flooding and Groundwater Levels
Groundwater Monitoring and Site Borehole Logs

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071


Google Map
Satellite
OS Map
Bing Map
MONITORING WELL
MONITORING WELL
LANE TO SIDE OF FIELD
OWNER'S SHETTY'S HOUSE
SHETTY'S WELL
DITCH
THESE FIELDS ARE A LOWER LEVEL WITH DITCH IN BETWEEN THESE FIELDS OCCASIONALLY FLOOD


ACCESS TO PUBLIC FOOTPATH
East End
Surgery
PH
Beaumoor Place
Ginger Bread Cottage
Path (um)
MONITORING WELL
Track
MONITORING WELL
YARD
LANE TO SIDE OF FIELD
East End House
Pengernc
Meadowcroft
The Divot
Daubney House
Club
Bridam
Cattle Grid
Moor Farm
The Bull Pens
OWNER'S SISTER'S HOUSE
Lygon Court
Autumn Lodge
Beaumoor Barn Ho
SISTER'S WELL
FRONT GARDENS LAST FLOODED IN 60'S BEFORE GARDEN LEVEL WAS RAISED
OWNER HAS NEVER SEEN THIS FIELD FLOOD
DITCH
THESE FIELDS AT A LOWER LEVEL WITH DITCH IN BETWEEN. THESE FIELDS OCCASIONALLY FLOOD
Path (um)
Sewage Pumping Station
Map: 50 of 200 views used

229/2020 Beaumoor Place, Fairford : Site Visit Photograph Index

Access from north west corner to Beaumoor Pace

Access from public footpath to Beaumoor Place

Ditch along adjoining field

Heras fencing to front of mobile home

lane on east side of site

Lane running to east side of field

Lane running to side of site with yard to right

Length of pole approx 4m a

Length of pole approx 4m

Mobiole home

monitoring well on south side of site

Neighbouring house to mobile home

Neighbouring houses

Owner standing in his sisters well several years ago

Owner with pole going into monitoring well

Public footpath along north boundary

Public footpath running along northern boundary of site

Site to the left, adjoining yard in front

Some damp at bottom 30cm of pole after putting in well

Vew from Beaumoor PLace towards public footpath

View from Beumoor Place towards public footpath on th...

View from east of site towards Beaumoor Place

View from south east corner of site







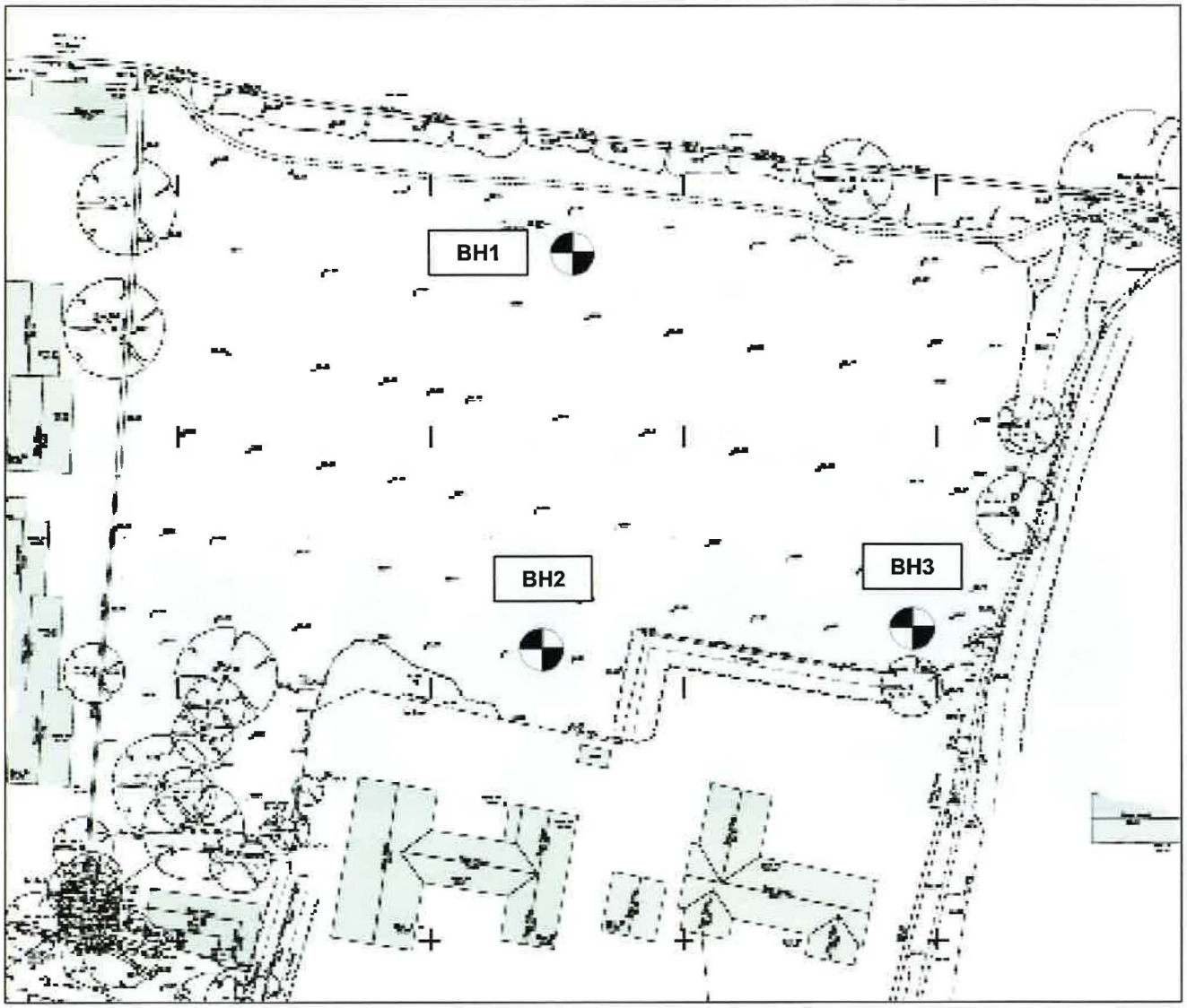












Key

Groundwater Monitoring Borehole

N

Do Not Scale

NottGroup

Title:	**Appendix A - Borehole Location Plan**
Project Name:	**Fairford**
Client:	**Earlswood Homes**
Project No: **73047**	Date: **18/01/2021**
Drawing No **1**	

Fairford, Glos	Depth of Groundwater (m below ground level)

Borehole Reference	Date			
	17/01/2021	**18/02/2021**	**25/03/2021**	**22/04/2021**
WS1	1.49	1.40	1.90	1.93
WS2	1.90	1.93	2.16	2.18
WS3	1.75	1.76	2.03	2.02
Borehole Reference	**Date**			
	14/05/2021	**08/06/2021**	**15/07/2021**	**18/08/2021**
WS1	2.08	1.80	1.95	1.85
WS2	2.24	2.27	2.10	2.20
WS3	2.13	2.04	2.08	2.05
Borehole Reference	**Date**			
	14/09/2021	**08/10/2021**	**05/11/2021**	**14/12/2021**
WS1	1.95	1.96	1.94	1.95
WS2	2.05	2.05	2.26	2.01
WS3	2.06	2.08	2.13	1.98

Borehole Reference	Date			
	15/01/2022	**17/02/2022**		
WS1	1.44	1.60		
WS2	1.89	2.03		
WS3	1.69	1.88		
Borehole Reference	**Date**			
WS1				
WS2				
WS3				
Borehole Reference	**Date**			
WS1				
WS2				
WS3				

DRILLHOLE LOG

Project				DRILLHOLE No
Fairford				BH1
Job No	Date	Ground Level (m)	Co-Ordinates ()	
73047	07-01-21			
Contractor				Sheet
Nott Group				1 of 1

RUN DETAILS				STRATA					
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities	Detail	Main	Geology / Instrument / Backfill
					(0.25) 0.25			Grass over firm friable dark brown slightly sandy CLAY with frequent roots and rootlets. (Topsoil).	
0.85					(0.60) 0.85			Light brown slightly gravelly slightly silty SAND with occasional comminuted shell fragments. Gravel is fine sub angular limestone.	
2.35	100 (0) 0				(2.65)			Weak light greyish brown and light brown shelly LIMESTONE. Discontinuities are horizontal locally sub vertical intersecting very closely to closely spaced stepped and undulating rough with light brown clayey sand infill and brown staining.	
3.50	100 (22) 7				3.50				

Drilling Progress and Water Observations							Rotary Flush				GENERAL REMARKS
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns	

All dimensions in metres Scale 1:22.5	Client Earlswood Homes	Method/ Plant Used Comacchio 205	Logged By EB

AGS3 UK DH FAIRFORD.GPJ GINT STD AGS 3_1.GDT 16/3/22

DRILLHOLE LOG

Project				DRILLHOLE No
Fairford				BH2
Job No	Date	Ground Level (m)	Co-Ordinates ()	
73047	07-01-21			
Contractor				Sheet
Nott Group				1 of 1

RUN DETAILS				STRATA					
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities	Detail	Main	Geology / Instrument / Backfill
					(0.32) 0.32			Grass over firm friable dark brown slightly sandy CLAY with frequent roots and rootlets. (Topsoil).	
0.95					(0.63) 0.95			Light brown slightly gravelly slightly silty SAND with occasional comminuted shell fragments. Gravel is fine sub angular limestone.	
2.45	100 (75) 51				(3.15)			Weak light greyish brown and light brown shelly LIMESTONE. Discontinuties are horizontal locally sub vertical intersecting very closely to closely spaced stepped and undulating rough with light brown clayey sand infill and brown staining.	
4.10	100 (100) 88				4.10				

Drilling Progress and Water Observations							Rotary Flush				GENERAL REMARKS
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns	

All dimensions in metres Scale 1:26.25	Client Earlswood Homes	Method/ Plant Used Comacchio 205	Logged By EB

AGS3 UK DH FAIRFORD.GPJ GINT STD AGS 3_1.GDT 16/3/22

DRILLHOLE LOG

Project				DRILLHOLE No
Fairford				BH3
Job No	Date	Ground Level (m)	Co-Ordinates ()	
73047	07-01-21			
Contractor				Sheet
Nott Group				1 of 1

RUN DETAILS				STRATA				
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities	Detail	Main	Geology	Instrument/ Backfill
					(0.27) 0.27			Grass over firm friable dark brown slightly sandy CLAY with frequent roots and rootlets. (Topsoil).		
0.90					(0.63) 0.90			Light brown slightly gravelly slightly silty SAND with occasional comminuted shell fragments. Gravel is fine sub angular limestone.		
2.40	100 (22) 7				(3.00)			Weak light greyish brown and light brown shelly LIMESTONE. Discontinuities are horizontal locally sub vertical intersecting very closely to closely spaced stepped and undulating rough with light brown clayey sand infill and brown staining.		
3.90	100 (92) 71				3.90					

Drilling Progress and Water Observations							Rotary Flush				GENERAL REMARKS
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns	

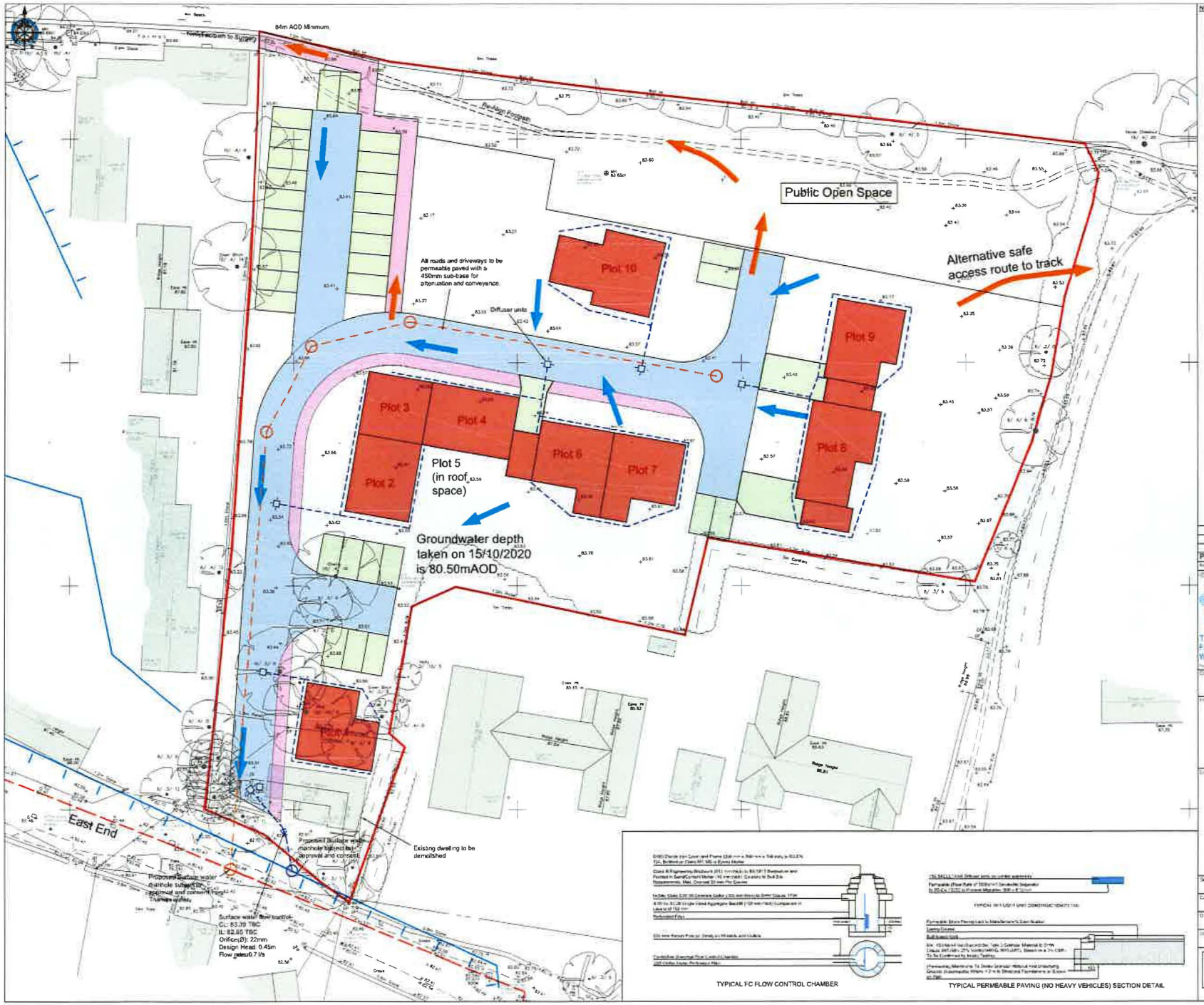
All dimensions in metres Scale 1:25	Client Earlswood Homes	Method/ Plant Used Comacchio 205	Logged By EB

AGS3 UK DH FAIRFORD.GPJ GINT STD AGS 3_1.GDT 16/3/22

APPENDIX H

Proposed Drainage Strategy and Flood Resilience Measures – Drawing No. 229/2020/03

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071



NOTES:

1. This drawing is to be read in conjunction with GHB series 229/2020 drawings and documents and any other relevant project team documents.
2. Preliminary Issue - Any work undertaken before approvals are received (in writing) are at risk of abortive works.
3. This drawing has been prepared solely for the purpose of obtaining a Planning Consent based on information available and planning requirements at the date of issue only.
4. This drawing is not to be used for construction or detailed pricing purposes.
5. Drawing Based on a Topographical survey undertaken by D&H Surveys on OCT 2020.

P2	03/11/2020	Title change

GHBullard & Associates LLP
Civil and Traffic Engineering Consultants
27 Barton Road, Thurston, Suffolk, IP31 3PA
T: (01359) 235071
F: (01359) 231136
W: http://www.ghbullard.co.uk

Client: Earlswood Homes Ltd.

Project: Land Off East End, Fairford

Drawing Title: Proposed Site Plan Layout and Drainage Strategy

Scale:	1:200 @ A1		
Date:	OCT 2020	Drawn: JWT	Checked: ER
CAD Reference:	229-2020.DWG		
Status:	FOR INFORMATION		
Drawing Number:	229/2020/03	Revision:	P2

APPENDIX I

Micro-Drainage Design Calculations

G.H. Bullard & Associates LLP,
27 Barton Road, Thurston, Suffolk, IP31 3PA
Tel: 01359 235071

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	82.728	0.078	0.3	29.5	O K
30 min Summer	82.751	0.101	0.3	38.2	O K
60 min Summer	82.774	0.124	0.3	47.3	O K
120 min Summer	82.799	0.149	0.4	56.5	O K
180 min Summer	82.812	0.162	0.4	61.7	O K
240 min Summer	82.822	0.172	0.4	65.2	O K
360 min Summer	82.834	0.184	0.4	69.9	O K
480 min Summer	82.842	0.192	0.4	72.9	O K
600 min Summer	82.847	0.197	0.4	75.0	O K
720 min Summer	82.851	0.201	0.4	76.4	O K
960 min Summer	82.855	0.205	0.4	78.0	O K
1440 min Summer	82.857	0.207	0.4	78.6	O K
2160 min Summer	82.856	0.206	0.4	78.4	O K
2880 min Summer	82.854	0.204	0.4	77.6	O K
4320 min Summer	82.847	0.197	0.4	74.9	O K
5760 min Summer	82.838	0.188	0.4	71.6	O K
7200 min Summer	82.829	0.179	0.4	68.2	O K
8640 min Summer	82.821	0.171	0.4	64.8	O K
10080 min Summer	82.812	0.162	0.4	61.7	O K
15 min Winter	82.737	0.087	0.3	33.0	O K
30 min Winter	82.763	0.113	0.3	42.8	O K
60 min Winter	82.790	0.140	0.4	53.0	O K
120 min Winter	82.817	0.167	0.4	63.3	O K
180 min Winter	82.832	0.182	0.4	69.2	O K
240 min Winter	82.843	0.193	0.4	73.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	76.035	0.0	17.5	23
30 min Summer	49.499	0.0	21.1	38
60 min Summer	30.811	0.0	38.9	68
120 min Summer	18.615	0.0	45.2	126
180 min Summer	13.715	0.0	48.5	186
240 min Summer	10.995	0.0	50.6	246
360 min Summer	8.034	0.0	53.4	364
480 min Summer	6.428	0.0	55.2	484
600 min Summer	5.404	0.0	56.3	604
720 min Summer	4.687	0.0	57.1	722
960 min Summer	3.743	0.0	57.8	962
1440 min Summer	2.723	0.0	57.2	1282
2160 min Summer	1.979	0.0	98.9	1628
2880 min Summer	1.577	0.0	100.5	2020
4320 min Summer	1.143	0.0	97.6	2856
5760 min Summer	0.910	0.0	133.5	3688
7200 min Summer	0.762	0.0	139.1	4472
8640 min Summer	0.659	0.0	143.0	5280
10080 min Summer	0.583	0.0	144.6	6056
15 min Winter	76.035	0.0	19.0	23
30 min Winter	49.499	0.0	22.8	37
60 min Winter	30.811	0.0	42.8	66
120 min Winter	18.615	0.0	49.2	124
180 min Winter	13.715	0.0	52.7	184
240 min Winter	10.995	0.0	54.9	242

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
360 min Winter	82.857	0.207	0.4	78.6	O K
480 min Winter	82.866	0.216	0.5	82.1	O K
600 min Winter	82.873	0.223	0.5	84.6	O K
720 min Winter	82.877	0.227	0.5	86.3	O K
960 min Winter	82.883	0.233	0.5	88.4	O K
1440 min Winter	82.886	0.236	0.5	89.5	O K
2160 min Winter	82.883	0.233	0.5	88.6	O K
2880 min Winter	82.880	0.230	0.5	87.2	O K
4320 min Winter	82.868	0.218	0.5	82.9	O K
5760 min Winter	82.855	0.205	0.4	77.8	O K
7200 min Winter	82.841	0.191	0.4	72.7	O K
8640 min Winter	82.828	0.178	0.4	67.8	O K
10080 min Winter	82.817	0.167	0.4	63.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	8.034	0.0	57.9	360
480 min Winter	6.428	0.0	59.7	476
600 min Winter	5.404	0.0	60.9	592
720 min Winter	4.687	0.0	61.7	706
960 min Winter	3.743	0.0	62.3	932
1440 min Winter	2.723	0.0	61.7	1368
2160 min Winter	1.979	0.0	108.5	1712
2880 min Winter	1.577	0.0	109.8	2164
4320 min Winter	1.143	0.0	106.2	3072
5760 min Winter	0.910	0.0	149.6	3976
7200 min Winter	0.762	0.0	155.7	4824
8640 min Winter	0.659	0.0	159.7	5624
10080 min Winter	0.583	0.0	160.7	6456

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.208

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.104	4	8	0.104

Model Details

Storage is Online Cover Level (m) 83.300

Tank or Pond Structure

Invert Level (m) 82.650

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	380.0	0.450	380.0	0.451	0.0

Orifice Outflow Control

Diameter (m) 0.022 Discharge Coefficient 0.600 Invert Level (m) 82.650

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	82.791	0.141	0.4	53.6	O K
30 min Summer	82.835	0.185	0.4	70.2	O K
60 min Summer	82.880	0.230	0.5	87.4	O K
120 min Summer	82.925	0.275	0.5	104.5	O K
180 min Summer	82.950	0.300	0.5	114.1	O K
240 min Summer	82.967	0.317	0.6	120.4	O K
360 min Summer	82.989	0.339	0.6	128.9	O K
480 min Summer	83.004	0.354	0.6	134.6	Flood Risk
600 min Summer	83.015	0.365	0.6	138.7	Flood Risk
720 min Summer	83.023	0.373	0.6	141.6	Flood Risk
960 min Summer	83.032	0.382	0.6	145.2	Flood Risk
1440 min Summer	83.038	0.388	0.6	147.6	Flood Risk
2160 min Summer	83.036	0.386	0.6	146.5	Flood Risk
2880 min Summer	83.031	0.381	0.6	144.9	Flood Risk
4320 min Summer	83.020	0.370	0.6	140.5	Flood Risk
5760 min Summer	83.006	0.356	0.6	135.1	Flood Risk
7200 min Summer	82.991	0.341	0.6	129.6	O K
8640 min Summer	82.976	0.326	0.6	124.0	O K
10080 min Summer	82.962	0.312	0.6	118.6	O K
15 min Winter	82.808	0.158	0.4	60.0	O K
30 min Winter	82.857	0.207	0.4	78.7	O K
60 min Winter	82.908	0.258	0.5	97.9	O K
120 min Winter	82.958	0.308	0.6	117.2	O K
180 min Winter	82.987	0.337	0.6	128.0	O K
240 min Winter	83.006	0.356	0.6	135.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	26.4	23
30 min Summer	90.705	0.0	31.2	38
60 min Summer	56.713	0.0	61.8	68
120 min Summer	34.246	0.0	69.8	128
180 min Summer	25.149	0.0	73.9	186
240 min Summer	20.078	0.0	76.4	246
360 min Summer	14.585	0.0	79.7	366
480 min Summer	11.622	0.0	81.6	486
600 min Summer	9.738	0.0	82.8	604
720 min Summer	8.424	0.0	83.5	724
960 min Summer	6.697	0.0	83.8	962
1440 min Summer	4.839	0.0	82.1	1440
2160 min Summer	3.490	0.0	152.5	1836
2880 min Summer	2.766	0.0	151.9	2196
4320 min Summer	1.989	0.0	143.8	2984
5760 min Summer	1.573	0.0	229.3	3808
7200 min Summer	1.311	0.0	234.7	4616
8640 min Summer	1.129	0.0	234.2	5448
10080 min Summer	0.994	0.0	228.8	6256
15 min Winter	138.153	0.0	28.4	23
30 min Winter	90.705	0.0	33.5	37
60 min Winter	56.713	0.0	66.7	66
120 min Winter	34.246	0.0	75.2	126
180 min Winter	25.149	0.0	79.5	184
240 min Winter	20.078	0.0	82.2	242

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
360 min Winter	83.031	0.381	0.6	144.9	Flood Risk
480 min Winter	83.049	0.399	0.6	151.5	Flood Risk
600 min Winter	83.061	0.411	0.6	156.2	Flood Risk
720 min Winter	83.070	0.420	0.6	159.7	Flood Risk
960 min Winter	83.082	0.432	0.7	164.2	Flood Risk
1440 min Winter	83.092	0.442	0.7	167.9	Flood Risk
2160 min Winter	83.090	0.440	0.7	167.1	Flood Risk
2880 min Winter	83.082	0.432	0.7	164.2	Flood Risk
4320 min Winter	83.066	0.416	0.6	157.9	Flood Risk
5760 min Winter	83.045	0.395	0.6	150.1	Flood Risk
7200 min Winter	83.024	0.374	0.6	142.0	Flood Risk
8640 min Winter	83.003	0.353	0.6	134.1	Flood Risk
10080 min Winter	82.983	0.333	0.6	126.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	14.585	0.0	85.6	360
480 min Winter	11.622	0.0	87.6	478
600 min Winter	9.738	0.0	88.8	594
720 min Winter	8.424	0.0	89.5	710
960 min Winter	6.697	0.0	89.9	940
1440 min Winter	4.839	0.0	88.0	1388
2160 min Winter	3.490	0.0	165.2	2028
2880 min Winter	2.766	0.0	164.3	2284
4320 min Winter	1.989	0.0	155.3	3200
5760 min Winter	1.573	0.0	255.4	4104
7200 min Winter	1.311	0.0	259.2	4976
8640 min Winter	1.129	0.0	257.3	5880
10080 min Winter	0.994	0.0	250.6	6752

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.208

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.104	4	8	0.104

Model Details

Storage is Online Cover Level (m) 83.300

Tank or Pond Structure

Invert Level (m) 82.650

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	380.0	0.450	380.0	0.451	0.0

Orifice Outflow Control

Diameter (m) 0.022 Discharge Coefficient 0.600 Invert Level (m) 82.650