Hilfield Solar Farm and Battery Storage

Flood Risk Assessment

on behalf of Elstree Green Limited

Prepared by RMA Environmental | December 2020 |
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FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

Hilfield Solar Farm and Battery Storage

Land North East and West of Elstree Aerodrome
Watford
Hertfordshire
WD25 8DD

Prepared for:
Elstree Green Limited

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1 INTRODUCTION

Background

1.1 RMA Environmental Limited was commissioned by Aardvark EM Limited on behalf of Elstree Green Limited to prepare a Flood Risk Assessment (FRA) to support a full planning application for a proposed solar farm and battery storage facility ("the Proposed Development") on land North East and West of Elstree Aerodrome near Watford, Hertfordshire, WD25 8DD ("the Site").

1.2 This FRA has been prepared in accordance with the National Planning Policy Framework (NPPF), associated Planning Practice Guidance (PPG) and Environment Agency (EA) standing advice on flood risk for new development.

Site Location and Land Use

1.3 The Site comprises greenfield land which is currently in agricultural use; it extends to an area of approximately 130.6 hectares (ha) and is located at National Grid Reference TQ 15200 96600 (refer to Figure 1.1). The Proposed Development is formed by three parcels of land (refer to Appendix A); the western parcel of land comprises Field 1, the central parcel of land comprises Fields 2 to 5 and the eastern parcel of land comprises Fields 7 to 20 (field 6 has been removed from the original scheme).

1.4 The Site is located in a semi-suburban setting, with localised intrusion of man-made features areas. The Site is bordered by the following land-uses:

- Hilfield Lane bisects the western and central parcel of land;
- North Western Avenue Tylers Way (A41) is located to the south of the Field 1;
- M1 is located to the south-west of Field 1, beyond the A41;
- Hilfield Park Reservoir is located to the east of Field 1;
- London Elstree Aerodrome is located to the south-east of the Field 5;
- commercial development is located to the south-west of Field 3;
- National Grid Elstree Substation is located to the north-west of the Fields 2 to 5;
- Watling Street is located to the east of the Field 14;
- Butterfly Lane is located to the south of the eastern parcel of land, beyond which lies Aldenham Park and The Haberdashers' Aske's Boys School; and
- Aldenham Road and Aldenham School are located to the west and north-west of the eastern parcel of land respectively.

1.5 Access to Field 1 is via an existing agricultural field access from Hilfield Lane. The central parcel of land is accessed via the existing access to Hilfield Farm from Hilfield Lane. Access to the eastern parcel of land is via the existing access to Slades Farm from Butterfly Lane.

1.6 Further details on Site topography, geology and hydrology are set out in Section 2.

Proposed Development

1.7 The Proposed Development comprises the construction, operation, management and decommissioning of a grid connected solar farm with battery storage and associated infrastructure ("the generating station"). The generating station would supply up to 49.9 MW of clean renewable electricity to the National Grid for c. 35 years. The battery storage facility would be utilised to reinforce the power generation of the solar farm, storing energy at times of low demand and releasing to the grid in periods of higher demand or when solar irradiance is lower, as well as providing balancing services to maintain National Grid stability. The Proposed Site Layout is contained within the Planning Application Drawing Pack (Drawing No: HF2.0) accompanying the application.

1.8 The metal framework that supports the solar panels would be fixed into the ground by posts, which would be pile-driven to a depth of around 2 m to 2.5 m (i.e. no concrete foundations). Solar panels would be laid out in rows with gaps of approximately 3 m – 4.5 m between each row depending on the topography of particular fields.

1.9 Solar panels will be mounted on framework which incorporates a fixed tilt system (Drawing No: HF3.0).

1.10 The Site would be accessed via the existing access points. These access routes would be used during both the construction and operational phases.

Requirements for a Flood Risk Assessment

1.11 The requirements for FRA are provided in the NPPF and associated PPG. Paragraph 163 of the NPPF (2019) requires that a site-specific FRA should be submitted with planning applications for:

- all sites greater than 1 ha in Flood Zone 1;
- for sites of any size within Flood Zones 2 or 3;
- in an area within Flood Zone 1 which has critical drainage problems;
- in an area within Flood Zone 1 which is identified in a strategic flood risk assessment as being at increased flood risk in the future; and/or
- an area within Flood Zone 1 that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

1.12 The EA's Flood Zones are defined as follows:

- Flood Zone 1 is defined as land with little or no flood risk (an annual exceedance probability [AEP] of flooding of less than 0.1%);
- Flood Zone 2 is defined as having a medium flood risk (an AEP of between 0.1% and 0.5% for tidal areas or 0.1% and 1.0% for rivers); and
- Flood Zone 3 is defined as high risk (with an AEP of greater than 0.5% for tidal areas or greater than 1.0% for rivers).

1.13 FRAs should describe and assess all flood risks (from rivers, the sea, surface water, sewers, reservoirs and groundwater) to and from the development and demonstrate how they will be managed, including an evaluation of climate change effects.

Consultation

1.14 Consultation has been undertaken with the EA to confirm the approach of the FRA (refer to Appendix B).

2 BASELINE ENVIRONMENTAL CONDITIONS

Topography

2.1 A site-specific topographical survey has been undertaken which indicates that in general the Site is characterised by gentle to moderate gradients ranging from approximately 1 in 83 to 1 in 23 (refer to Appendix C).

2.2 Field 1 slopes downwards in a north-easterly and south-westerly direction towards the Hilfield Brook. The highest level is approximately 94.80 mAOD in the south-eastern corner, falling to 72.82 mAOD in the northern corner.

2.3 The highest level within Fields 2 to 5 is approximately 98.20 along the eastern boundary of Field 5 falling to approximately 75.56 mAOD along the western boundary of Field 2. Fields 2, 3 and 5 slope downwards in a westerly direction and Field 4 slopes downwards in a south-westerly direction.

2.4 For Fields 7 to 20, levels range between 91.85 along the southern boundary of Field 20 to approximately 80.14 mAOD along the southern boundary of Field 13. Field 18 slopes in a northerly direction and the majority of Field 12 slopes in a north-easterly direction. Fields 8 and 16 slope downwards in an easterly direction. Fields 11 slopes downwards in a southerly direction and Fields 4, 9 and 10 slope downwards in a south-westerly direction. Fields 7 and 19 slope downwards in a westerly direction, whilst Fields 14 and 17 slope in a north-westerly direction towards the Aldenham Brook.

2.5 The northern part of Field 13 slopes downwards in a southerly direction and the southern part slopes downwards in a northerly direction towards the Aldenham Brook. The majority of Field 15 slopes in a north-westerly direction towards the Aldenham Brook with the eastern part sloping in a north-easterly direction. Field 20 slopes in multiple directions towards the Aldenham Brook and Aldenham Tributary.

Hydrology

2.6 A number of 'main rivers'[1] and 'ordinary watercourses'[2] are located within and surrounding the Site (refer to Figure 2.1).

2.7 Hilfield Brook is located within Field 1 and is classified by the EA as a 'main river'. This watercourse originates from Hilfield Park Reservoir and at the Site location Hilfield Brook has a catchment area of approximately 1.53 km^2 and flows in a north-westerly direction.

[1] Main river is defined by the EA as any watercourse that contributes significantly to the hydrology of a catchment.

[2] Ordinary watercourse is defined by the EA as any watercourse including every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a main river.

2.8 An unnamed watercourse (hereafter referred to as Aldenham Brook) flows through Fields 8, 9, 13, 14, 15 and 20 and is classified as a 'main river'. At the Site location, Aldenham Brook has a small catchment area of approximately 2.41 km^2 and flows in a north-easterly direction into Tykes Water, a 'main river', approximately 880 m to the north-east of the site.

2.9 An unnamed watercourse (hereafter referred to as Aldenham Tributary) flows through Fields 19 and 20 and is classified as an 'ordinary watercourse'. This watercourse flows in a northerly direction and the Flood Estimation Handbook (FEH) Web Service map does not define the catchment area of this watercourse as it is smaller than 0.5 km^2. This watercourse is a tributary of the Aldenham Brook which it joins along the northern boundary of Field 20.

2.10 Ordnance Survey (OS) mapping and the topographical survey (refer to Appendix C) indicates a number of land drains are located within Fields 2, 3 and 5 which flow in a north-westerly direction towards the Hilfield Brook and a number of land drains located within Fields 7 to 17, Field 19 and Field 20 which either flow towards the Aldenham Brook or in a southerly direction (refer to Figure 2.1). The Flood Estimation Handbook (FEH) Web Service map does not define the catchment areas of these watercourses because they are smaller than 0.5 km^2.

2.11 OS mapping has identified that two ponds are located in the northern part of Fields 3 and 5 and five ponds are located within Fields 11, 12, 13 and 15. The topographical survey only identified three ponds within Fields 11, 12 13 and 15; however, some of the surface water features may not have been identified due to dense vegetation (refer to Appendix C).

2.12 A waterbody covering an area of approximately 5200 m^2 is located immediately adjacent to the eastern boundary of Field 1.

2.13 Hilfield Park Reservoir covering an area of approximately 450,000 m^2 is located approximately 170 m to the east of Field 1.

2.14 There are no other significant watercourses or water bodies within the surrounding area.

Geology and Hydrogeology

2.15 When reviewing the British Geological Survey (BGS) online map viewer, the Site is not underlain by any superficial geology and the majority of the site is underlain by the bedrock geology of the London Clay Formation comprising clay, silt and sand. The northern corner of Field 1, the majority of Fields 2 and 12 are underlain by the bedrock geology of the Lambeth Group comprising clay, silt and sand.

2.16 The EA classify the London Clay Formation, as Unproductive Strata; these are defined as *"rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow".*

2.17 The EA classify the Lambeth Group as Secondary A Aquifer; these are defined as *"permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers."*

2.18 The Site is not located within a groundwater Source Protection Zone (SPZ).

3 EXTERNAL FLOOD RISK

Flooding Mechanisms

3.1 The Environment Agency's (EA's) flood map for planning (refer to Figure 3.1) indicates that the majority of the site is located within Flood Zone 1 (low risk). An area of Flood Zone 2 and 3 (medium and high risk, respectively) is located in the north-western part of Field 1 associated with Hilfield Brook. The flood risk is considered to be only from fluvial sources which is discussed further below.

3.2 The EA's risk of flooding from surface water mapping identifies that the majority of the Site has a very low risk of flooding from surface water and some small areas have up to a high surface water flood risk (refer to Figure 3.2). This is discussed further below.

3.3 The Hertsmere Borough Council Strategic Flood Risk Assessment (SFRA; AECOM, 2018) indicates that western parcel and the majority of the central parcel of land lies within a postcode area with between 1 and 5 records of Thames Water sewer flooding and the eastern parcel of land and the eastern part of Field 5 lies within a postcode area with between 41 and 70 records of Thames Water sewer flooding incidents. No further details are given on the location or extent of these records and, given that the Proposed Development does not require a sewer connection, the Site is not considered to be at a significant risk of flooding from this source.

3.4 The SFRA (AECOM, 2018) indicates that the Site is located within an area that is '*not considered to be prone to groundwater flooding'*. According to two borehole records within the London Clay Formation deposits, groundwater was encountered at 2.13 metres below ground level (mbgl; BGS Reference: TQ19NW151, along the southern boundary of Field 1) and was not encountered within a borehole 30.8 m deep (BGS Reference: TQ19NW150, along the western boundary of Field 1). According to a borehole record 45 m to the north of Field 1 within the Lambeth Group deposit, groundwater was encountered at 1.83 mbgl (BGS Reference: TQ19NW148). Any groundwater flooding is likely to be shallow and can be mitigated alongside measures proposed for fluvial and surface water flooding.

3.5 A review of the EA's reservoir flood risk map identifies that part of the Site is at risk from reservoir flooding from the Hilfield Reservoir (refer to Figure 3.3).

3.6 A review of the SFRA and EA flood maps, has identified that the principal risks to the Site are from fluvial and surface water flooding which forms the focus of the assessment below.

Historic Flooding

3.7 The SFRA (AECOM, 2018) identifies that a record of flooding due to land drainage occurred in the north-western corner of Field 2. This record of flooding is considered to be related to the surface water flood extent in this area.

3.8 The EA's historic flood map indicates that there are no historic flood records for the Site or surrounding area.

3.9 During pre-application consultation, anecdotal information was received that surface water runoff from Fields 7 and 20 flows onto Aldenham Road; however, from a review of the site topography this is not considered possible since the Site drains away from Aldenham Road.

3.10 Additional information during the pre-application consultation indicated that the land drain from Haberdasher's playing fields that discharges into Field 19 is poorly maintained and this is identified on the EA's surface water flood map. However, the proposed mitigation outlined below will maintain the existing hydrological response of the Site and, therefore, the Proposed Development will not increase flood risk to this area.

Fluvial Flood Risk

Hilfield Brook

3.11 Detailed flood data for the Hilfield Brook was received from the EA is included as Appendix D. This flood data shows that the 1%, 1% AEP plus 20% climate change (CC) and 0.1% AEP defended flood extents are confined to the channel of the Hilfield Brook when compared to the topographical survey. Therefore, the Proposed Development will not be adversely affected by flooding from the Hilfield Brook.

Climate Change

3.12 The operational lifetime of the development is 35 years and, therefore, the climate change allowances for the period 2040 to 2069 are appropriate. Based on this operational timescale, the latest guidance on climate change states that for 'essential infrastructure' development within the Thames river basin district, climate change could increase river flows by 35% for the upper end allowance and by 40% for the High ++ allowance.

3.13 The EA flood data for the Hilfield Brook only includes a 20% allowance for climate change; however, it is considered appropriate to use the 0.1% AEP event as a proxy for the 1% AEP plus 35% CC and the 1% AEP plus 40% CC flood events as a conservative approach. Given that the operational lifetime of the development is 35 years (i.e. approx. to the year 2055), this would fall half way between the 2040 to 2069 timeframe.

3.14 Therefore, the 0.1% AEP is taken as the 'design event' and this approach has been agreed with the EA (Appendix B). Therefore, the Proposed Development will not be adversely affected by flooding from the Hilfield Brook with climate change for the operational lifetime of the development.

Aldenham Brook, Aldenham Tributary and other Unnamed Watercourses

3.15 The EA's flood map for planning does not include flood extents for Aldenham Brook, Aldenham Tributary or the other unnamed watercourses within the Site. These watercourses have small catchment areas of significantly less than 3 km^2 and, therefore, are excluded from the JFLOW model and EA's flood map for planning.

3.16 Given the small catchment area of 2.4 km^2 for Aldenham Brook and less than 0.5 km^2 for Aldenham Tributary and the other unnamed watercourses, it is considered unlikely that they would pose a significant flood risk to the Proposed Development. It is beyond the scope of this assessment to undertake hydraulic modelling which is considered inappropriate given the size of the watercourses and the nature of the development.

3.17 However, in this instance the EA's surface water flood map appears to show that surface water flooding is interlinked with fluvial flooding (refer to Figure 3.2). Therefore, it is considered appropriate to use the EA's surface water flood map as an indicator for fluvial flood depths and extents for Aldenham Brook, Aldenham Tributary and the unnamed watercourses. This approach has been agreed with the EA through consultation (refer to Appendix B).

3.18 Figure 3.4a/b provides flood depths for the low risk event (i.e. between 1.0% and 0.1% AEP). The majority of the site is either located outside of the low risk extent or affected by shallow depths, i.e. less than 600 mm. However, a number of areas are affected by greater depths, principally in the vicinity of watercourses.

Climate Change

3.19 For Aldenham Brook, Aldenham Tributary and the other unnamed watercourses, it is considered appropriate to use the low risk surface water flood depths as a proxy indicator for the 1% AEP event plus 40% climate change (refer to Figure 3.2). Given the short operational lifetime of the development and that the low risk scenario represents an extreme 0.1% AEP event, this is a conservative approach. This approach was agreed with the EA through consultation (refer to Appendix B).

3.20 Therefore, it is proposed to raise the solar panels on framework at least 0.8 m above ground level, which would elevate the panels above the low risk flood depth, i.e. only the framework would be inundated and, therefore, flow would not be impeded and the displacement of floodplain storage would be negligible.

Surface Water Flood Risk

3.21 The EA's Risk of Flooding from Surface Water mapping (refer to Figure 3.2) shows that the majority of the Site has a very low surface water flood risk, however; some areas throughout the Site have a low, medium or high risk of surface water flooding.

3.22 Very low surface water flood risk is defined where *"each year, this area has a chance of flooding of less than 1 in 1000 (0.1%)."* Low surface water flood risk is defined where "*each year, the area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)".* Medium surface water flood risk is defined where "*each year, this area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%)."* High surface water flood risk is defined where *"each year, this area has a chance of flooding of greater than 1 in 30 (3.3%)".*

3.23 Areas of low, medium and high risk areas are located within Fields 1, 2, 3, 5, 7, 8, 9, 12, 13, 14 and 20 in the vicinity of the watercourses within the Site. These areas of surface water flooding are considered to be related to the fluvial flooding of the watercourses, as discussed above.

3.24 However, there a number of additional surface water flow paths which relate to overland flow and are not directly associated with the watercourses. Surface water flow paths with up to a high surface water flood risk is located in Fields 10 and 15 which flow towards the Aldenham Brook. There are surface water flow paths with up to a medium surface water flood risk located in Fields 1 and 4 which flow towards watercourses within the Site. Surface water flow paths with up to a low surface water flood risk are located in Fields 1, 3, 7, 10 and 14, which flow towards the watercourses within the Site.

3.25 There are areas of isolated ponding with up to a low surface water flood risk within Fields 5, 9, 11, 12 and 20. There are areas of isolated ponding with up to a medium surface water flood risk within Fields 5 and 20.

3.26 The low risk depths are almost entirely limited to less than 600 mm with a few areas with depths greater than 600 mm. The areas with depths greater than 600 mm are in the vicinity of the watercourses and in Fields 2 and 8. In the areas of localised ponding within the Proposed Development area, the maximum low surface water flood risk depths are estimated below 150 mm for the areas of flooding in Fields 9 and 12 and between 150 mm and 300 mm for areas of flooding in Fields 5, 11 and 20.

3.27 However, the solar panels would be elevated on framework at least 0.8 m above ground level (Drawing No: HF3.0). This would elevate the panels above the maximum surface water flood depths, and, therefore, would not impede any surface water flow paths or displace any ponding of surface water. Panels have been excluded from areas where it is not practicable to elevate them above the flood depth.

Reservoir Flood Risk

3.28 A review of the EA's reservoir flood risk map identifies that Fields 1 to 3 and Field 5 are at risk from reservoir flooding from Hilfield Park Reservoir located approximately 100 m to the east of Field 1 (refer to Figure 3.3). The EA's mapping indicates that in a failure of the reservoirs, the Site could be affected by flooding to depths of over 2 m. However, this map is based upon a worst-case scenario and it is considered unlikely that flooding would be to the extent modelled.

3.29 All reservoirs over 25,000 m^3 capacity are regularly inspected and supervised by reservoir panel engineers, therefore ensuring that they are maintained in a stable condition. The EA's further information on reservoir flood risk also states that "*Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925*."

3.30 It is therefore considered that flood risk to the Site from reservoirs is negligible to low, and, therefore, no specific mitigation is considered necessary from this source. Nonetheless, the most sensitive part of the Proposed Development (i.e. the battery storage area and substation) will be located outside the area at risk of reservoir flooding, as a precautionary approach.

Mitigation Measures

Design Levels

3.31 A sequential approach will be taken in the layout whereby the most vulnerable parts of the development will be located in the areas at lowest risk of flooding (refer to Drawing No: HF2.0). In particular, the substation and battery storage area will be located outside areas at risk of flooding, where practicable.

3.32 The Proposed Development is classified as 'essential infrastructure' and, therefore, it is acceptable to locate solar arrays within all areas at risk of surface water flooding where the depth is below the level of the solar panels.

3.33 Solar arrays will be located within the low risk surface water flood extent where the estimated depths are shallow. This is considered acceptable as solar panels will be elevated on framework at least 0.8 m above ground level and, therefore, flow would not be impeded and the displacement of floodplain storage would be negligible. Panels have been excluded from areas where it is not practicable to elevate them above the flood depths discussed above.

3.34 Parts of the substation and battery storage area will be located in an area at a low risk of surface water flooding. Therefore, it is recommended that any buildings and sensitive equipment associated with the substation and battery storage area which are located within the low risk extent, should be raised 150 mm above the existing ground level, i.e. above the estimated low surface water flood depth. This is considered to be a conservative approach given that the low risk event represents an extreme scenario which is beyond the 'design event'.

3.35 It is necessary to distribute the inverter stations evenly throughout the Site, as these convert direct current (DC) generated by the panels into alternating current (AC) and, therefore, need to be located in close proximity to the solar arrays. Inverter stations that cannot be practicably located outside of the flood extent will be raised on supports above the surface water flood depths.

Floodplain Compensation

3.36 A small number of the solar arrays will be located within the low risk surface water flood extent where the depth of flooding is below the level of the solar panels, i.e. where only the framework would be inundated and, therefore, flow would not be impeded and the displacement of floodplain storage would be negligible. As such, it is not considered necessary to provide floodplain compensation.

3.37 The metal framework that supports the solar panels would be fixed into the ground with posts centred 3.4 m apart. The posts are formed of a C-shaped section of 4 mm galvanised steel and, therefore, would displace a negligible volume of water.

3.38 It is concluded that the Proposed Development will not result in a significant increase in flood risk elsewhere and floodplain compensation is not required.

Safe Access/Egress

3.39 Access/egress to the Site would be via Hilfield Lane for Field 1, via the commercial development leading to Hilfield Lane for Fields 2, 3, 4 and 5 and via an existing track leading to Slades Farm and Butterfly Lane for the Fields 7 to 20. According to the EA's Surface Water Flood map, all of the access routes are located partially within the low surface water flood extent (refer to Figure 3.2).

3.40 The access/egress route for Field 1 via Hilfield Lane could flood during the low surface water event to an estimated depth of between 300 mm and 600 mm. In accordance with FD2320/TR2[3], the hazard rating for this area would be classified as a 'danger for some' and a 'danger for most' depending on the velocity. A 'danger for some' is defined as a danger for children, the elderly and disabled people. A 'danger for most' is defined as a danger for the general public.

3.41 The access/egress route for Fields 2, 3, 4 and 5 via Hilfield Lane could flood during the low surface water flood event to an estimated depth of between 150 mm and 300 mm. In accordance with FD2320/TR2, the hazard rating for this area would be classified as a 'very low hazard' and a 'danger for some' depending on the velocity. A 'very low hazard' is defined as a caution for access/egress.

3.42 The access/egress route via Butterfly Lane could flood during the low surface water event to an estimated depth of between 900 mm and 1200 mm in the vicinity of the Aldenham Brook. In accordance with FD2320/TR2, the hazard rating for this area would be classified as a 'danger for most' and a 'danger for all' depending on the velocity. A 'danger for all' is defined as a danger for the general public including the emergency services.

3.43 It is anticipated that personnel will only be on-site during the construction phase of the Proposed Development and for occasional maintenance visits twice a month once construction has been completed. There will be no other personnel present at the Site for the majority of the operational lifetime of the development.

3.44 The developer and maintenance contractor would sign up to the EA's flood warning service for the local area. This would ensure that all personnel would have sufficient time to leave the Site or reschedule their planned visits.

3.45 On this basis, it is concluded that future occupants of the development would be safe during the design flood event for the operational lifetime of the development.

Land Use Vulnerability

3.46 Table 2 of the PPG sets out a schedule of land uses based on their vulnerability or sensitivity to flooding. Solar farms are considered as being 'essential infrastructure' to flooding. Referring to Table 3 of the NPPF PPG, 'essential infrastructure' land uses are considered appropriate in Flood Zones 1, 2, 3a and 3b, subject to passing the Sequential Test.

[3] Framework and Guidance for Assessing and Managing Flood Risk for New Development

3.47 The solar farm needs to be in its proposed location due to the capacity in the national grid in the area, owing to its close proximity to the Elstree National Grid Substation. Given the large Site area of 130.6 ha, it is concluded that no other sites in the vicinity of the electricity distribution station are reasonably available at a lower risk of flooding. As such, it is considered that the Sequential Test should be passed.

3.48 Therefore, on the basis of land use vulnerability, the development should be deemed appropriate in planning policy terms in its proposed location.

Other Considerations

Maintenance Buffers

3.49 A minimum of 9 m buffer for 'main rivers' (Hilfield Brook and Aldenham Brook) and 'ordinary watercourses' (Aldenham Tributary and other watercourses shown on OS mapping), will be provided from the top of bank to the proposed fences in order to ensure access for maintenance.

3.50 This is in accordance with Policy SADM16 of the Local Plan which states that '*development on sites that contain a watercourse or are situated next to a watercourse will comply with the following principles (inter alia), conserving or improving the natural environment of the watercourse, maintaining a minimum 9m wide undeveloped buffer zone will be provided from the top of the bank of any watercourse and supporting opportunities for restoration and enhancement within the catchment of the watercourse'.*

3.51 Where planting is proposed in the maintenance buffers, this will be in the form of neutral grassland with wildflowers or tussocky grassland that would not prohibit access to the watercourses.

4 DRAINAGE ASSESSMENT

Introduction

4.1 This drainage strategy has been prepared in accordance with Defra's *"Non-statutory technical standards for sustainable drainage systems"* (March 2015) to ensure that the Proposed Development does not increase flood risk to the Site or elsewhere and where practicable reduces flood risk over the lifetime of the development.

4.2 Surface water arising from a developed site should, as far as is practicable, be managed to mimic the surface water flows arising from the site prior to the Proposed Development while reducing the flood risk to the site itself and elsewhere.

4.3 With the below mitigation it is considered that the Site will mimic the existing greenfield runoff arrangement and, therefore, it is not considered necessary to undertake infiltration testing or provide a controlled discharge to a watercourse. It is noted that this approach has been accepted on other recent solar farm developments (refer to application reference P20/13909/F South Gloucestershire Council and 2/2019/0850/PAEIA Dorset Council).

Drainage Strategy

<u>Solar Arrays</u>

4.4 The surface water drainage strategy has been based on the research report "Hydrologic Response of Solar Farms" (Cook and McCuen, 2013) published in the Journal of Hydrologic Engineering. It should be noted that the report states *"this study, along with design recommendations, can be used as a guide for the future design of solar farms"*. The report provides robust evidence that SuDS are not required to manage solar farm surface water runoff.

4.5 Cook and McCuen (2013) demonstrates that solar panels do not have a significant effect on runoff volumes, peaks or time to peak if grass cover is located underneath panels and between rows. The study concludes that this is true for the 2 year, 25 year and 100 year events for a range of storm durations.

4.6 The report also notes that although the panels could concentrate runoff onto the ground, this only has the potential to cause erosion if it falls directly onto bare ground or a gravel surface.

4.7 On this basis, it is concluded that solar farms only significantly change the hydrologic response if gravel is placed under panels or if patchy or bare ground is created between rows. Therefore, the proposed planting framework discussed below will maintain the current hydrological response of the Site and will not increase flood risk elsewhere.

4.8 The Proposed Development will result in a reduction in runoff rates and improved water quality of runoff due to the absence of typical farming activities such as ploughing and soil compaction by heavy machinery.

4.9 The current arable use, comprising crops and agricultural tillage, gives rise to poor vegetation cover and bare ground following harvesting, resulting in increased runoff and erosion. It is considered that with the proposed planting framework discussed below, there is likely to be a reduction in surface water runoff and erosion.

4.10 The research report also investigated the effects of ground slope on the solar farm. It considers the differences in the hydrological response between a slope of 1% (i.e. 1 in 100) and 5% (i.e. 1 in 20). The report concluded that the '*greater ground slope did not significantly influence the response of the solar farm*'.

4.11 The study notes that grass cover can deteriorate if it is not sufficiently maintained or if it is eroded by vehicle traffic. It is recommended that the grass cover is regularly maintained underneath panels and between rows to avoid patchy grass or bare ground, as set out below. Operational vehicle trips will include approximately two maintenance visits per month, typically with a transit style van and, therefore, the risk from erosion by vehicle traffic is low.

Mitigation

4.12 The Landscape and Ecology Management Plan (LEMP; refer to Document Reference: R009) outlines the proposed planting framework and enhancement to the quality of grass cover. The LEMP states that the Site will be permanently vegetated with modified grassland located beneath the solar arrays and between rows.

4.13 Further to the modified grassland beneath the panels, the LEMP includes additional planting between the proposed solar arrays and field boundaries/watercourses which will provide a further betterment to surface water runoff and erosion. This includes:

- neutral grassland with wildflowers and scrub;
- tussocky Grassland;
- new structure planting; and
- native woodland planting.

4.14 The proposed planting framework will reduce runoff, encourage interception, infiltration and evapotranspiration and provide water quality treatment before surface water enters the watercourses within and surrounding the Site. The proposed planting will also provide sufficient mitigation against soil erosion.

4.15 Grass cover would be inspected and maintained at least twice a year, which is considered an appropriate level of mitigation. It is recommended that during maintenance, any patchy grass or bare ground is re-seeded.

4.16 In the unlikely event that any evidence of significant erosion should occur during the operation of the solar farm, then appropriate mitigation should be taken at that point, which could include scrapes beneath the arrays following the contours of the slope, should this be necessary.

4.17 The increased interception, evapotranspiration and infiltration due to the proposed planting will provide a betterment on the existing runoff rates at the Site and, therefore, will also provide a betterment in any future climate change scenarios.

Inverter Stations, Transformers and Battery Storage Area

4.18 The inverter stations and the battery storage facility (refer to Drawing No: BF4.0 and HF12.0) will be raised on supports above a 300 mm deep sub-base formed of permeable material, i.e. gravel (MOT Type 3). The plan area of the sub-base will extend at least 300 mm beyond the footprint of the container or cabin. The invert of the sub-base should be level to encourage infiltration to occur evenly.

4.19 The permeable sub-base would receive surface water from the containers or cabins and would promote infiltration to the ground without concentrating runoff. This will mimic the existing greenfield surface water runoff arising from the Site and ensure that runoff rates are not increased post-development. It is noted that this approach has been accepted on other recent solar farm developments (e.g. application reference P20/13909/F South Gloucestershire Council and 2/2019/0850/PAEIA Dorset Council).

4.20 A small number buildings/equipment within the substation compound require concrete foundations; however, it is understood that these will be surrounded by an extensive gravel sub-base which will cover all substation ground surfaces. The auxiliary transformer needs to be mounted on a concrete base (refer to Drawing No: HF10.0); however, given the small surface area of 4.1 m x 4.1 m, it is considered appropriate mitigation to surround the base by a 300 mm x 300 mm gravel-filled trench to intercept runoff and promote infiltration. It is noted that this approach was also accepted in the latter above-mentioned solar farm application where a concrete base is unavoidable.

Tracks and Roads

4.21 Internal tracks would be required to facilitate vehicle movement around the Site for construction and maintenance purposes. The Proposed Development will utilise the existing access tracks where possible to minimise the extent of new tracks required.

4.22 All proposed roads and tracks will be constructed of a permeable material; therefore, there would be no increase in runoff from these areas. Over time it is likely that the tracks will become vegetated due to low usage.

Water Quality Treatment

4.23 Water quality treatment will be provided for surface water runoff from the solar arrays, inverter stations roofs, the substation, access roads and the battery storage facility.

4.24 In this instance, mitigation with an index or combined indices of more than 0.2 for Total Suspended Solids (TSS), 0.2 for metals and 0.05 for hydrocarbons is acceptable for the solar arrays as the pollution hazard level would be very low. The proposed planting beneath the panels will meet the water quality requirements required for the Proposed Development. It is considered that the proposed planting will provide a similar level of treatment to a filter strip.

4.25 Mitigation with an index or combined indices of more than 0.3 for TSS, 0.2 for metals and 0.05 for hydrocarbons is acceptable for the other aspects of the development as the pollution hazard level would be low. The granular sub-base beneath the inverter stations, battery storage facility, associated buildings within the proposed substation compound and the permeable access tracks will meet the water quality requirements. It is considered that the granular material in the sub-base will provide a similar level of treatment to permeable paving.

4.26 As discussed above, the proposed planting framework and the absence of harvesting and ploughing will increase the quality of surface water runoff.

Construction

4.27 Good construction practices will be undertaken to ensure that no adverse impacts on surface water or groundwater quality occur during the construction phase.

4.28 Construction vehicles will be properly maintained to reduce the risk of hydrocarbon contamination and will only be active when required. Construction materials will be stored, handled and managed with due regard to the sensitivity of the local aquatic environment and thus the risk of accidental spillage or release will be minimised.

4.29 The cable trenches will be backfilled with the excavated material to maintain the characteristics of the ground.

4.30 It is possible that construction could give rise to some ground compaction; however, it is considered that this would be no worse than other traditional farming practices with heavier machinery. During construction it is recommended that vegetation disturbance should be minimised as much as possible and any bare ground resulting from construction should be re-seeded.

5 CONCLUSIONS

5.1 The requirements for Flood Risk Assessment are provided in the National Planning Policy Framework and its associated Planning Practice Guidance, together with the Environment Agency's Guidance Notes. This policy and associated guidance have been followed in the preparation of this FRA.

5.2 The EA's flood map for planning indicates that the majority of the site is located within Flood Zone 1 (low risk). An area of Flood Zone 2 and 3 (medium and high risk, respectively) is located in the north-western part of Field 1 associated with Hilfield Brook.

5.3 The EA's risk of flooding from surface water mapping identifies that the majority of the Site has a very low risk of flooding from surface water and some small areas have up to a high surface water flood risk.

5.4 The Site is potentially at risk of flooding from sewers and groundwater; however, flood risk to the Site from these sources is considered to be low.

5.5 Part of the Site is at risk from reservoir flooding; however, as reservoirs are regularly inspected ensuring that they are maintained in a stable condition. It is therefore considered that flood risk to the Site from reservoirs is negligible to low and, therefore, no specific mitigation is considered necessary from this source. Nonetheless, the most sensitive part of the Proposed Development (i.e. the battery storage area and substation) will be located outside the area at risk of reservoir flooding, as a precautionary approach.

5.6 Detailed flood data for the Hilfield Brook was received from the EA which indicates that 1%, 1% AEP plus 20% climate change (CC) and 0.1% AEP defended flood extents are confined to the channel of the Hilfield Brook when compared to the topographical survey.

5.7 It is considered appropriate to use the 0.1% AEP event as a proxy for the 1% AEP plus 35% CC and 1% AEP plus 40% CC flood events as a conservative approach. Therefore, the Proposed Development will not be adversely affected by flooding from the Hilfield Brook with climate change for the operational lifetime of the development.

5.8 The EA's flood map for planning does not include flood extents for Aldenham Brook, Aldenham Tributary or the other unnamed watercourses within the Site. These watercourses have small catchment areas of significantly less than 3 km^2 and, therefore, are excluded from the JFLOW model and EA's flood map for planning. As such, it is considered that these watercourses are unlikely to pose a significant source of flood risk.

5.9 In this instance, the EA's Risk of Flooding from Surface Water mapping appears to show that the majority of the surface water flood risk is interlinked with the fluvial flooding.

5.10 The 1% AEP plus 35% CC flood levels are not available for the Site and, therefore, it is proposed to use the low surface water flood extent as a proxy for the future fluvial Flood Zone 3 extent.

5.11 A sequential approach will be taken in the layout whereby the most vulnerable parts of the development will be located in the areas at lowest risk of flooding. In particular, the substation and battery storage area will be located outside areas at risk of flooding, where practicable.

5.12 The Proposed Development is classified as 'essential infrastructure' and, therefore, it is acceptable to locate solar arrays within all areas at risk of surface water flooding where the depth is below the level of the solar panels.

5.13 Solar arrays will be located within the low risk surface water flood extent where the estimated depths are shallow. This is considered acceptable as solar panels will be elevated on framework at least 0.8 m above ground level and, therefore, flow would not be impeded and the displacement of floodplain storage would be negligible.

5.14 Parts of the substation and battery storage area will be located in an area at a low risk of surface water flooding. Therefore, it is recommended that any buildings and sensitive equipment associated with the substation and battery storage area which are located within the low risk extent, should be raised 150 mm above the existing ground level, i.e. above the estimated low surface water flood depth.

5.15 An appropriate buffer will be provided from the top of the bank of the watercourses in order to ensure access for maintenance.

5.16 The hazard ratings for the access/egress route for Field 1 via Hilfield Lane are a 'danger for some' and a 'danger for most', a 'very low hazard' and a 'danger for some' for Fields 2, 3, 4 and 5 via Hilfield Lane and a 'danger for most' and a 'danger for all' via Butterfly Lane, depending on the velocity. However, it is anticipated that personnel will only be onsite during the construction phase and for occasional maintenance visits.

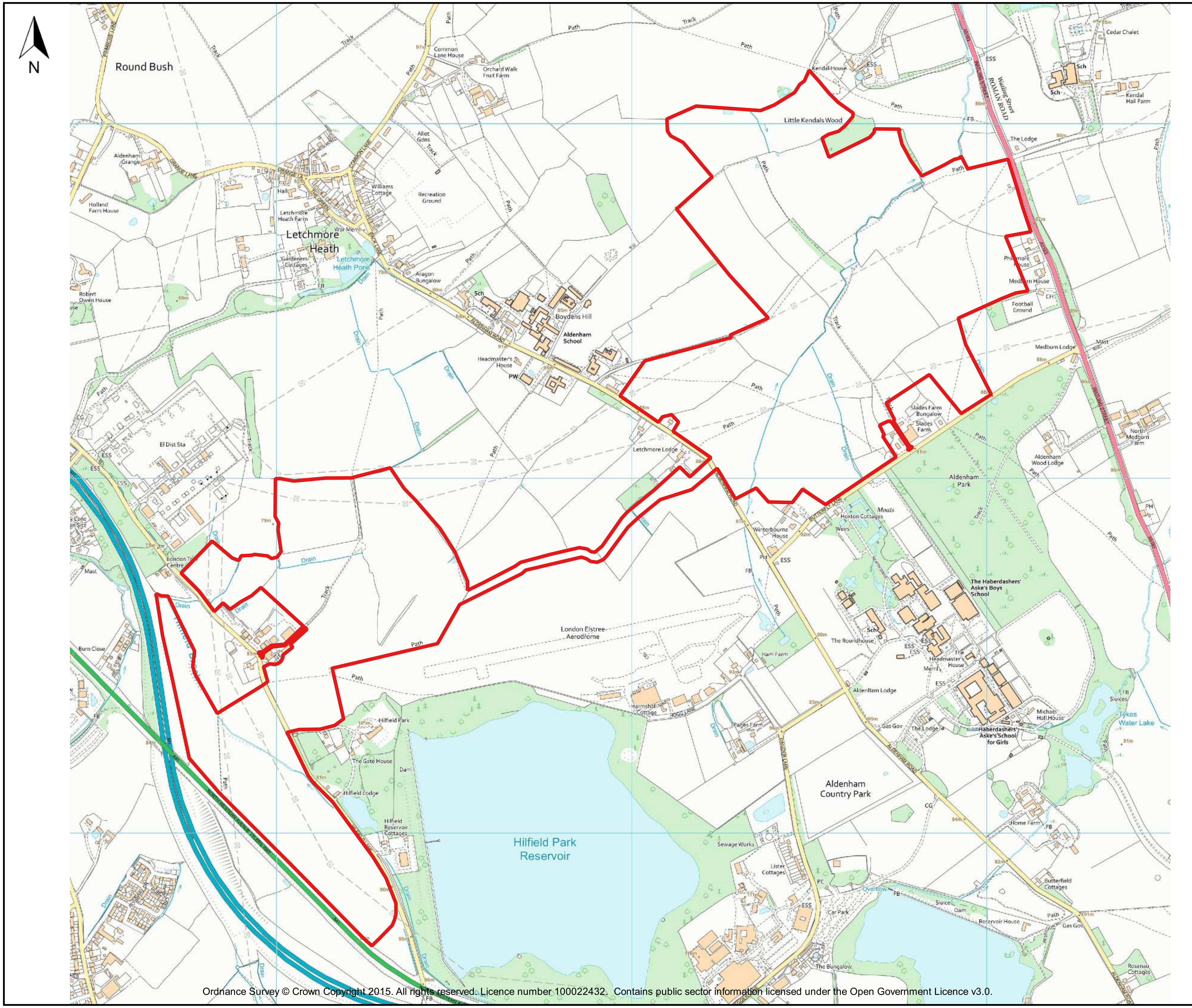
5.17 It is not considered necessary to provide SuDS for the proposed solar panel arrays. Cook and McCuen (2013) demonstrated that solar panels do not have a significant effect on runoff volumes, peaks or time to peak if grass cover is well maintained underneath panels and between rows. Therefore, it is proposed to maintain the grass cover to prevent areas of bare ground and erosion occurring.

5.18 All proposed roads and tracks will be constructed of a permeable material; therefore, there would be no increased runoff from these areas. Battery storage and inverter stations will be located in storage containers or cabins on legs above a 300 mm sub-base formed of permeable material i.e. gravel (MOT Type 3).

5.19 This FRA has therefore demonstrated that the Proposed Development will be safe and that it would not increase flood risk elsewhere. The proposed land use is classified as 'essential infrastructure' and is considered appropriate in relation to the flood risk vulnerability classifications set out in Table 3 of the NPPF subject to passing the Sequential Test.

5.20 Given the large Site area of 130.6 ha, it is concluded that no other sites in the vicinity of the Elstree National Grid Substation are reasonably available at a lower risk of flooding. As such, it is considered that the Sequential Test should be passed. The development should therefore be considered acceptable in planning policy terms.

Figures



Key

Application Site

Figure 1.1:	**Site Location Plan**
Client:	**Elstree Green Limited**
Project:	**Hilfield Solar Farm**
Project No.:	**C2096**

RMA ENVIRONMENTAL

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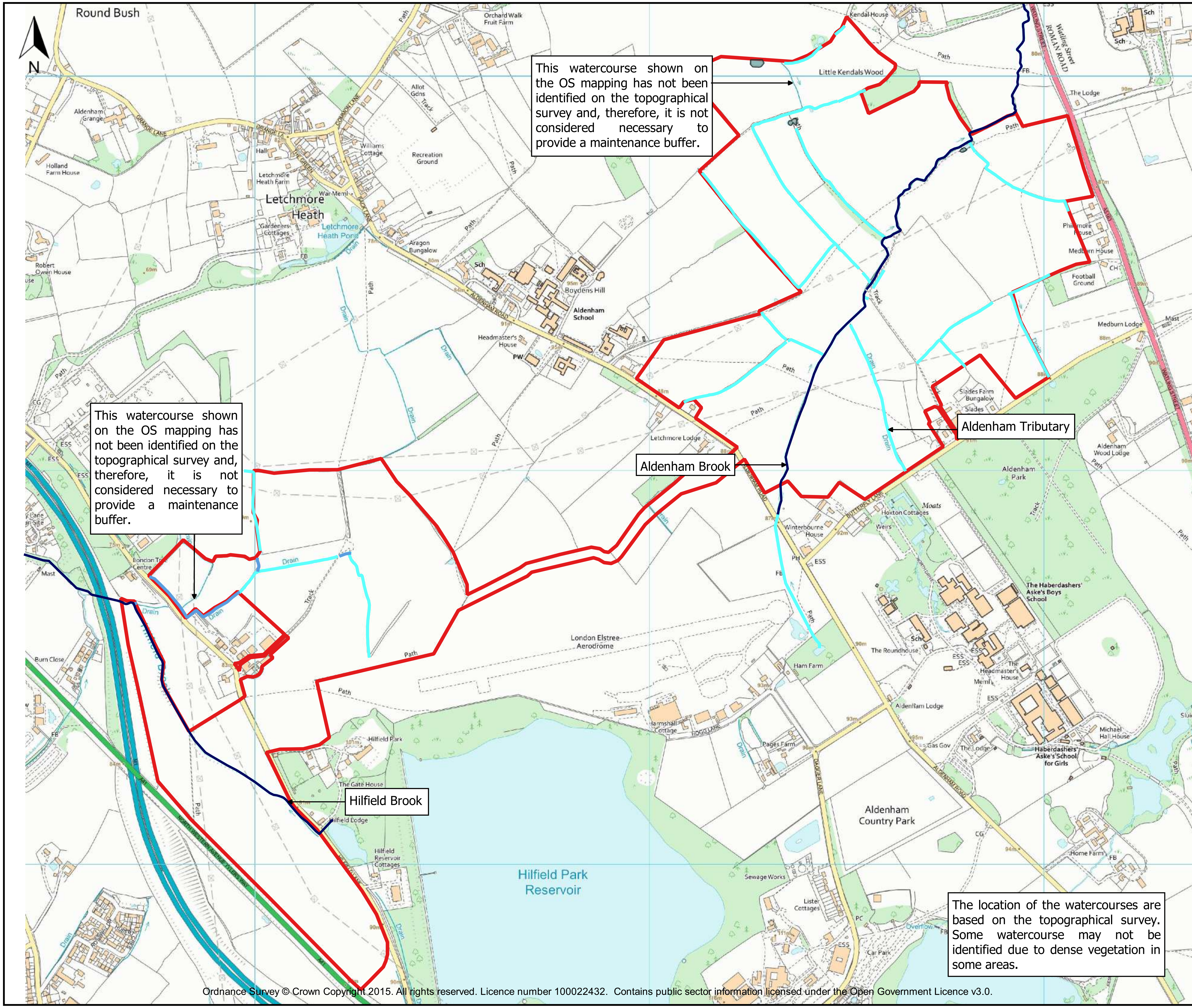

Key

- Application Site
- Main River
- Ditches identified on the Topographical Survey
- Ditches only identified on OS Mapping
- Pond

Figure 2.1:	**Watercourse Plan**
Client:	**Elstree Green Limited**
Project:	**Hilfield Solar Farm**
Project No.:	**C2096**

RMA ENVIRONMENTAL

Drawn:	Checked:	Date:	Scale:
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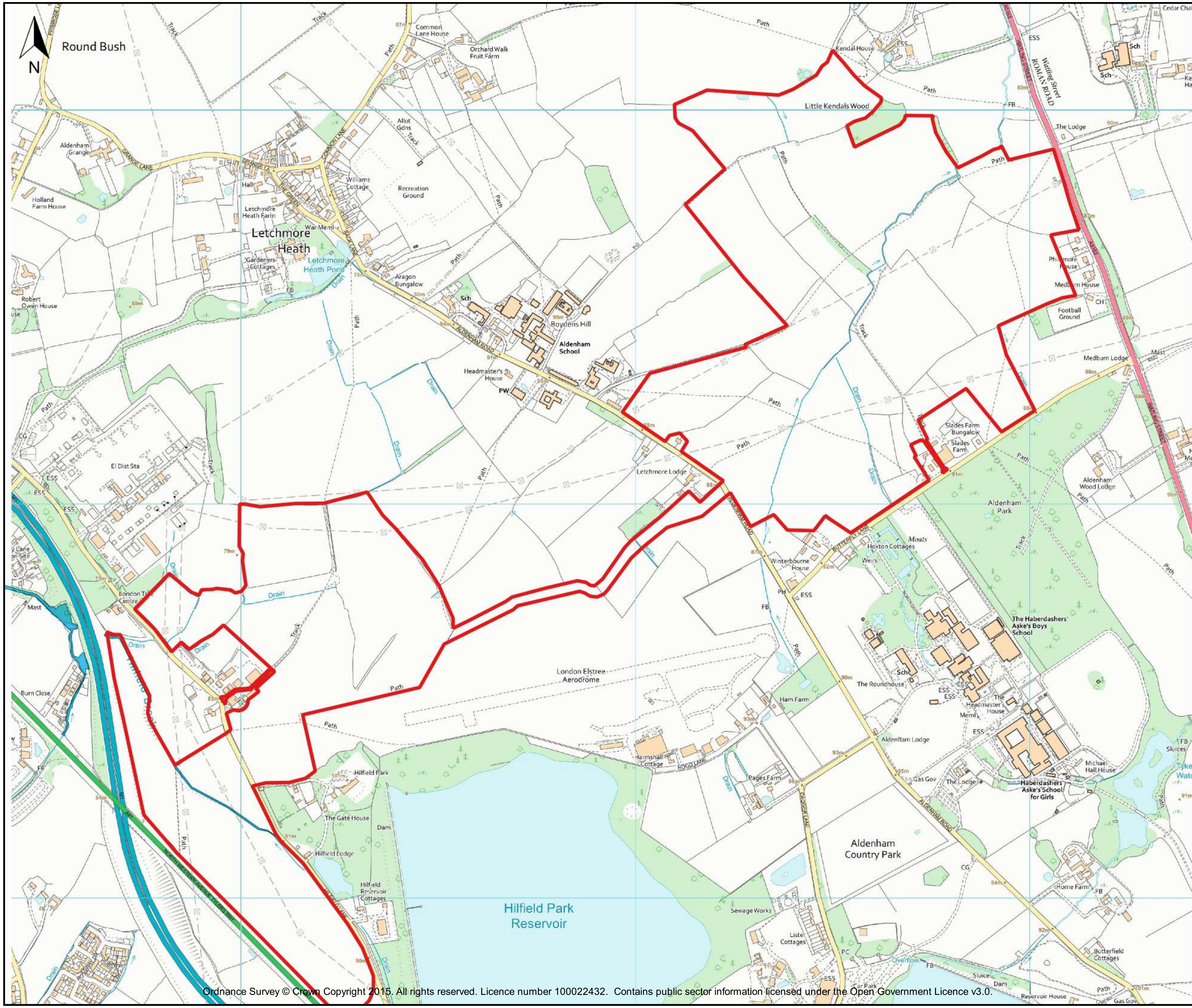

Key

- Application Site
- Flood Zone 2
- Flood Zone 3

Figure 3.1:	**EA's Flood Map for Planning**
Client:	**Elstree Green Limited**
Project:	**Hilfield Solar Farm**
Project No.:	**C2096**

RMA ENVIRONMENTAL

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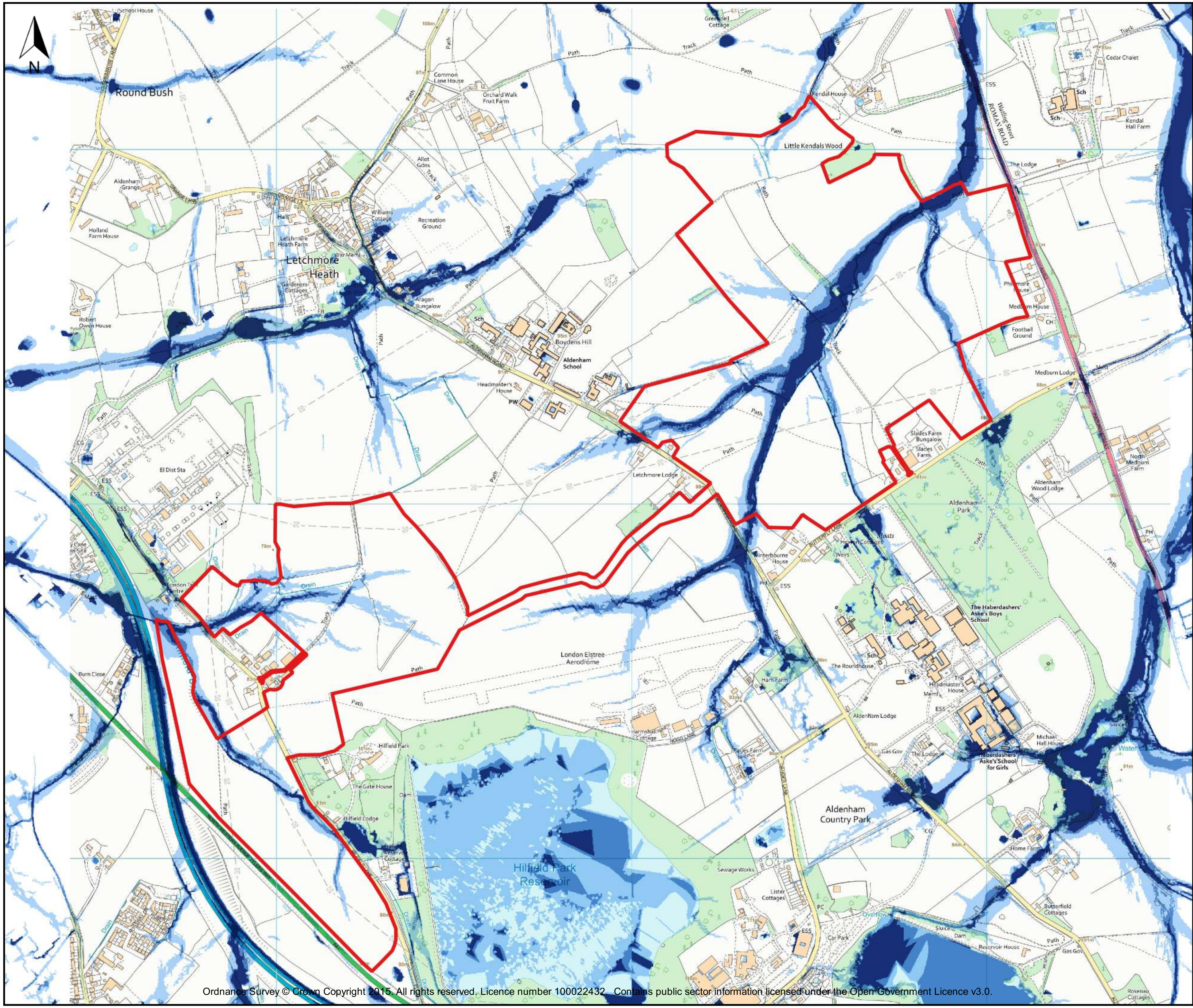

Figure 3.2: **EA's Surface Water Flood Risk Map**

Client:	**Elstree Green Limited**
Project:	**Hilfield Solar Farm**
Project No.:	**C2096**

RMA ENVIRONMENTAL

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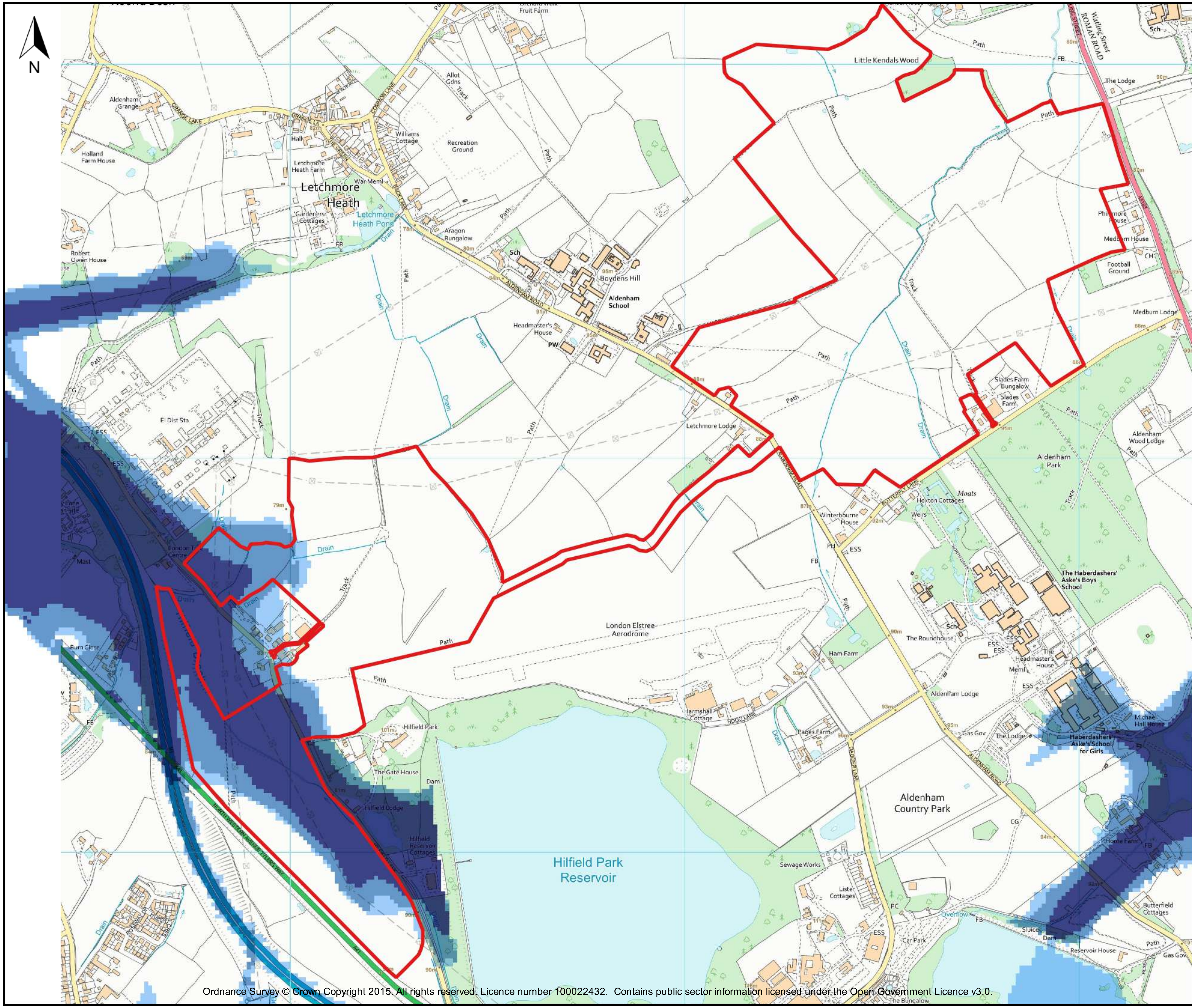
RT	NY	14/12/2020	1:10,000@A3



Key

- Application Site

Reservoir Flood Depths

- Below 0.3 m
- Between 0.3 m and 2 m
- Over 2 m

Figure 3.3:	**EA's Reservoir Flood Depth Map**
Client:	**Elstree Green Limited**
Project:	**Hilfield Solar Farm**
Project No.:	**C2096**

RMA ENVIRONMENTAL

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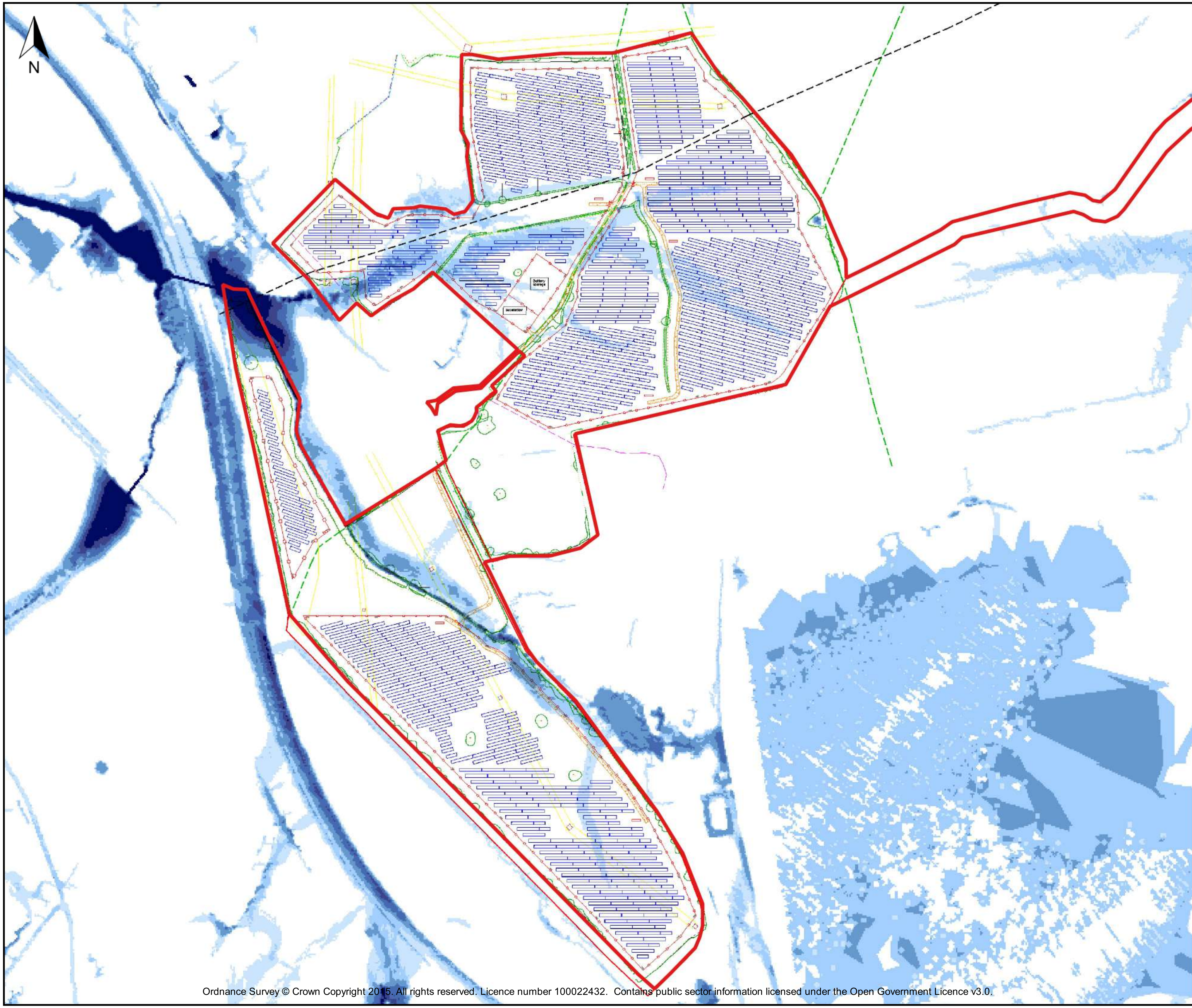


Key

- Application Site

Surface Water Flood Depths

- Below 150 mm
- 150 mm - 300 mm
- 300 mm - 600 mm
- 600 mm - 900 mm
- 900 mm - 1200 mm
- Over 1200 mm

Figure 3.4a: **EA's Low Risk Surface Water Flood Depths**

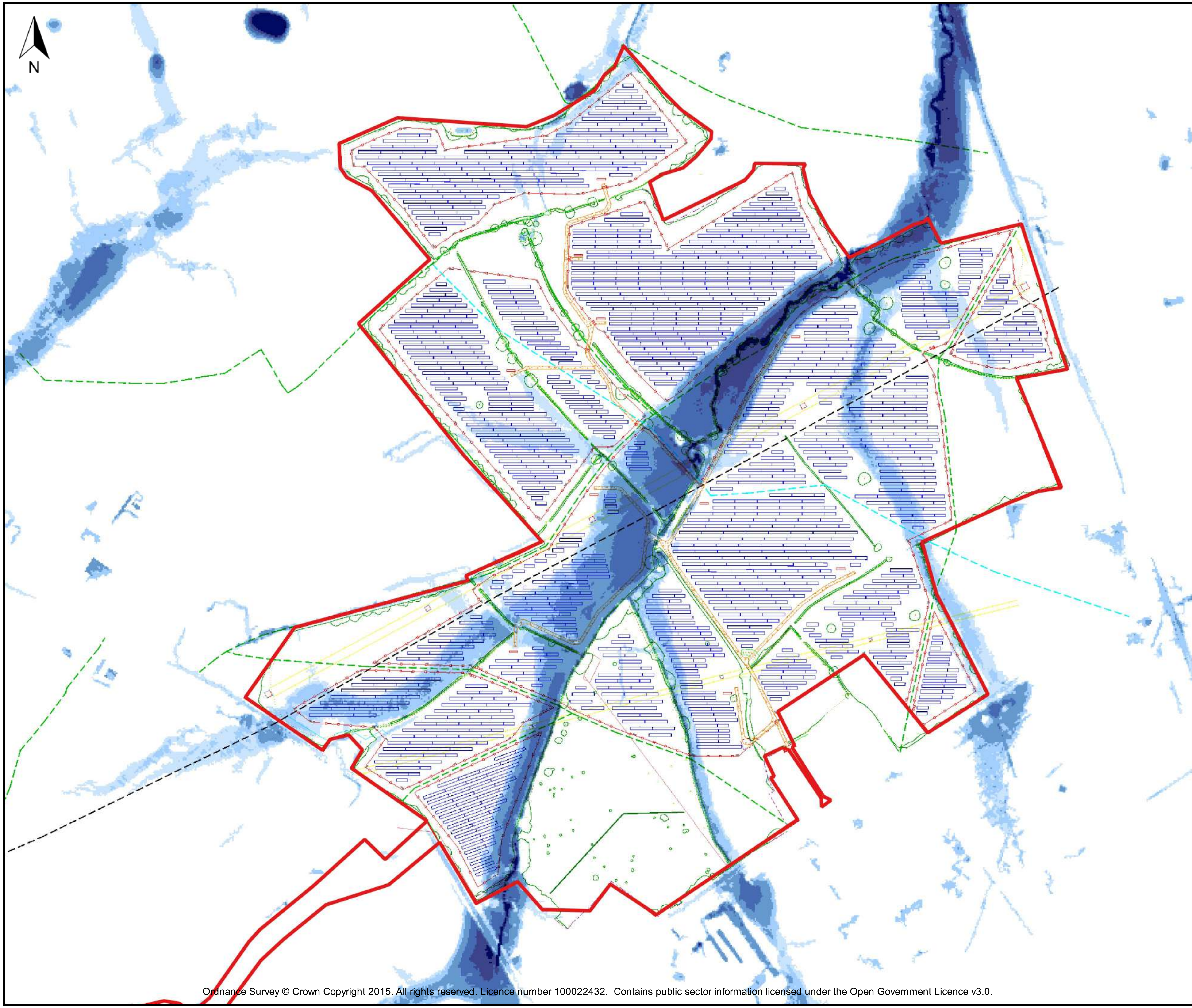
Client: **Elstree Green Limited**

Project: **Hilfield Solar Farm**

Project No.: **C2096**

RMA ENVIRONMENTAL

Drawn:	Checked:	Date:	Scale:
RT	NY	14/12/2020	1:5,000@A3



Key

Application Site

Surface Water Flood Depths

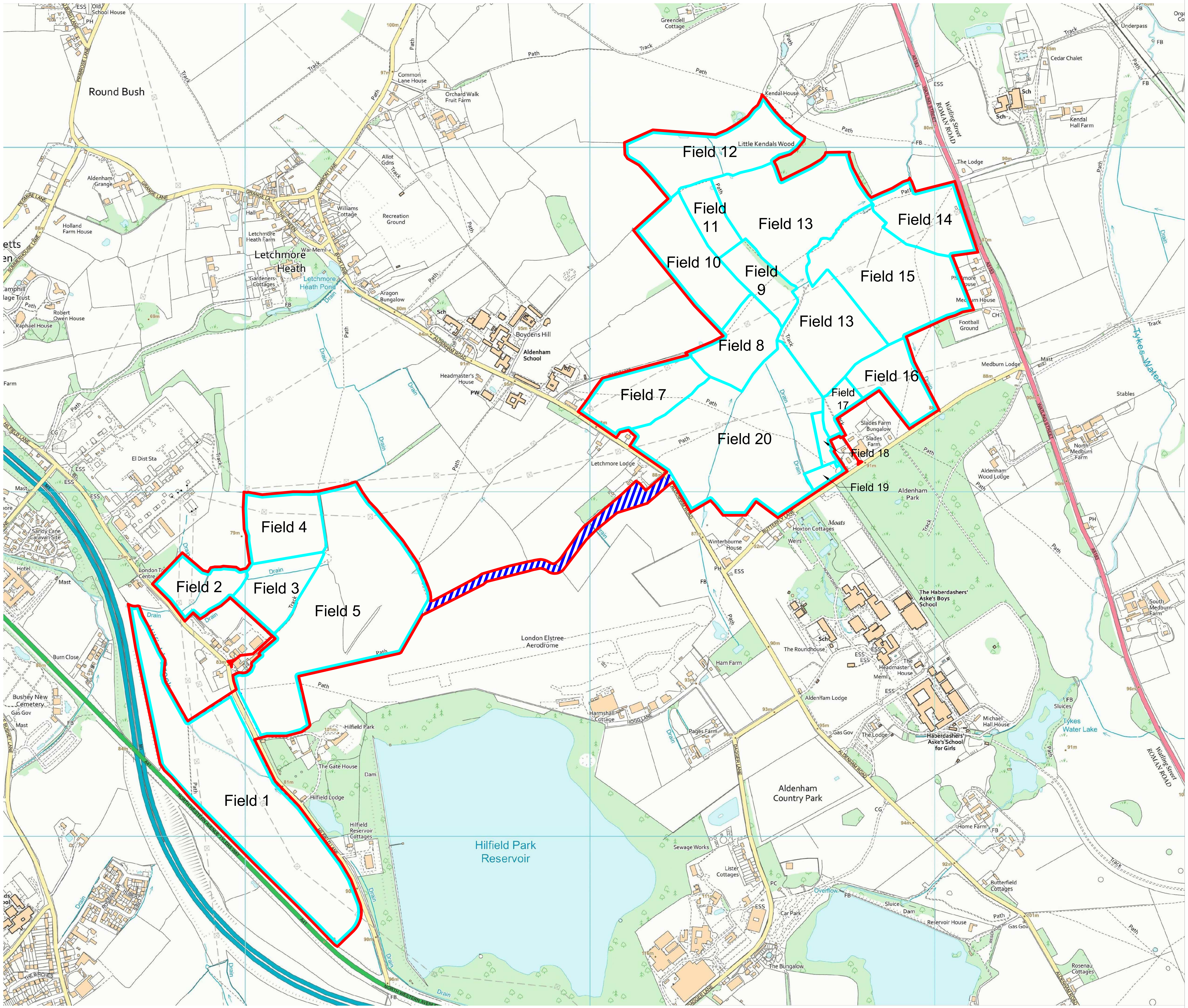
- Below 150 mm
- 150 mm - 300 mm
- 300 mm - 600 mm
- 600 mm - 900 mm
- 900 mm - 1200 mm
- Over 1200 mm

Figure 3.4b:	**EA's Low Risk Surface Water Flood Depths**
Client:	**Elstree Green Limited**
Project:	**Hilfield Solar Farm**
Project No.:	**C2096**

RMA ENVIRONMENTAL

Drawn:	Checked:	Date:	Scale:
RT	NY	14/12/2020	1:5,000@A3

Appendix A: Field Number Plan



General Notes

Field 6 has been removed from scheme

Key

Red Line Area

Field Number

Underground Cable Connection Route

REV	DSGD	DATE	MODIFICATION

PROJECT NAME: Hilfield Solar Farm

DRAWING TITLE: Field Arrangement Plan

DRAWING No: 2017/D003

REVISION: v.f

N

SCALE: 1:4000

FORMAT: A0

DATE: 10 Dec 2020

Drawn By: DP

Checked By: NL

aardvark environment matters

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Taunton • Somerset • TA4 2RL

Tel: 01984 624989
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environment@aardvarkem.co.uk
www.aardvarkem.co.uk

File:\Z:\Data 2020\2017 Enso Green Holdings - Elstree\Data & Drawings\CAD\2017-D004-v.f-Hilfield Solar Farm.dwg

Appendix B:
EA Consultation

Rosie Tutton
RMA Environmental Ltd
Swallow Court (Suite 4)
Sampford Peverell
Tiverton
EX16 7EJ

Our ref: NE/2020/132357/01-L01
Your ref: RMA-LC2096_03 – Hilfield Solar

Date: 15 October 2020

Dear Rosie

ENVPAC/1/HNL00247 - Charged Agreement

Proposed Solar Farm on land to the north-east and west of Elstree Aerodrome, near Watford, Hertfordshire - Flood Risk Screening Appraisal

Land to north east and west of Elstree Aerodrome

Thank you for your request for pre-application advice. We have undertaken a review of the following document in line with charged agreement ENVPAC/1/HNL00247.

- RMA-LC2096_03 – Hilfield Solar Farm FRS (your letter dated 14/09/2020)

Flood zone 2 & 3 has been noted as being confined to the river with a very minor overspill at the north of Field 1. Given that this development will not be affected by flooding or pose an additional flood risk we have no further comments relating to flood risk.

We note that a minimum 8 meter buffer (measured from the top of bank) to the river will be provided and we welcome this. If there are to be any construction works within 8 metres of the river (e.g. storage, vehicle access) an Environmental Permit should be obtained.

The Environmental Permitting (England and Wales) Regulations 2016 require a permit to be obtained for any activities which will take place:

- on or within 8 metres of a main river (16 metres if tidal)
- on or within 8 metres of a flood defence structure or culvert (16 metres if tidal)
- on or within 16 metres of a sea defence
- involving quarrying or excavation within 16 metres of any main river, flood defence (including a remote defence) or culvert
- in a floodplain more than 8 metres from the river bank, culvert or flood defence structure (16 metres if it’s a tidal main river) and you don’t already have planning permission.

For further guidance please visit https://www.gov.uk/guidance/flood-risk-activities-environmental-permits or contact our National Customer Contact Centre on 03702 422 549. The applicant should not assume that a permit will automatically be forthcoming once planning permission has been granted, and we advise them to consult with us at the earliest opportunity.

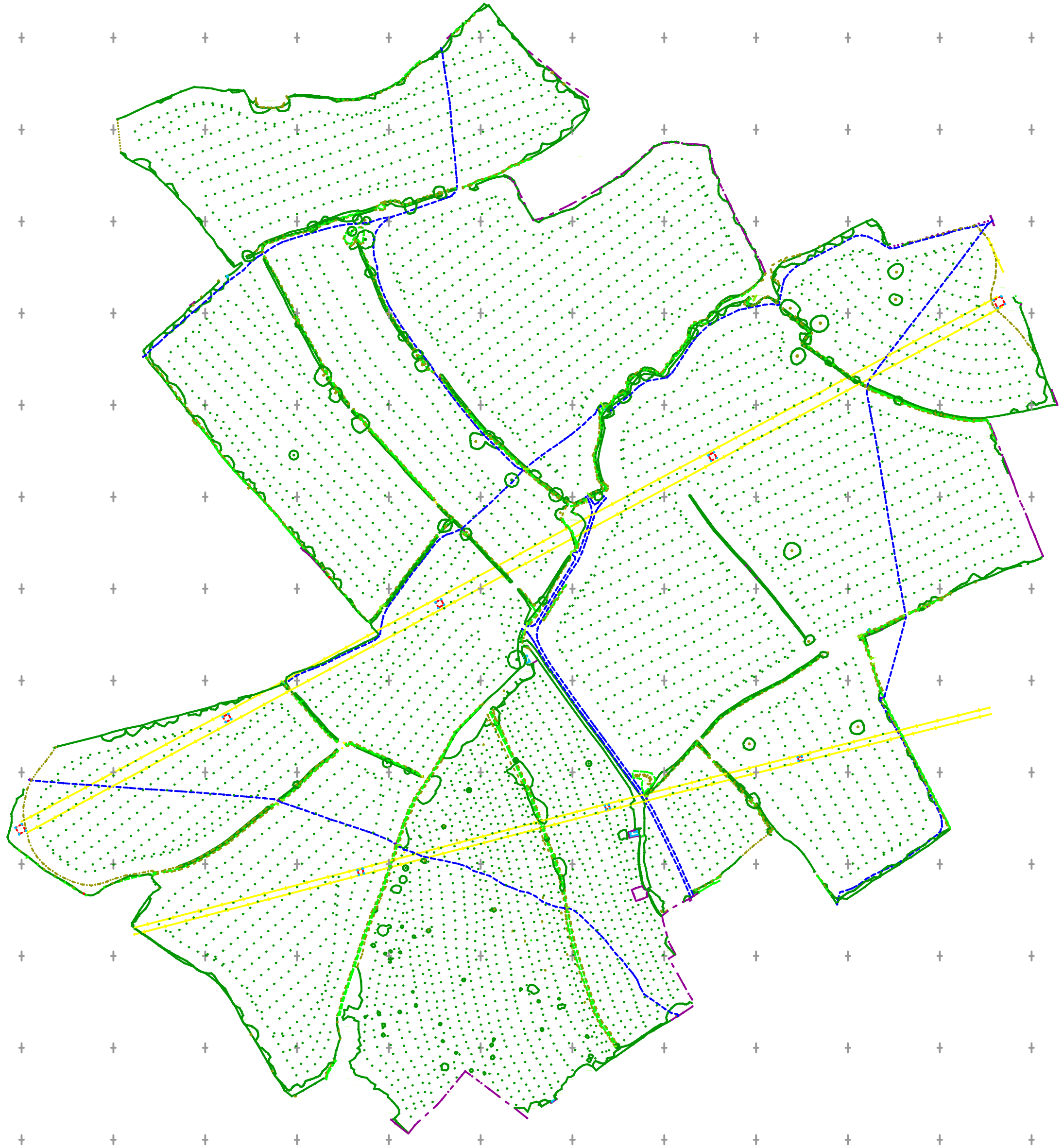
Please note that the view expressed in this letter by the Environment Agency is in response to a pre-application enquiry only and does not represent our final view in relation to any future planning application made in relation to this site. We reserve the right to change our position in relation to any such application. You should seek your own expert advice in relation to technical matters relevant to any planning application before submission. This opinion is based on the information submitted and current planning policy and guidance.

I hope the contents of this letter are useful to you. If you have any queries regarding this response please contact me.

Yours sincerely

Deborah Simons
Planning Advisor
Direct e-mail HNLSustainablePlaces@environment-agency.gov.uk

Appendix C: Topographical Survey



Appendix D:
EA Flood Data

Rosie Tutton

From: NET Enquiries <HNLenquiries@environment-agency.gov.uk>
Sent: 27 July 2020 12:22
To: Rosie Tutton
Subject: RE: HNL178901NR - 200705/VR17 FW: Flood Data Request - Land near Elstree Substation near Watford, WD25 8HF
Attachments: HNL178901NR.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Rosie

Enquiry regarding P4, 5, 6 & 7 for Field 1 - TQ 14932 96217

Thank you for your enquiry which was received on 2 July 2020.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

There is modeling but it doesn't really have that much of an impact on the site, the 1 in 1000 defended flood outlines stay in the bank. I have done the P4 for you, please see attached.

Please note that there are no 2D nodes for this area.

I am not able to get the defences and structures data from our internal system, but this data is already available online and you can use the following link for more information:
https://environment.data.gov.uk/asset-management/index.html

The P4 data is supplied subject to the Open Government Licence, which you should read.

We do not have any JFLOW data to supply.

I have included the model, reports etc. see below.
Upper Colne P5, 6 & 7: https://ea.sharefile.com/d-sb27cace13bc469db

Name	Products 5, 6 and 7
Description	*Upper Colne Flood Risk Mapping Study (Halcrow, 2010)*
Licence	Environment Agency Conditional Licence
Conditions	1.0 You may use the Information for your internal or personal purposes and may only sublicense others to use it if you do so under a written licence which includes the terms of these conditions and the agreement and in particular may not allow any period of use longer than the period licensed to you. 2.0 Notwithstanding the fact that the standard wording of the Environment Agency Conditional Licence indicates that it is perpetual, this Licence has a limited duration of 5 years at the end of which it will terminate automatically without notice. 3.0 We have restricted use of the Information as a result of legal restrictions placed upon us to protect the rights or confidentialities of others. In this instance it is because of third party data. If you contact us in writing (this includes email) we will, as far as confidentiality

	rules allow, provide you with details including, if available, how you might seek permission from a third party to extend your use rights. 4.1 The Information may contain some data that we believe is within the definition of "personal data" under the Data Protection Act 1998 but we consider that we will not be in breach of the Act if we disclose it to you with conditions set out in this condition and the conditions above. This personal data comprises names of individuals or commentary relating to property that may be owned by an individual or commentary relating to the activities of an individual. 4.2 Under the Act a person who holds and uses or passes to others personal data is responsible for any compliance with the Act and so we have no option but to warn you that this means you have responsibility to check that you are compliant with the Act in respect of this personal data. 5.0 The location of public water supply abstraction sources must not be published to a resolution more detailed than 1km2. Information about the operation of flood assets should not be published.. 6.1 Where we have supplied model data which may include model inputs or outputs you agree to supply to the Environment Agency copies of any assessments/studies and related outputs, modifications or derivatives created pursuant to the supply to you of the Information, all of which are hereinafter referred to as "the Data". 6.2 You agree, in the public interest to grant to the Environment Agency a perpetual royalty free non-exclusive licence to use the Data or any part thereof for its internal purposes or to use it in any way as part of Environment Agency derivative products which it supplies free of charge to others such as incorporation into the Environment Agency's Open Data mapping products.
Information Warnings	Please be aware that model data is not raw, factual or measured but comprises of estimations or modelled results based on the data available to us. This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.
Attribution	Contains Environment Agency information © Environment Agency and/or database rights. May contain Ordnance Survey data © Crown copyright 2017 Ordnance Survey 100024198.

Here is the link to the climate change allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Further details about the Environment Agency information supplied can be found on the GOV.UK website:

https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments

https://www.gov.uk/planning-applications-assessing-flood-risk
https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Data Available Online

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

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

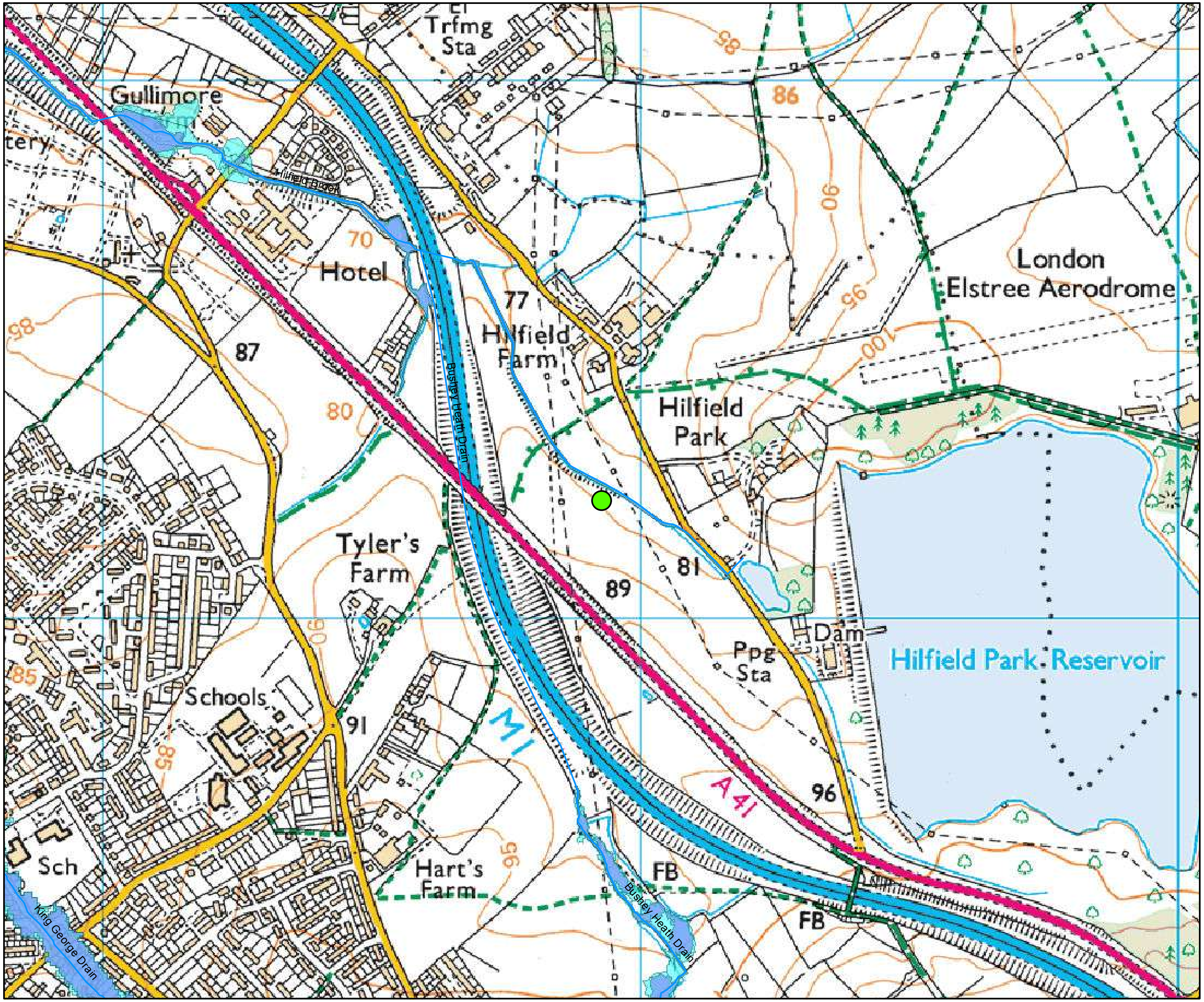
Yours sincerely

Naoimh Richardson
Customers and Engagement Officer

☎ 0203 0257507 HNLenquiries@environment-agency.gov.uk
✉ **Environment Agency, Hertfordshire and North London**
Alchemy, Bessemer Road, Welwyn Garden City, Hertfordshire, AL7 1HE
Pronouns: she/her (why is this here?)

Working days: Monday to Friday 7am – 3pm

Flood Map for Planning centred on: TQ 14932 96217 - 27/07/2020 - HNL178901NR



Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

0 150 300 600
Metres

Legend

Main Rivers
Site location

Flood Map for Planning

Flood Storage Area
Areas Benefiting from Flood Defences
Flood Zone 3
Flood Zone 2

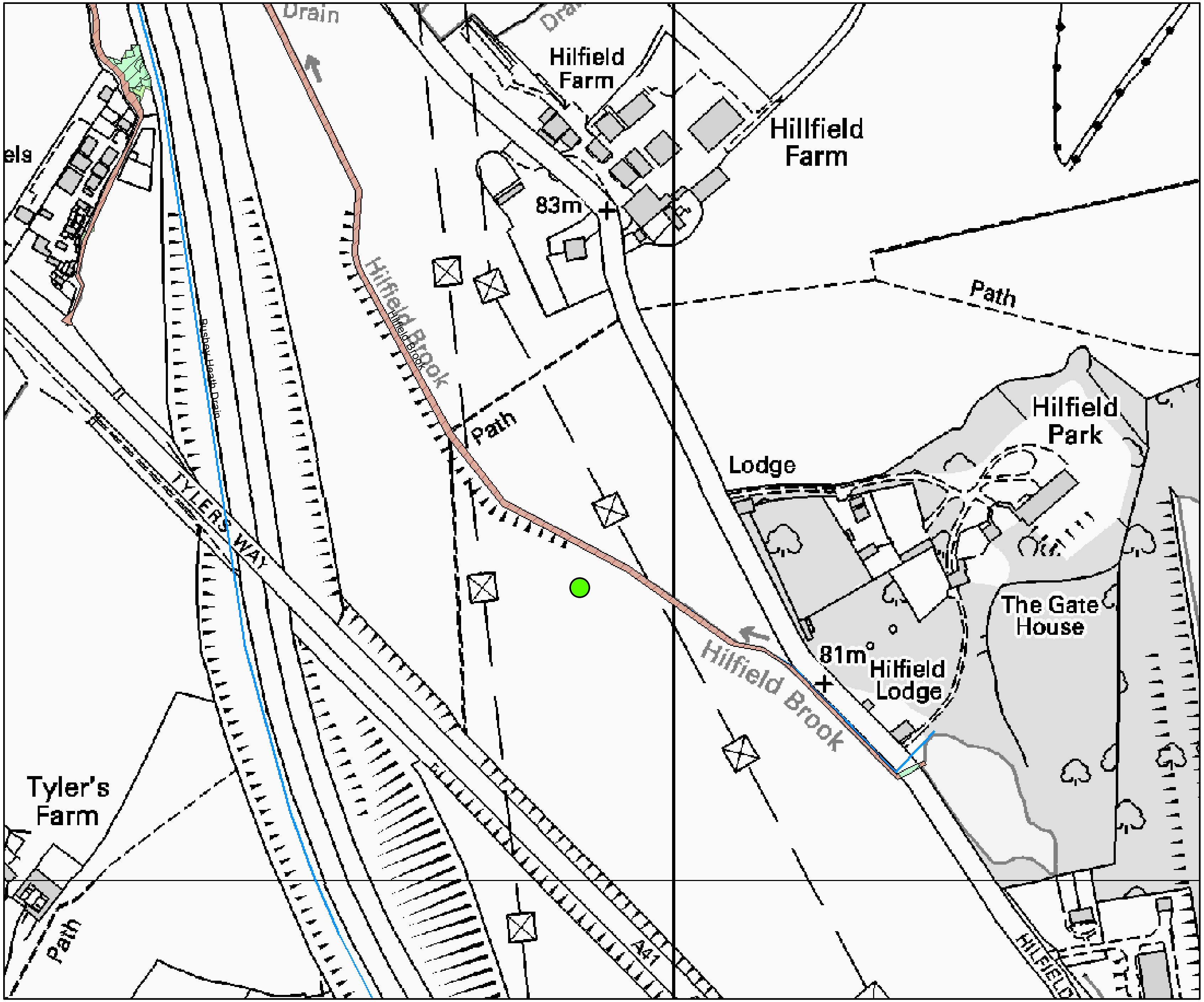
Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: TQ 14932 96217 - 27/07/2020 - HNL178901NR



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

0 60 120 240
Metres

Legend

- Main Rivers
- Site location

Defended Flood Outlines

- 1 in 2 (50%) Defended
- 1 in 5 (20%) Defended
- 1 in 10 (10%) Defended
- 1 in 20 (5%) Defended

The data in this map has been extracted from the Upper Colne Flood Risk Mapping Study (Halcrow, 2010). This model has been designed for catchment wide flood riskmapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

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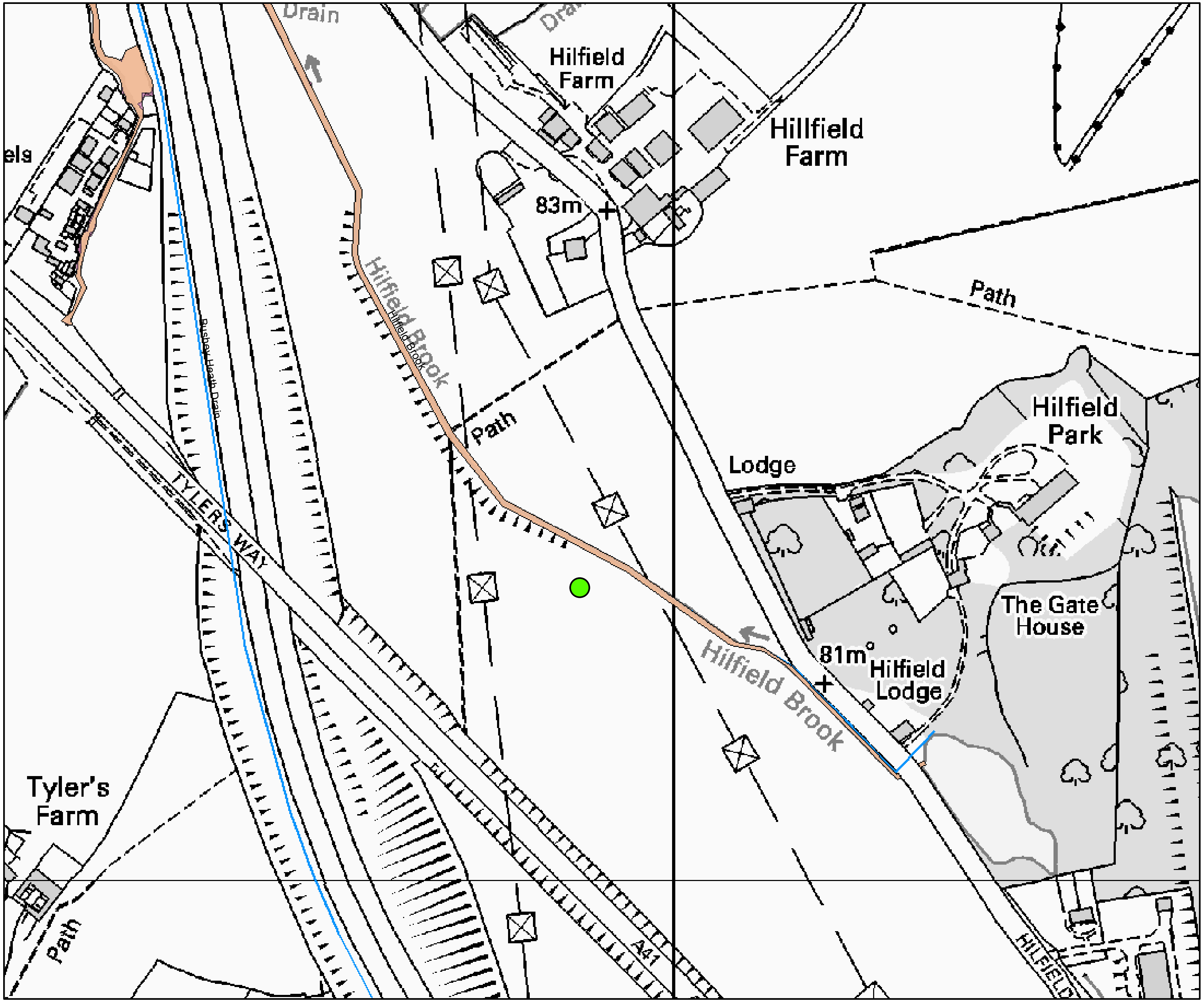
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: TQ 14932 96217 - 27/07/2020 - HNL178901NR



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

0 60 120 240
Metres

Legend

Main Rivers
Site location

Defended Flood Outlines

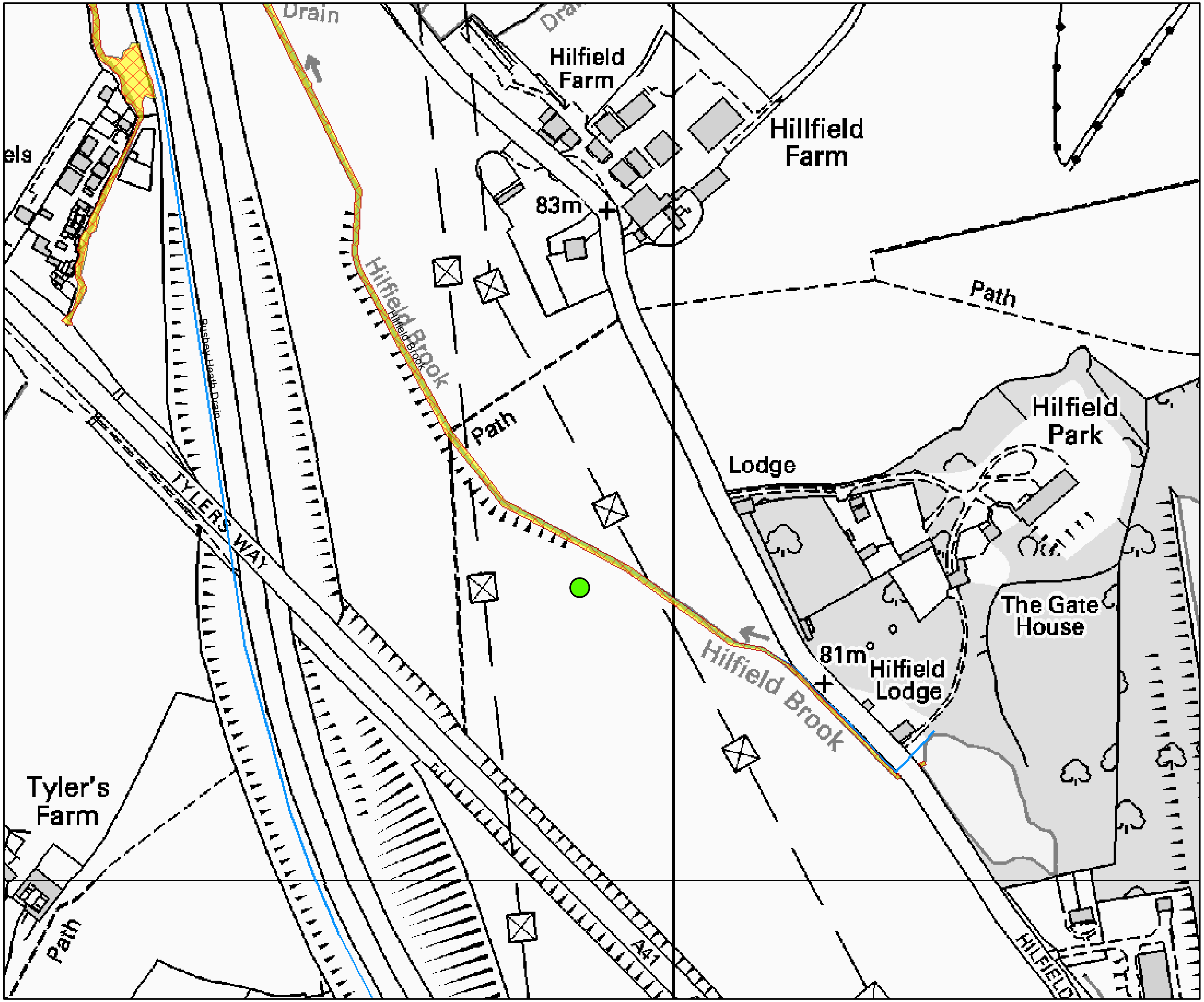
1 in 50 (2%) Defended
1 in 100 (1%) Defended
1 in 200 (0.5%) Defended

The data in this map has been extracted from the Upper Colne Flood Risk Mapping Study (Halcrow, 2010). This model has been designed for catchment wide flood riskmapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: TQ 14932 96217 - 27/07/2020 - HNL178901NR



Environment Agency

Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

0 60 120 240
Metres

Legend

Main Rivers
Site location

Defended Flood Outlines

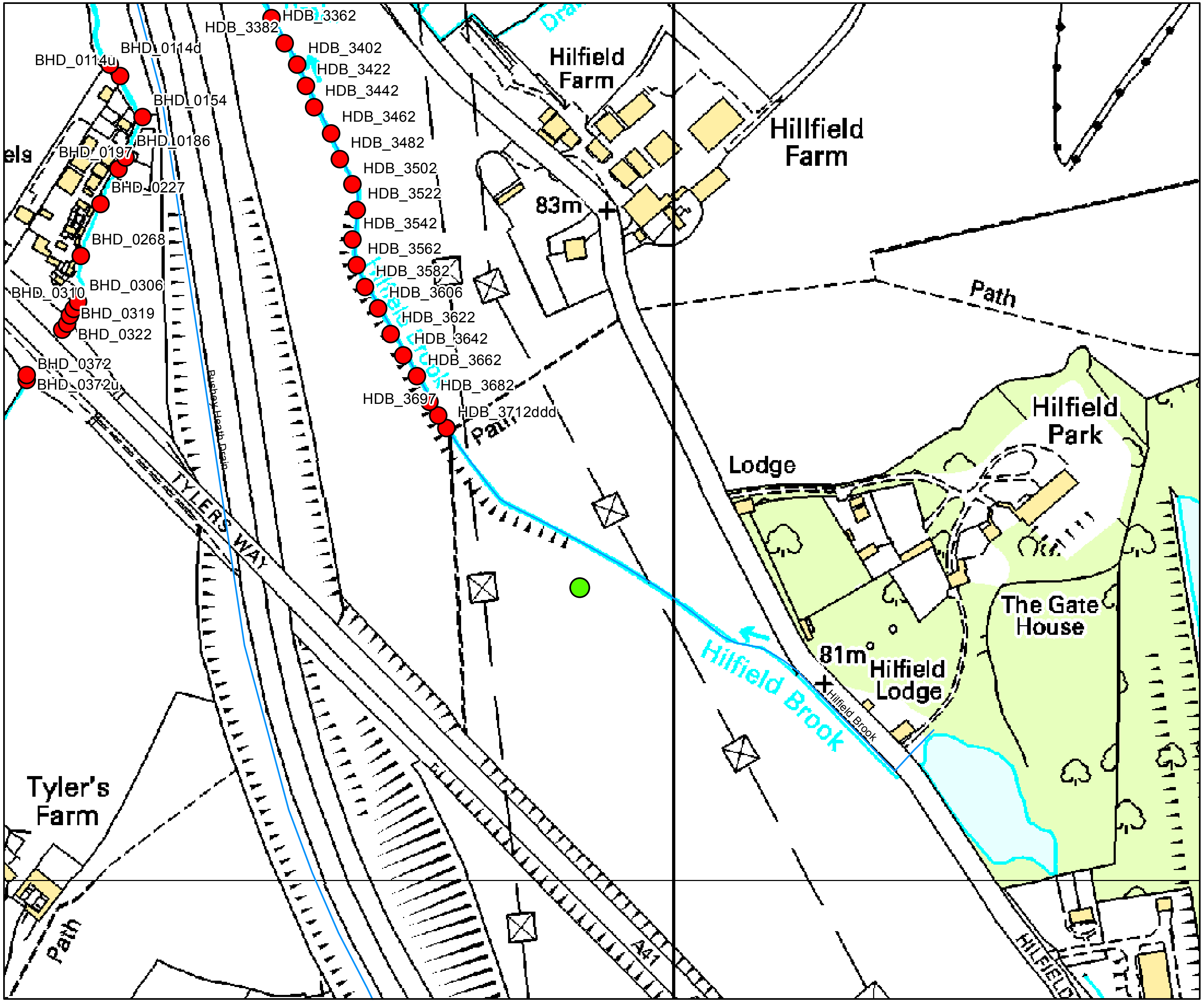
1 in 100+20% (*CC) Defended
1 in 1000 (0.1%) Defended

The data in this map has been extracted from the Upper Colne Flood Risk Mapping Study (Halcrow, 2010). This model has been designed for catchment wide flood riskmapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA centred on: TQ 14932 96217 - 27/07/2020 - HNL178901NR



Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

0 60 120 240
Metres

Legend

Main Rivers
Site location

1D Node Results

Node Results

The data in this map has been extracted from the Upper Colne Flood Risk Mapping Study (Halcrow, 2010). This model has been designed for catchment wide flood riskmapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Environment Agency ref: HNL178901NR

The following information has been extracted from the Upper Colne Flood Risk Mapping Study (Halcrow, 2010)

Flood risk data requests including an allowance for climate change will be based on the 1 in 100 flood plus 20% allowance for climate change, unless otherwise stated. You should refer to 'Flood risk assessments: climate change allowances' to check if this allowance is still appropriate for the type of development you are proposing and its location. You may need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.

https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Caution:
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment.

All flood levels are given in metres Above Ordnance Datum (mAOD)
All flows are given in cubic metres per second (cumecs)

Based on an understanding of the data used to develop the hydraulic and hydrological model, and the resolution of hydrological and hydraulic representation, a confidence score of 1 (high) to 5 (low) was attributed to model results within different reaches of the Upper Colne catchment for each of the following four aspects and an average produced to provide an overall confidence score.

- Hydrological Data
- Hydrological Analysis
- Hydraulic Data
- Hydraulic Analysis

MODELLED FLOOD LEVEL

			Return Period									
Node Label	**Easting**	**Northing**	**2 yr**	**5 yr**	**10 yr**	**20yr**	**50yr**	**100yr**	**100yr +20%**	**200yr**	**1000yr**	**Confidence**
HDB_3712ddd	514832	196335	76.16	76.23	76.28	76.32	76.38	76.42	76.49	76.46	76.59	2
HDB_3697	514826	196345	75.77	75.86	75.93	75.97	76.05	76.10	76.18	76.15	76.30	2
HDB_3682	514819	196355	75.55	75.64	75.70	75.74	75.82	75.87	75.94	75.92	76.06	2
HDB_3662	514810	196374	75.20	75.29	75.35	75.40	75.47	75.53	75.59	75.57	75.71	2
HDB_3642	514800	196390	74.85	74.94	75.01	75.05	75.12	75.17	75.23	75.21	75.34	2
HDB_3622	514790	196406	74.57	74.66	74.73	74.77	74.84	74.89	74.95	74.93	75.05	2
HDB_3606	514781	196424	74.38	74.48	74.56	74.60	74.68	74.73	74.80	74.78	74.91	2
HDB_3582	514771	196440	74.04	74.12	74.20	74.24	74.32	74.38	74.46	74.43	74.58	2
HDB_3562	514765	196457	73.82	73.92	74.00	74.05	74.13	74.19	74.28	74.25	74.41	2
HDB_3542	514762	196476	73.67	73.76	73.82	73.87	73.94	73.99	74.07	74.04	74.19	2
HDB_3522	514765	196498	73.37	73.45	73.51	73.56	73.63	73.69	73.77	73.74	73.89	2
HDB_3502	514762	196517	73.17	73.26	73.33	73.38	73.46	73.52	73.60	73.57	73.74	2
HDB_3482	514752	196536	72.99	73.08	73.15	73.20	73.28	73.34	73.42	73.39	73.55	2
HDB_3462	514746	196555	72.84	72.93	73.01	73.06	73.14	73.19	73.27	73.24	73.40	2
HDB_3442	514733	196574	72.66	72.75	72.82	72.87	72.95	73.01	73.08	73.05	73.20	2

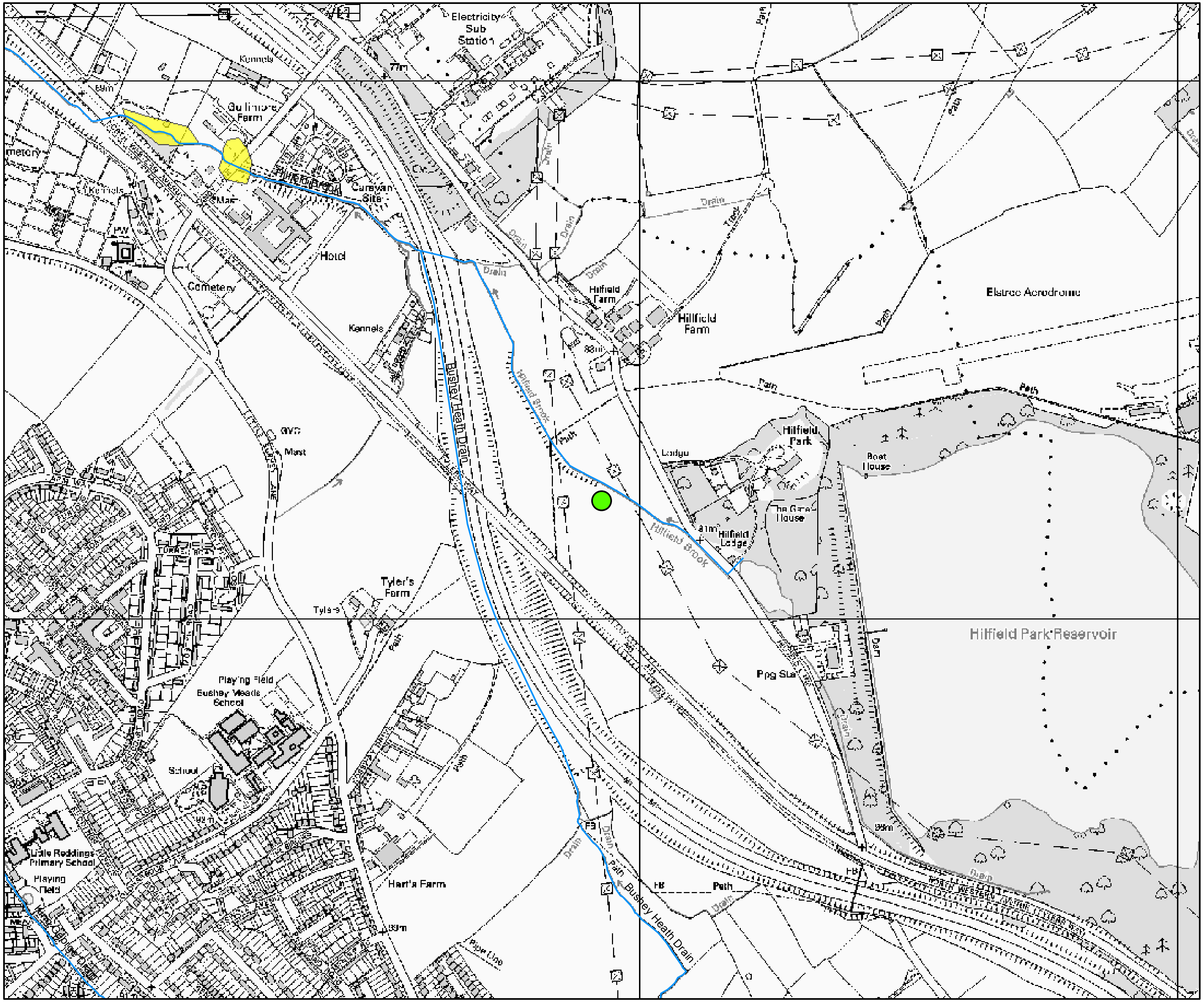
HDB_3422	514727	196590	72.48	72.56	72.63	72.67	72.74	72.79	72.87	72.84	72.98	2
HDB_3402	514721	196606	72.32	72.41	72.47	72.51	72.58	72.63	72.71	72.68	72.82	2
HDB_3382	514711	196622	72.15	72.22	72.28	72.32	72.38	72.43	72.49	72.47	72.60	2
HDB_3362	514702	196641	71.89	71.96	72.02	72.05	72.12	72.17	72.24	72.22	72.37	2
BHD_0372	514519	196371	77.90	77.99	78.06	78.12	78.21	78.28	78.39	78.35	78.57	2
BHD_0372u	514519	196375	77.89	77.98	78.06	78.11	78.21	78.28	78.39	78.35	78.57	2
BHD_0323	514546	196409	77.04	77.11	77.17	77.21	77.27	77.32	77.39	77.37	77.51	2
BHD_0322	514549	196413	77.04	77.11	77.17	77.21	77.28	77.33	77.41	77.38	77.54	2
BHD_0319	514552	196419	76.43	76.52	76.59	76.65	76.73	76.80	76.89	76.86	77.04	2
BHD_0310	514554	196424	76.36	76.46	76.53	76.58	76.65	76.72	76.80	76.77	76.94	2
BHD_0306	514558	196430	76.29	76.38	76.45	76.50	76.57	76.63	76.71	76.69	76.85	2
BHD_0268	514560	196464	75.73	75.81	75.87	75.91	75.98	76.04	76.12	76.09	76.25	2
BHD_0227	514574	196502	74.96	75.05	75.11	75.16	75.24	75.29	75.37	75.34	75.49	2
BHD_0197	514588	196528	74.55	74.64	74.70	74.74	74.81	74.86	74.92	74.90	75.02	2
BHD_0186	514593	196537	74.40	74.47	74.53	74.57	74.63	74.67	74.73	74.71	74.83	2
BHD_0154	514606	196567	73.93	73.99	74.04	74.07	74.12	74.16	74.20	74.19	74.26	2
BHD_0114u	514589	196597	73.50	73.58	73.61	73.63	73.66	73.67	73.67	73.67	73.75	2
BHD_0114d	514581	196606	73.26	73.33	73.39	73.43	73.50	73.54	73.59	73.58	73.63	2

MODELLED FLOWS

			Return Period									
Node Label	**Easting**	**Northing**	**2 yr**	**5 yr**	**10 yr**	**20yr**	**50yr**	**100yr**	**100yr +20%**	**200yr**	**1000yr**	**Confidence**
HDB_3712ddd	514832	196335	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3697	514826	196345	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3682	514819	196355	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3662	514810	196374	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3642	514800	196390	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3622	514790	196406	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3606	514781	196424	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3582	514771	196440	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3562	514765	196457	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3542	514762	196476	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3522	514765	196498	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3502	514762	196517	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3482	514752	196536	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3462	514746	196555	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3442	514733	196574	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2

HDB_3422	514727	196590	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3402	514721	196606	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3382	514711	196622	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
HDB_3362	514702	196641	0.75	1.02	1.27	1.45	1.77	2.05	2.46	2.31	3.22	2
BHD_0372	514519	196371	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0372u	514519	196375	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0323	514546	196409	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0322	514549	196413	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0319	514552	196419	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0310	514554	196424	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0306	514558	196430	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0268	514560	196464	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0227	514574	196502	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0197	514588	196528	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0186	514593	196537	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0154	514606	196567	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0114u	514589	196597	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2
BHD_0114d	514581	196606	0.73	1.00	1.24	1.42	1.74	2.01	2.41	2.26	3.15	2

Historic Flood Map centred on: TQ 14932 96217 - 27/07/2020 - HNL178901NR



Environment Agency
Alchemy,
Bessemer Road,
Welwyn Garden City,
Hertfordshire,
AL7 1HE

0 150 300 600
Metres

Legend

Main Rivers

Site location

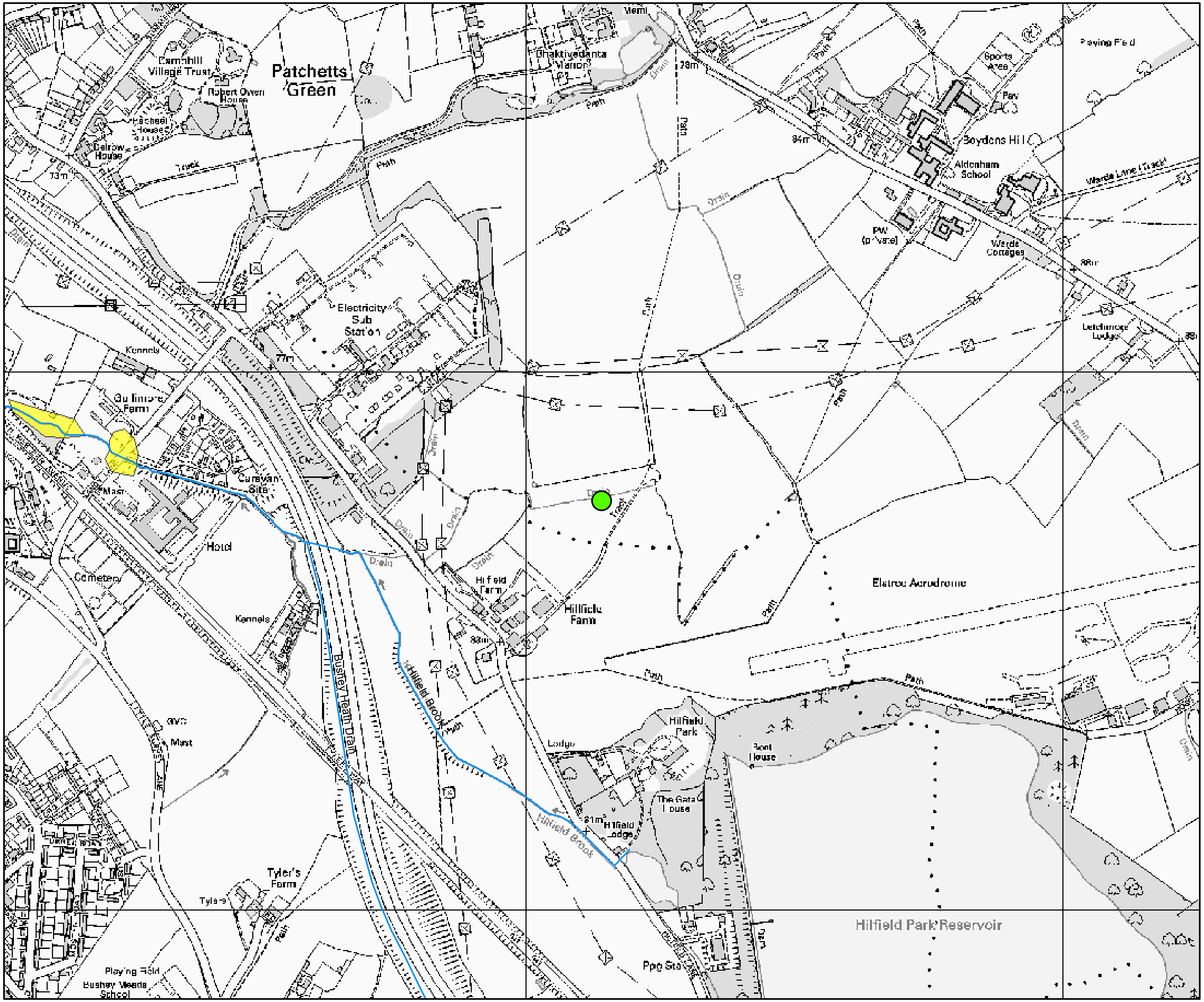
Flood Event Outlines

1988

The historic flood event outlines are based on a combination of anecdotal evidence, Environment Agency staff observations and survey.
Our historic flood event outlines do not provide a definitive record of flooding.
It is possible that there will be an absence of datain places where we have not been able to record the extent of flooding.
It is also possible for errors occur in the digitisation of historic records of flooding.

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Historic Flood Map centred on:TQ 15160 96765 - 27/07/2020 - HNL178901NR



Environment Agency
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0 150 300 600
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