Springwell Solar Farm

Flood Risk Assessment

(Clean)

EN010149/APP/7.16.2
Revision 2
January 2025
Springwell Energyfarm Ltd

APFP Regulation 5(2)(q)

Planning Act 2008

Infrastructure Planning
(Applications: Prescribed Forms
and Procedure) Regulations 2009

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Appendix A - Outline Drainage Strategy

1. Introduction

1.1.1. RSK Land and Development Engineering Ltd was commissioned by Springwell Energyfarm Limited (the Applicant) to provide a Flood Risk Assessment (FRA) to be submitted as part of the Development Consent Order (DCO) Application for Springwell Solar Farm (the Proposed Development). A water Environmental Statement (ES) chapter (**ES Volume 1, Chapter 15: Water** [**EN010149/APP/6.1**]) has been prepared with reference to this FRA.

1.1.2. The purpose of the FRA is to establish the flood risk associated with the Proposed Development and to propose suitable mitigation, if required, to reduce it to an acceptable level. The FRA must demonstrate that the development will be safe for its lifetime (assumed to be 40 years) taking account of the vulnerability of its users, without increasing flood risk elsewhere.

1.1.3. This document has been produced to assess the flood risk from tidal, fluvial, surface water, groundwater, sewers, reservoirs and artificial sources in line with the National Planning Policy Framework (NPPF) **[Ref. 1]**, its corresponding Planning Practice Guidance (PPG) **[Ref. 2]** and the Overarching National Policy Statement for Energy (EN-1) **[Ref. 3]**.

1.1.4. This assessment has been undertaken in consultation with the relevant authorities, and with reference to data, documents and guidance published by the Environment Agency, the Lead Local Flood Authority (Lincolnshire County Council), the Local Planning Authority (North Kesteven District Council), the Water Authority (Anglian Water) and the Witham First District Internal Drainage Board.

2. Existing site

2.1. Site location and Proposed Development

2.1.1. The Proposed Development comprises a large scale solar photovoltaic (PV) electricity generating and battery storage facility with associated infrastructure which would allow for the generation and export of electricity exceeding 50 megawatts (MW). The full description of the Proposed Development is provided within **ES Volume 1, Chapter 3: Proposed Development Description** [**EN010149/APP/6.1**].

2.1.2. The majority of the Site consists of agricultural land. The Site is located in North Kesteven, Lincolnshire. The Order Limits of the Proposed Development are presented in **Location, Order Limits and Grid Coordinate Plans [EN010149/APP/2.1]**. The area surrounding the Proposed Development is rural with a mixture of small villages and current Royal Air Force facilities / bases.

2.2. Topography

2.2.1. Based on high level analysis of Department for Environment, Food & Rural Affairs's (Defra) ground survey data **[Ref. 4]** (provided as Light Detection and Ranging (LIDAR) survey data) within QGIS (industry standard GIS software), reproduced below as **Plate 2.1,** the Site generally slopes from west to east from approximately 60 metres above ordnance datum (mAOD) down to 5 mAOD. The mapping also highlights several valleys throughout the area.

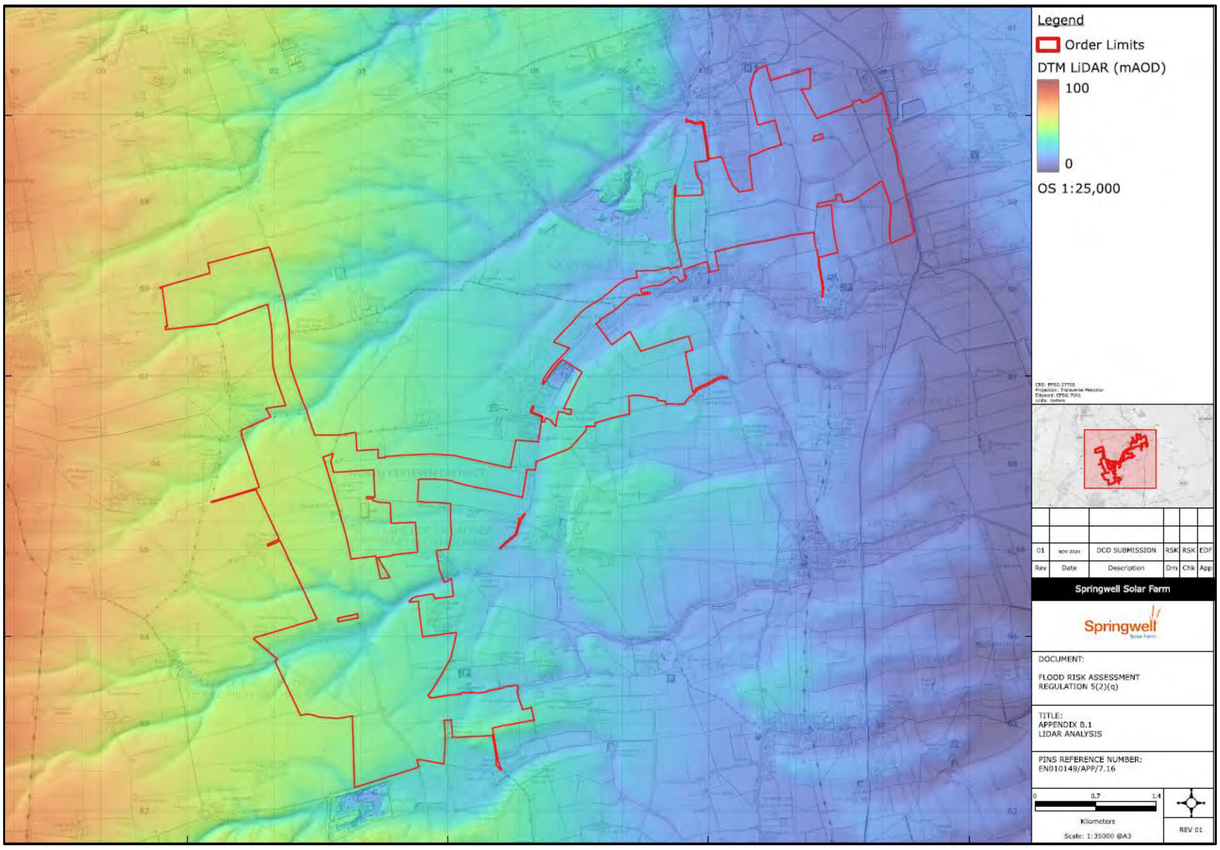


Plate 2.1: QGIS LiDAR Analysis (Defra) (full map in Appendix B.1)

2.3. Existing Drainage

2.3.1. Surface water runoff from the Site currently discharges to several surface water channels throughout the Site via overland flow or via infiltration to ground. There are several unnamed Ordinary Watercourses which can be described as field boundary ditches across the site.

2.3.2. There are likely to be land drains which will assist with the drainage of arable land within the Order Limits. The presence and location of land drains are unconfirmed given the historic and informal nature of the construction of land drainage.

2.4. Geology

2.4.1. The Site is recorded on the British Geological Survey (BGS) online mapping **[Ref. 5]** as typically lying above limestone bedrock in the form of:

- Lincolnshire Limestone Formation;
- Blisworth Limestone Formation;
- Upper Lincolnshire Limestone Member;

- Lower Lincolnshire Limestone Member;
- Cornbrash Formation; and
- Occasional areas of Blisworth Clay Formation - Mudstone.

2.4.2. BGS mapping highlights minimal superficial deposits in the area, with isolated areas of Tidal Flat Deposits - Clay and Silt and Sleaford Sand and Gravel present around the local watercourses.

2.5. Hydrology

2.5.1. There are several Environment Agency Main Rivers in proximity to the Site (though noted to be outside a 1 km buffer from the Order Limits). Springwell Brook is located at Digby, approximately 2 km east of Field Bcd141. This Main River is fed by several small field drains and drainage ditches. New Cut Drain is located approximately 2 km south of Field Lf11.

2.5.2. Further named watercourses in the area include Metheringham Beck which flows north from the site at Field By04. Though the watercourse is an Ordinary Watercourse within the Order Limits, it does become a Main River approximately 2.1 km north from Field By04.

2.5.3. All watercourses not deemed to be Main Rivers would fall under the jurisdiction of Lincolnshire County Council as Lead Local Flood Authority or the Witham First Internal Drainage Board. Based on the Ordnance Survey (OS) mapping **[Ref. 6]**, the mapped watercourses in the area typically extend to the B1191 (west of Scopwick/Ashby de la Launde) and the B1180 (west of Blankney), though there are numerous small field drains and ditches which are aligned along the perimeters of a number of the fields within the Order Limits.

2.6. Hydrogeology

2.6.1. Hydrogeological information was obtained from Defra's online Magic Map **[Ref. 7]** service. These maps indicate that:

- The majority of the Site is not underlain by a superficial aquifer. The areas of the Site that do have superficial deposits are Secondary (A) superficial aquifers;
- The majority of the Site is underlain by a Principal bedrock aquifer, with some areas where the limestone designation changes being Secondary (A and B) bedrock aquifers;
- The majority of the Site is located within an area of High groundwater vulnerability;
- The Site is also located within an area of Soluble Rock Risk; and

- The Site largely falls outside of any Source Protection Zone (SPZ), except for a small area to the west of Scopwick. This area falls within a localised inner zone (Source Protection Zone 1) which provides protection around a groundwater abstraction source located to the west of Scopwick, adjacent to Springwell Central. There are no outer catchments associated with this Source Protection Zone 1. There is also a total catchment zone (Source Protection Zone 3) located across the southern extent of Springwell West.

3. Flood risk

3.1. Criteria

3.1.1. In accordance with the NPPF, NPS EN-1 and advice from the Environment Agency, an assessment of the risk associated with various flooding sources is required along with consideration of the effects of climate change over the design life of the Proposed Development.

3.1.2. The Environment Agency's most recent climate change guidance, published in May 2022 **[Ref. 8]**, should be referenced in order to identify the appropriate peak river flow and rainfall intensity allowances for the Proposed Development. The appropriate allowance for peak river flow is based on the location of the Site in the country, the lifetime of the Proposed Development, the relevant Flood Zone and the vulnerability of the proposed end use.

3.1.3. The flood risk elements that need to be considered for any site are defined in BS 8533 'Assessing and managing flood risk in development Code of practice' **[Ref. 9]** as the "Forms of Flooding" and are listed as:

- Flooding from rivers (fluvial flood risk);
- Flooding from the sea (tidal flood risk);
- Flooding from the land;
- Flooding from groundwater;
- Flooding from sewers (sewer and drain exceedance, pumping station failure etc); and
- Flooding from reservoirs, canals and other artificial structures.

3.1.4. The following section reviews each of these in respect of the Site.

3.2. Fluvial flood risk

3.2.1. The Environment Agency Flood Map for Planning **[Ref. 10]** shows that the majority of the Site is located within Flood Zone 1, which represents a 1 in 1000 year or less annual probability of flooding from fluvial sources as shown in **Plate 3.1**. There is a small region within the northeastern corner of the Site that is located within Flood Zone 2 (between a 1 in 1000 and 1 in 100 annual probability of fluvial flooding) and Flood Zone 3 (a greater than 1 in 100 year annual probability of fluvial flooding). **Plate 3.2** below shows the northeastern region of the Site in which the Flood Zones intersect the Order Limits.

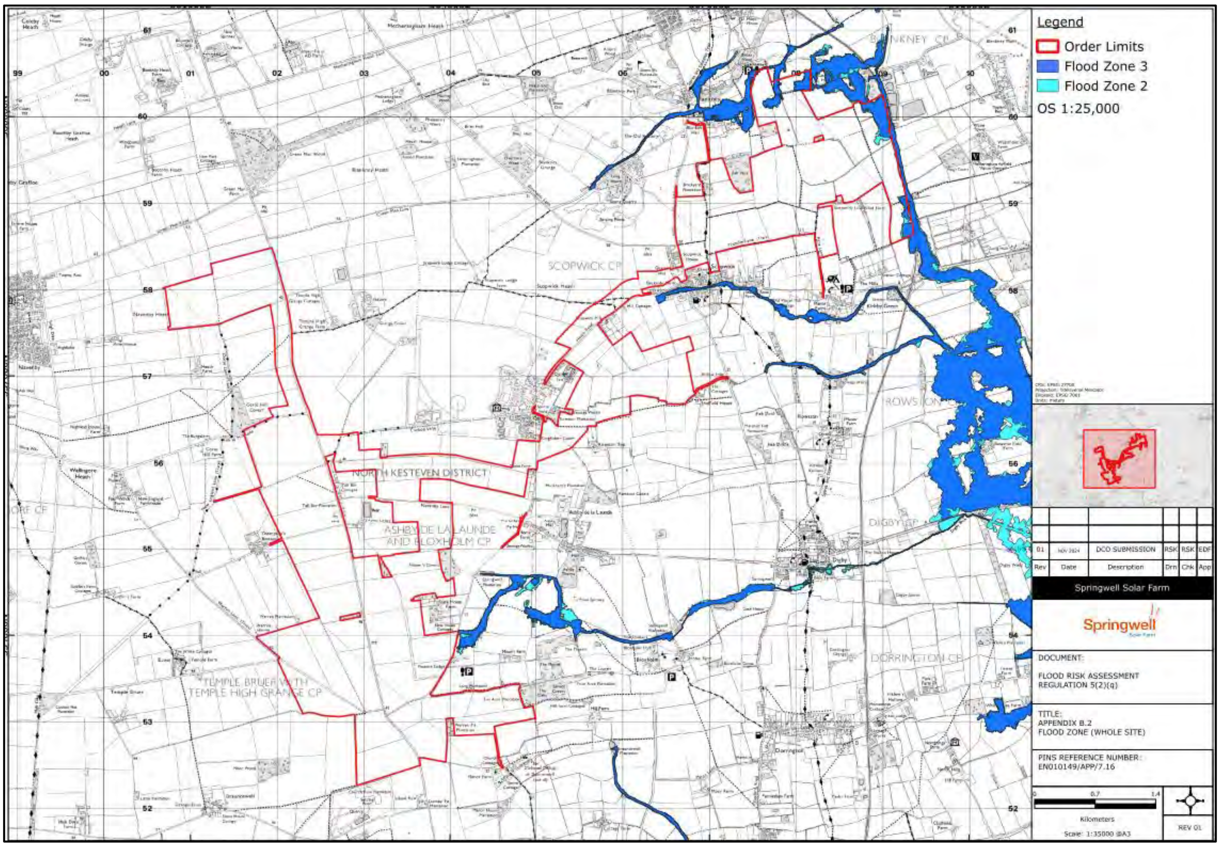


Plate 3.1: Environment Agency Flood Zones (model layer from Defra) – Whole site (full map in Appendix B.2)

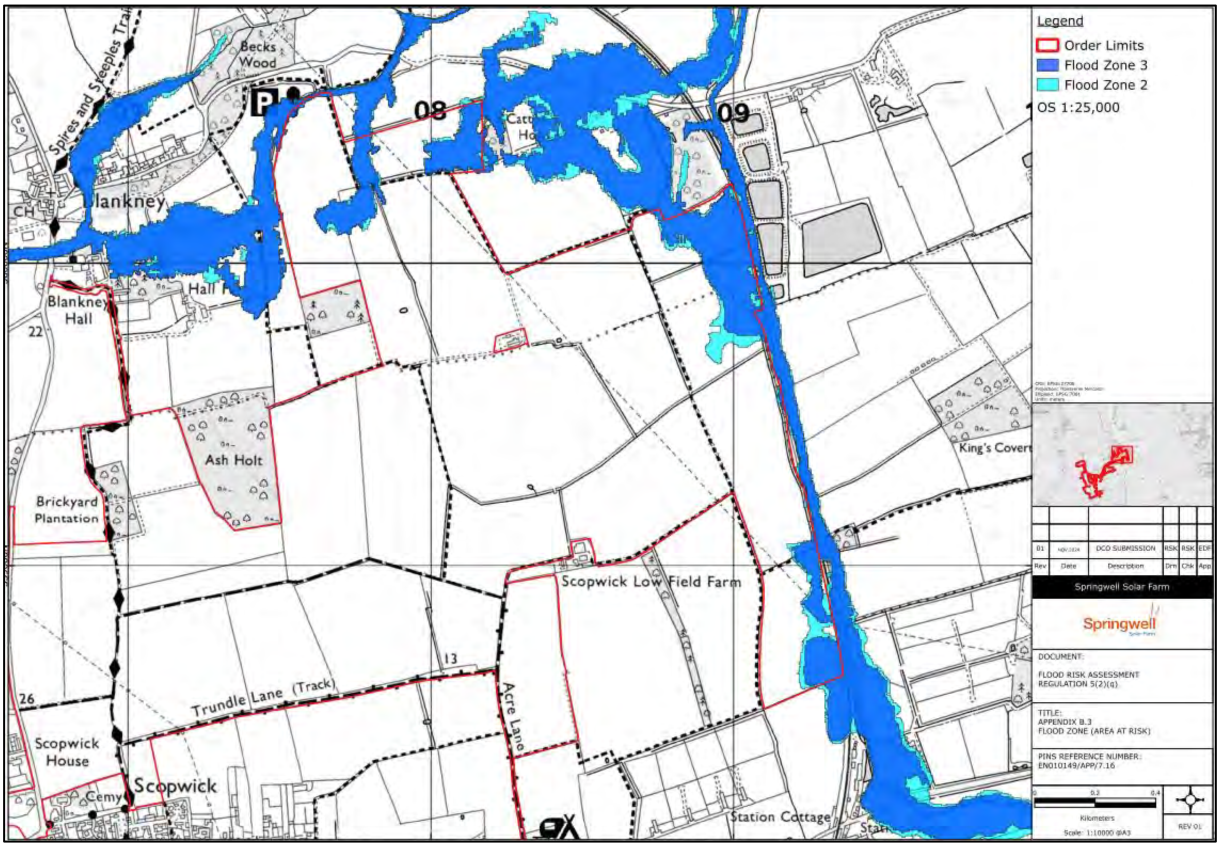
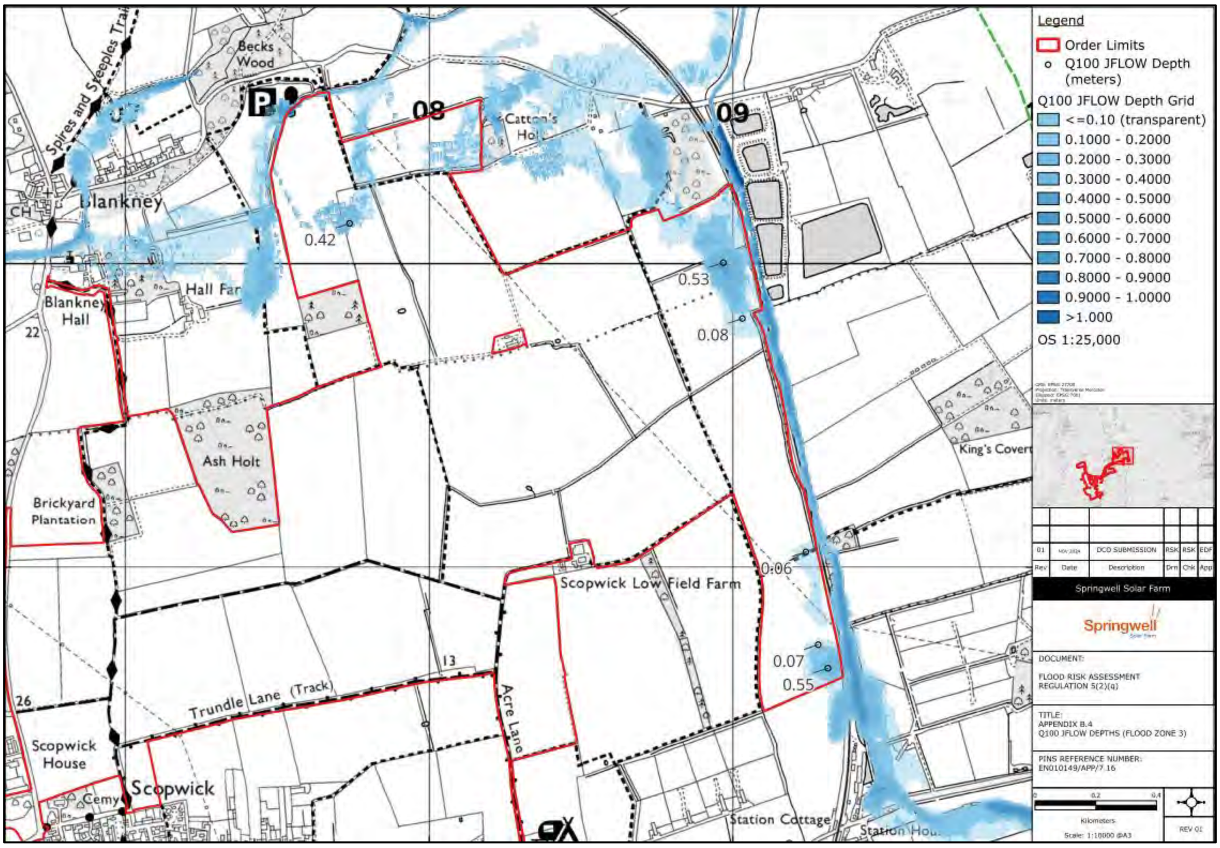


Plate 3.2: Environment Agency Flood Zones (model layer from Defra) – Areas at risk (full map in Appendix B.3)

3.2.2. The extents of flooding shown by Flood Zone 2 and Flood Zone 3 is associated with the Ordinary Watercourse that flows adjacent to the railway line that runs along the eastern area of the Order Limits. These flood waters emanate from the Environment Agency Main River (Springwell Beck) located to the southeast of the Site, with waters passing through several other surface water channels before reaching the eastern area of the Order Limits. The flood waters are generally contained within the channel next to the railway line, but they exceed channel capacity and spill over in the northeastern region of the Site. In this location there are several other surface water channels and ponded regions, which likely contribute additional flows, and thus resulting in more widespread flooding.

3.2.3. The Environment Agency was contacted as part of this assessment. It advised that the Flood Zones within this area were determined by the national scale generalised model, JFlow. JFlow modelling is generally considered to be low accuracy, broad-scale mapping. The Environment Agency issued JFlow Flood Zone depth grids with advice that these are likely to be inaccurate based on the nature of JFlow modelling outputs. This mapping revealed that flood depths within the Order Limits at the northeastern corner of the Site were approximately 300 mm, with some limited areas of lowered topography reaching approximately 549 mm in depth for the 1 in 100 year depth grid (equivalent to Flood Zone 3). This is shown on **Plate 3.3** which includes the JFLOW depth data for the area of Flood Zone 3 within the Order Limits with the deepest flooding with sample depths from the deepest points and sample depths at shallow areas for comparison.



Plates 3.3: JFlow 100 Year Model Depths with Samples (full map in Appendix B.4)

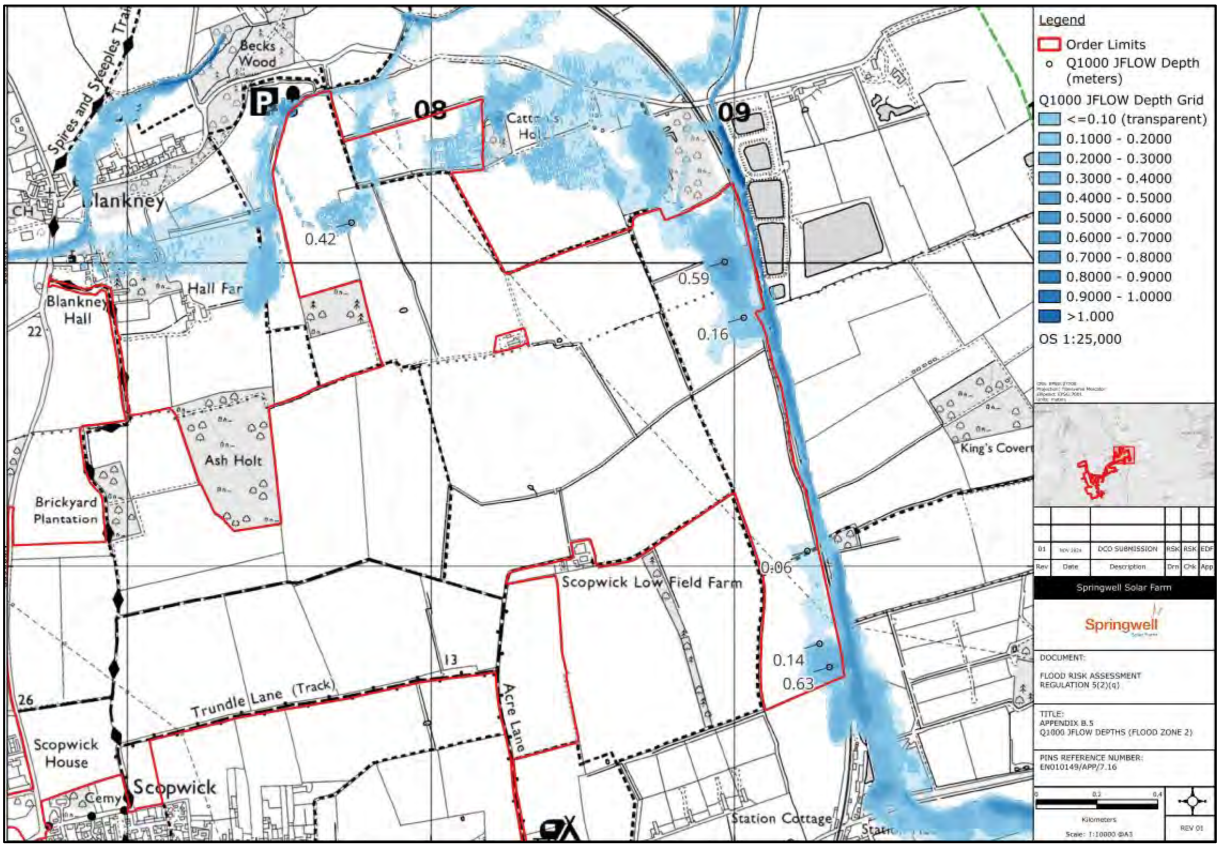
3.2.4. There are a number of Ordinary Watercourses within and around the Site. These have not been modelled by the Environment Agency and therefore have no associated Flood Zones on the Flood Map for Planning **[Ref. 10]**. Although there is the potential for these watercourses to overtop their banks, any associated flooding is likely to be localised to their respective channels. The Site is located on the edge of the Anglian and Humber catchments; being located at the head of both catchments, these watercourses are likely to receive relatively low flows and it is therefore unlikely that flooding within these channels will encroach significantly within the Site.

3.2.5. Fluvial flooding is likely to increase as a result of climate change. A greater intensity and frequency of precipitation is likely to raise river levels and increase the likelihood of a river overtopping its banks. Environment

Agency guidance **[Ref. 8]** and NPS EN-1 advocate a conservative approach to consideration of climate change for nationally significant infrastructure projects using a ‘credible maximum scenario’.

3.2.6. Environment Agency guidance on climate change advises that where it is appropriate to apply a credible maximum scenario then an upper end allowance should be used. Based on the design life of Springwell Solar Farm the development would not exceed the 2080’s threshold used for the climate change allowance categories, therefore the upper end allowance for the 2050’s climate change category has been used. The peak river flow climate change allowance for the upper end of the 2050’s within the Witham Management Catchment is 32%.

3.2.7. Due to the high-level nature of the flood modelling for Springwell Beck, it is not possible to quantify the fluvial flood level or extent for a 1 in 100 year plus 32% climate change flooding scenario. However, as a conservative approach the flood depths for the Flood Zone 2 JFlow depth model (equivalent to 1 in 1000 year) were provided. The greatest depth within the model within the Flood Zone 2 extents within Site reaches 626 mm. It is noted that the JFlow modelling is generally considered to be conservative, therefore the present day and climate change flood depths inferred in this report are inherently likely to be an overestimation. The JFlow mapping depths for the 1 in 1000 year return period are provided in **Plate 3.4** for the area of Flood Zone 2 within the Order Limits with the deepest flooding.



Plates 3.4: JFlow 1000 Year Model Depths with Samples (full map in Appendix B.5)

3.2.8. This is further evidenced by the Environment Agency's surface water flood risk modelling (discussed in **Section 3.4** of this report) which suggests a surface water depth of no greater than 300 mm in the present day scenario, and no greater than 600 mm in the proxy climate change scenario (taken as the 0.1% annual exceedance probability surface water depth flood map, discussed further in **Section 3.4**). There is minor encroachment of 0.1% annual exceedance probability of surface water flood risk within the 600 mm to 900 mm flood depth banding inside of the southern boundary of Field Lf11 which coincides with the approximate area of the greatest JFlow flood depth, however this is considered a negligible area of coverage within the Order Limits and these is uncertainty regarding the 300 mm interval provided within this range. The mapping is provided in **Plate 3.5**.

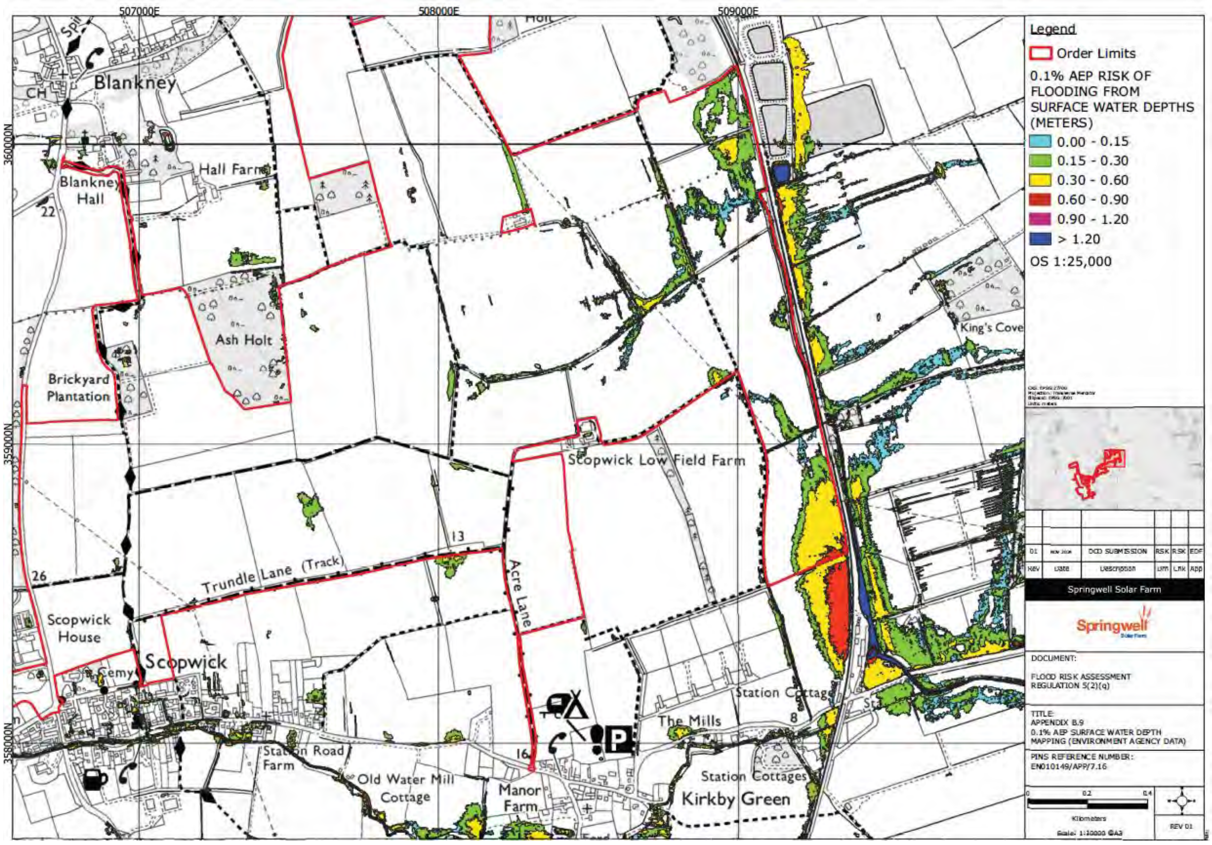


Plate 3.5: Surface water flood risk extents and depths for the 0.1% AEP modelled scenario. (full map in Appendix B.9)

3.2.9. To assess the uncertainty associated with 300mm further, the ground levels provided by LiDAR (as provided in **Plate 2.2**) was assessed further to determine the difference in ground levels between the area within the 300 mm to 600 m band of flooding depths, and 600 mm to 900 mm. The ground levels surrounding but outside of the area of 600 mm to 900 mm are approximately 6.10mAOD. Whilst the ground levels within the area of 600 mm to 900 mm flooding within the Order Limits are approximately 6.0 mAOD (there are no ground levels below this minimum). The minor differences in ground levels indicates that the surface water flood depths are likely to be close to the threshold value of 600 mm and unlikely to exceed 700 mm flooding.

3.2.10. Undertaking fluvial flood modelling to refine the flood extents was not considered proportionate to the scale of the risk and nature of the Proposed Development within Flood Zone 3. Following engagement with the Environment Agency (dated 7th March 2024 via video conference call) and on the response received (dated 30th April 2024 via email) it was agreed the use of JFlow modelling depths is acceptable for Solar PV modules provided a freeboard was included between estimated maximum depths. The freeboard height was not specified but professional judgement has been used to ensure Solar PV module panel heights are above the credible maximum scenario.

3.2.11. In response to a request by the Planning Inspectorate, additional fluvial hydraulic modelling has been undertaken to delineate Flood Zone 3a and 3b (functional flood zone). The basis of the model is a 2d overland flow model with inflows at each of the contributing watercourses. ReFH 2 methodology has been employed to estimate the inflows based on a contributing catchment analysis. ReFH 2 is the latest version of the Revitalised Flood Hydrograph (ReFH) model **(Ref: 11). Plate 3.6** shows the results of the hydraulic modelling and illustrates Flood Zone 3b in relation to the Proposed Development. It is noted that there are discrepancies in the results of the flood mapping where there are areas shown to be within the modelled Flood Zone 3b which sit outside of the Environment Agency Flood Zone 3 extent. This is shown on **Plate 3.7** below. **Plate 3.7** shows the extents of the modelled Flood Zone 3a, 3b and the Environment Agency Flood Zone 3 extent. For the purpose of this assessment all areas shown within the modelled flood extent or that within the Environment Agency mapped Flood Zone 3 are assumed to be located within Flood Zone 3.

3.2.12. The hydraulic modelling undertaken for the purpose of delineating Flood Zone 3b was based on a 2d model using flood modeller software. Inflows for each subcatchment have been derived from ReFH2 methodology and added as an inflow to each contributing watercourse. The resultant in channel and overland flow results have been used to generate the relevant flood maps, **Plate 3.6-3.8**. The ground model data used in the modelling have been derived from LiDAR.

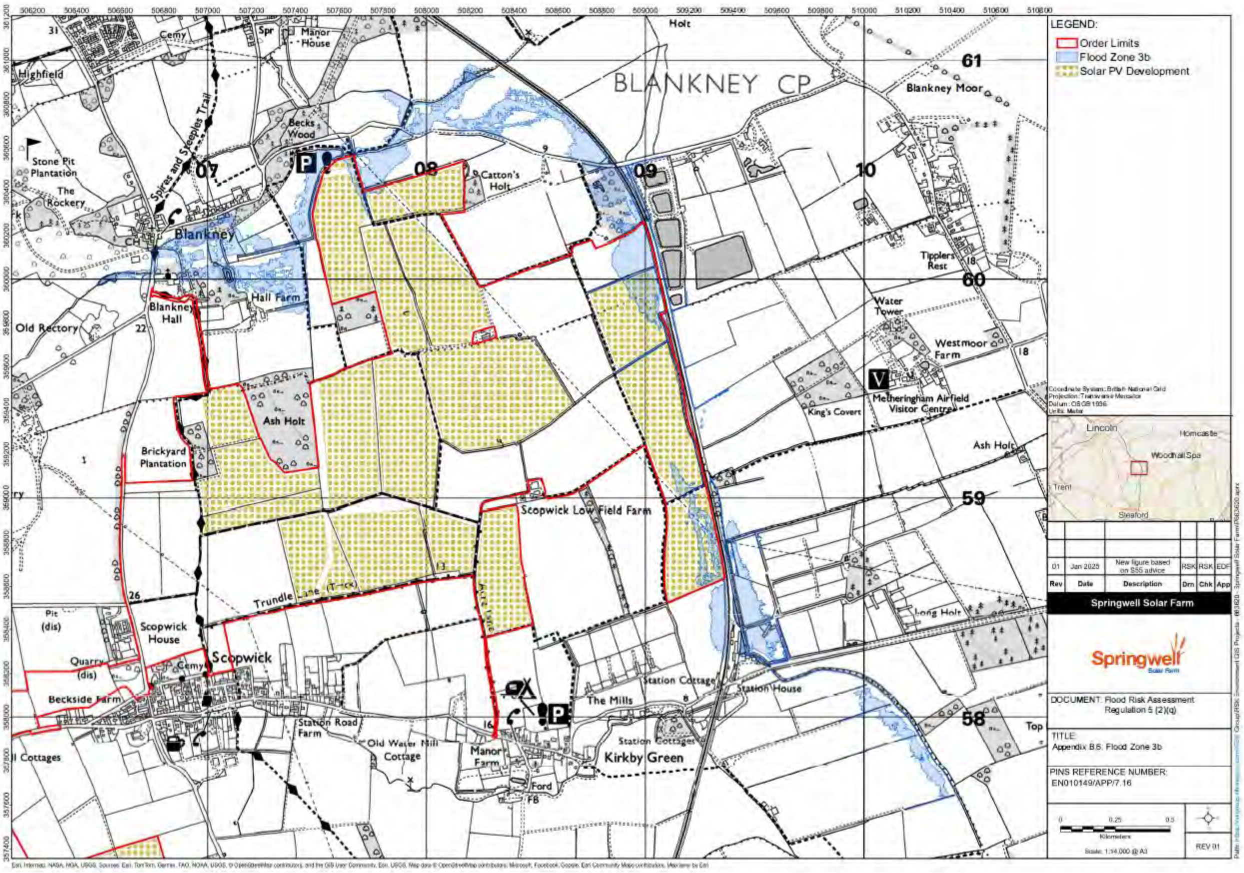


Plate 3.6: Modelled Flood Zone 3b (full map in Appendix B.6)

3.2.13. The resultant fluvial flood risk for the majority of the Site is **low**, whilst the areas deemed to be within Flood Zone 3a are considered to be **medium** risk and Flood Zone 3b as **high risk**.

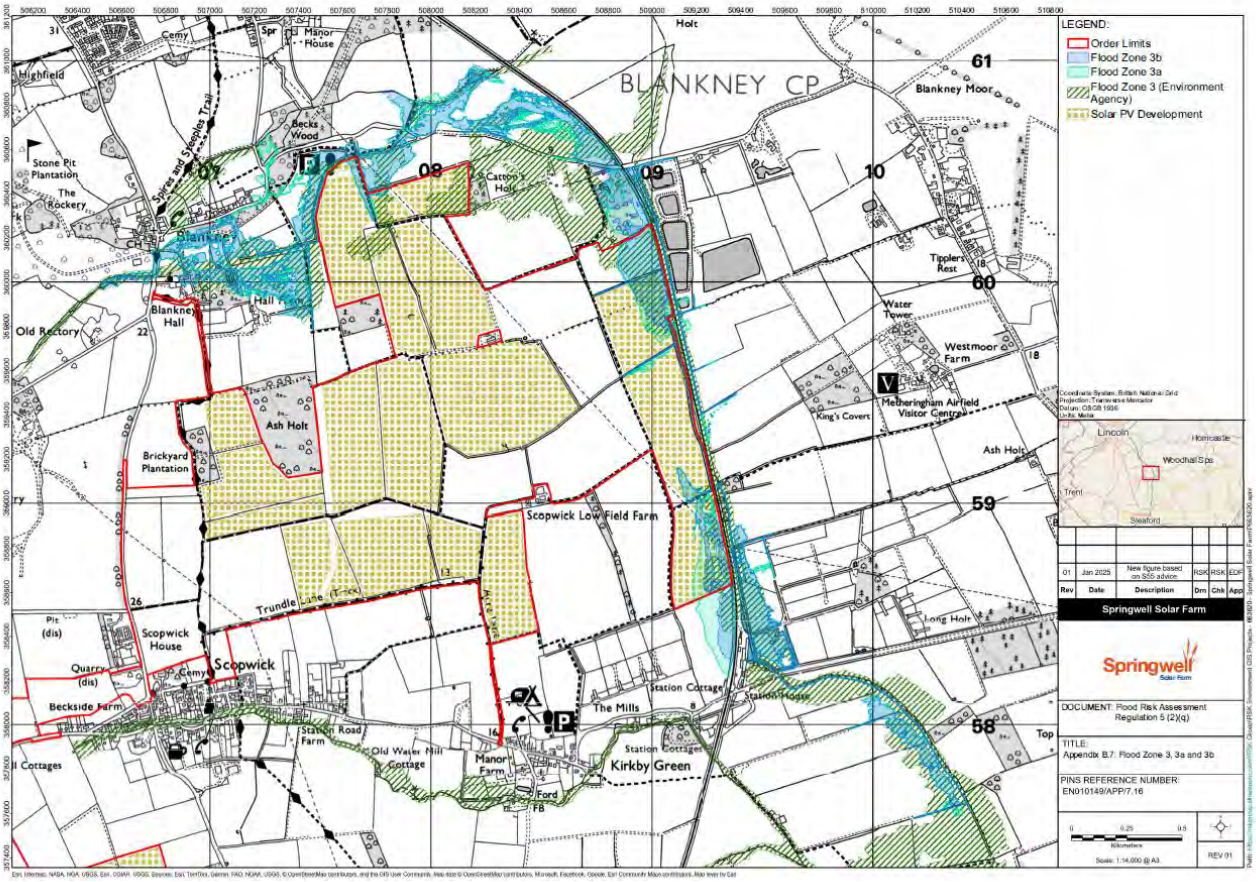


Plate 3.7: Flood Zone 3, 3a and 3b (full map in Appendix B.7)

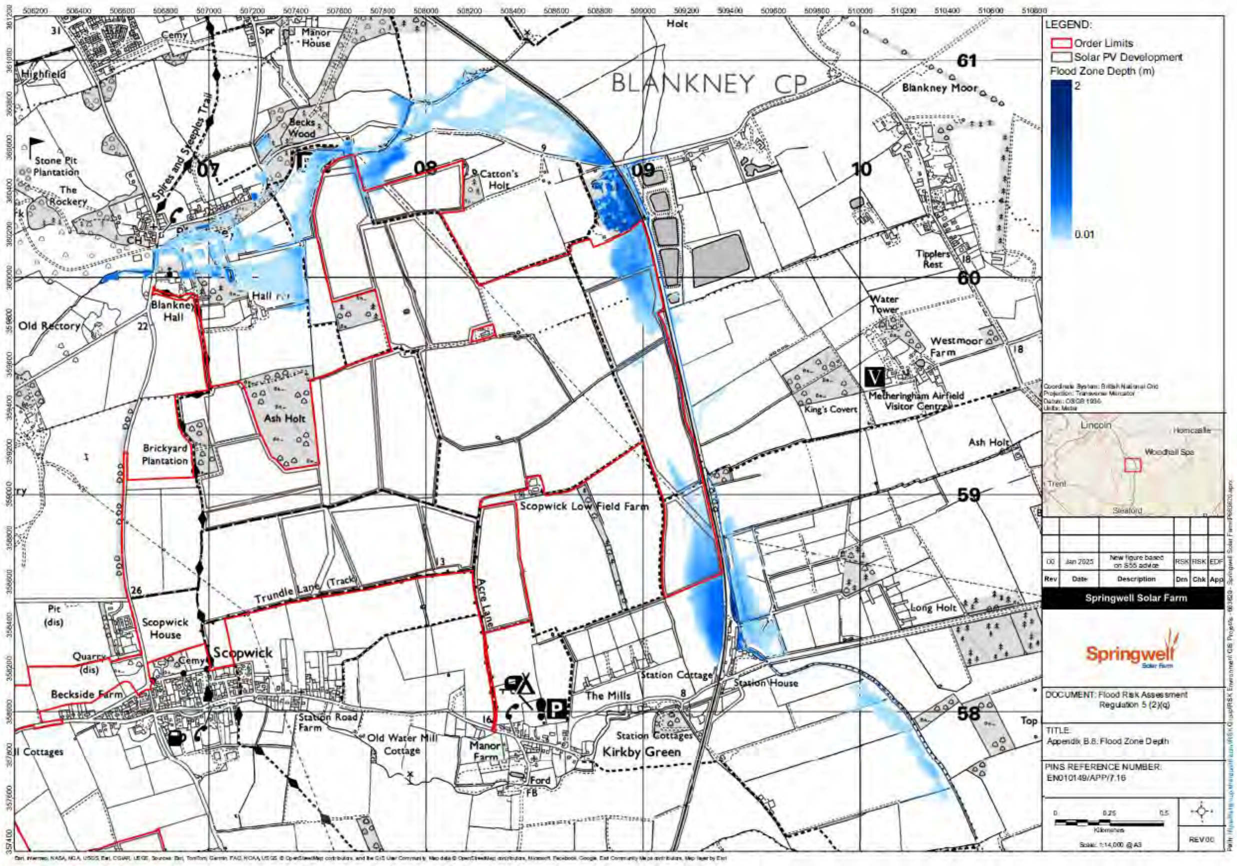


Plate 3.8: Flood Depth Modelling (full map in Appendix B.8)

3.3. Tidal flood risk

3.3.1. This Site is not considered to be at risk of flooding from tidal sources due to its inland location. The resultant flood risk is considered to be **very low.**

3.4. Surface water (pluvial) flood risk

3.4.1. If intense rain is unable to soak into the ground or be carried through manmade drainage systems, for a variety of reasons, it can run off over the surface causing localised floods before reaching a river or other watercourse.

3.4.2. Generally, where there is impermeable surfacing or where the ground infiltration capacity is exceeded, surface water runoff can occur. At present, excess surface water flows from the Site are believed to drain naturally to the local water features, either by overland flow or through infiltration.

3.4.3. The Environment Agency has produced surface water flood mapping to highlight areas at risk. This mapping has been overlaid within QGIS to show which regions of the Site may be at risk. The majority of the areas of flood risk at this Site are in the form of overland flow paths. At this Site these are areas where the topography is lowered and creates channel-like regions, resulting in the runoff from the surrounding area flowing towards these channels, collating the surface water and creating flow paths. These areas at risk within the Order Limits have been highlighted within **Plates 3.9** to **3.14**. The surface water modelling expected probabilities are provided as annual exceedance probability (AEP) which indicate a percentage chance of the flood event happening any given year.

3.4.4. **Plate 3.9** indicates an overland flow path crossing the southwestern region of the Site from west to east following the local topography of the region. This flow path is generally present during the 'medium' risk scenario i.e. between 1.0% annual exceedance probability and 3.3% annual exceedance probability, with some sections present during the 'high' risk scenario (greater than 3.3% annual exceedance probability). This flow path is generally contained within the area of lowered topography in the fielded area.

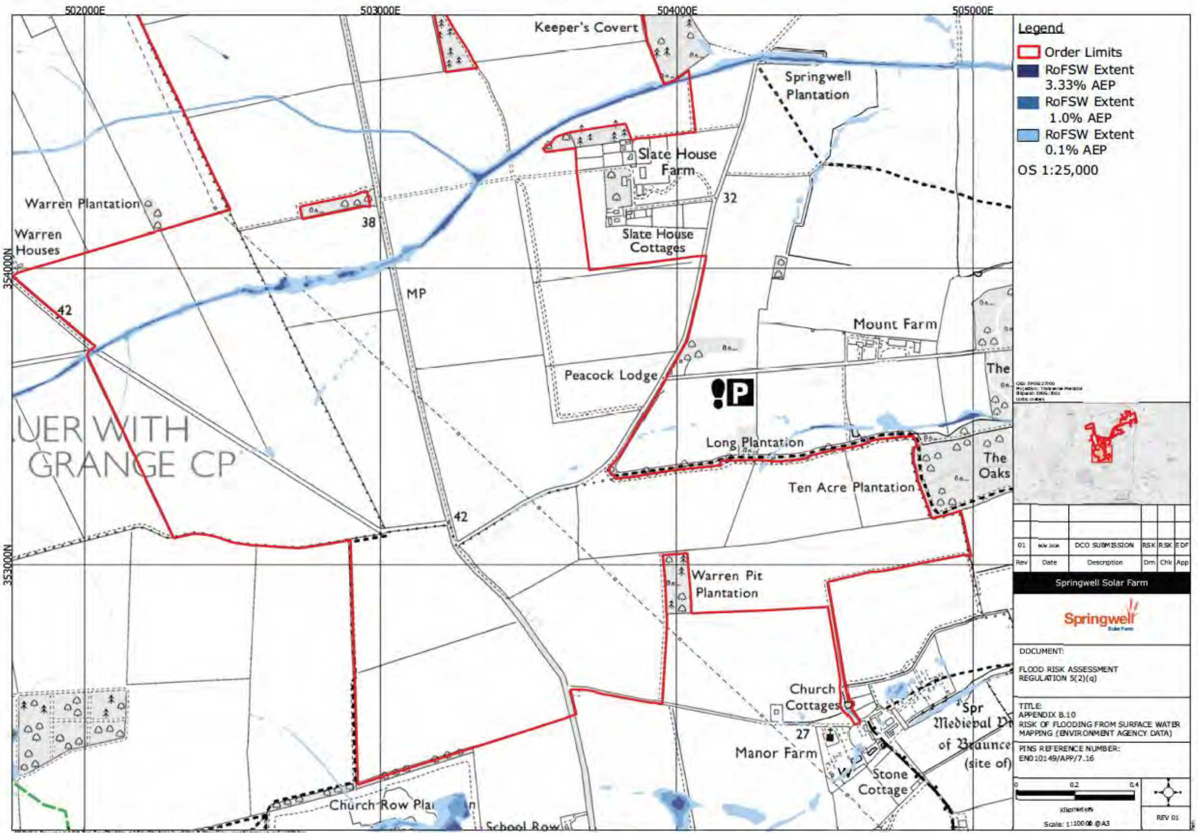


Plate 3.9: Surface water flood risk extents (1) (full map in Appendix B.10)

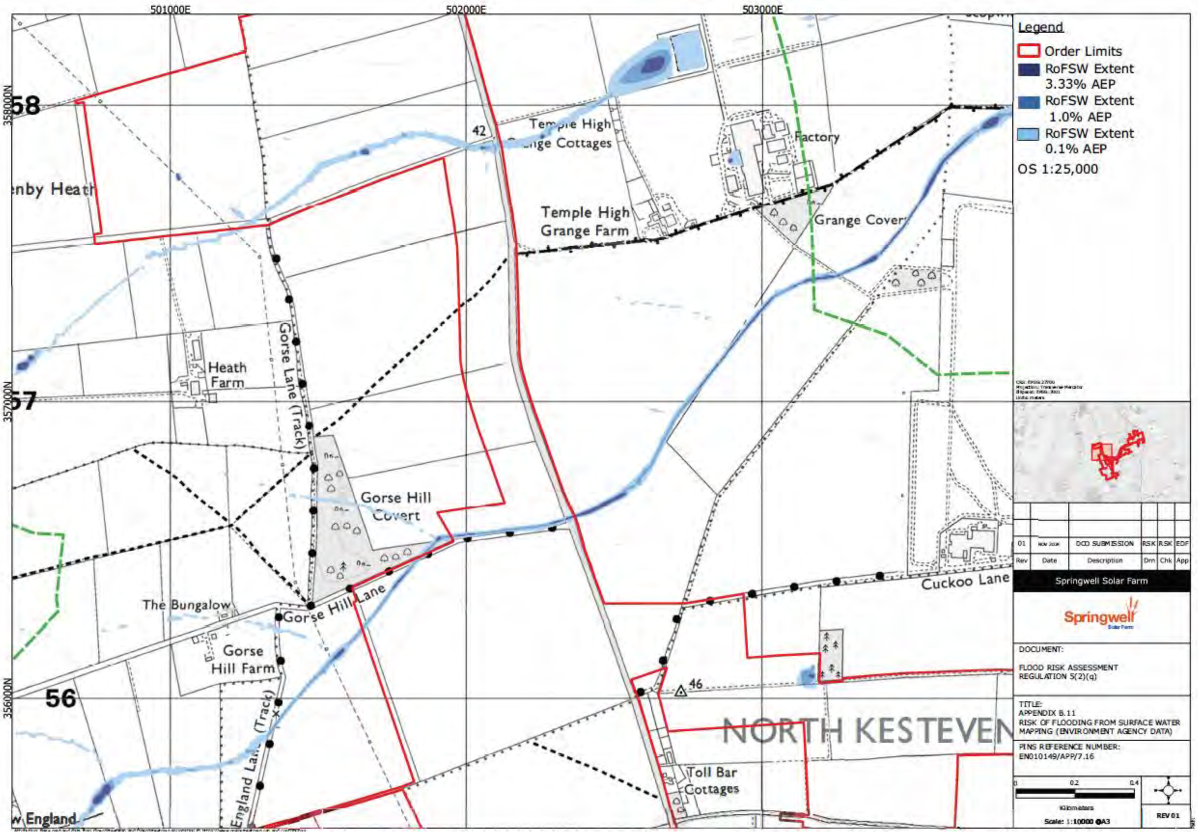


Plate 3.10: Surface water flood risk extents (2) (full map in Appendix B.11)

3.4.5. **Plate 3.10** shows two small flow paths crossing the northwestern region of the Site from west to east. The southern of these two flow paths is small in width and intersects the Site at a field boundary. This flow path is mainly present during the 'medium' risk scenario (between 1.0% annual exceedance probability and 3.3% annual exceedance probability). The northern flow path is mainly present during the 'low' risk scenario (between 0.1% annual exceedance probability and 1.0% annual exceedance probability), with some areas of ponding along the flow path being present during the 'high' risk event (greater than 3.3% annual exceedance probability).

3.4.6. **Plate 3.11** highlights an area of ‘low’ risk (between 0.1% annual exceedance probability and 1.0% annual exceedance probability) surface water flooding across the central portion of the Site, as well as a small, ponded region that would be present during the ’medium’ risk (between 1.0% annual exceedance probability and 3.3% annual exceedance probability) scenario.

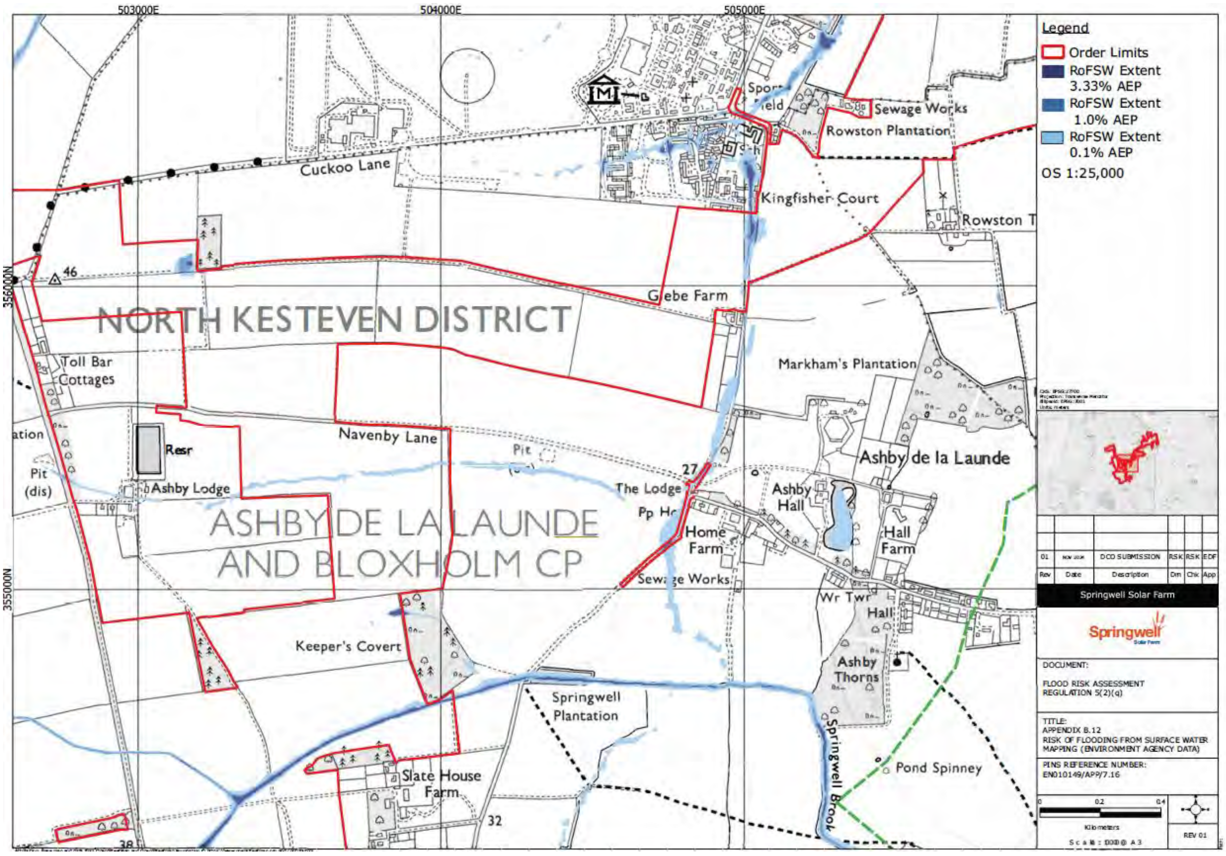


Plate 3.11: Surface water flood risk extents (3) (full map in Appendix B.12)

3.4.7. **Plate 3.12** shows the surface water extents around the central portion of the Site where the Site meets Royal Air Force Digby base. Most of the surface water flooding in this area is located outside the Order Limits and within the village, however there are some regions of surface water ponding within the Order Limits. These areas of ponding are predominantly present during the ‘low’ (between 0.1% annual exceedance probability and 1.0% annual exceedance probability) and ‘medium’ risk (between 1.0% annual exceedance probability and 3.3% annual exceedance probability) events, with some localised regions of ‘high’ risk (greater than 3.3% annual exceedance probability) nearer the village.

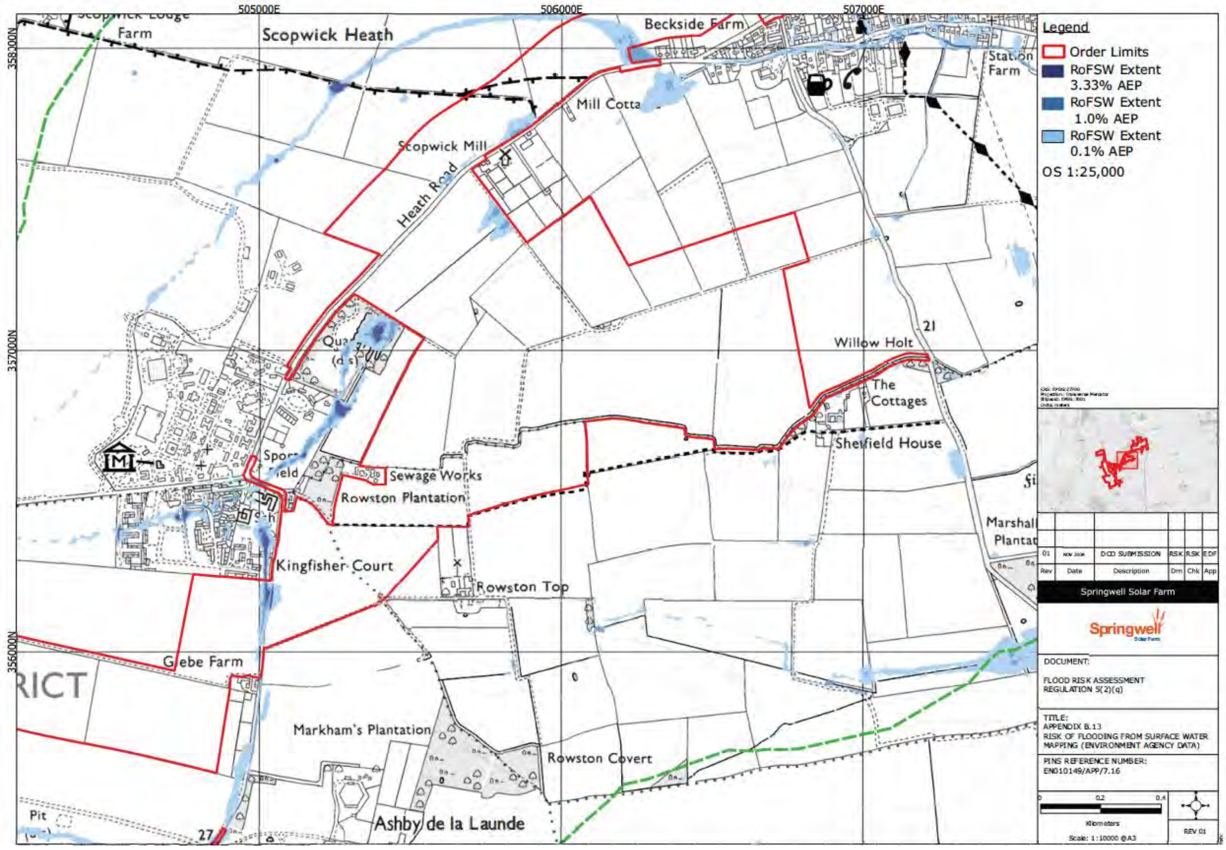


Plate 3.12: Surface water flood risk extents (4) (full map in Appendix B.13)

3.4.8. **Plate 3.13** highlights the surface water extents within the town of Scopwick. There is an overland flow path that flows eastward across the fielded regions to the west of the town before crossing the Order Limits and then flowing into the town. The area of the flow path that intersects the Site is mainly present during the 'low' risk (between 0.1% annual exceedance probability and 1.0% annual exceedance probability) scenario.

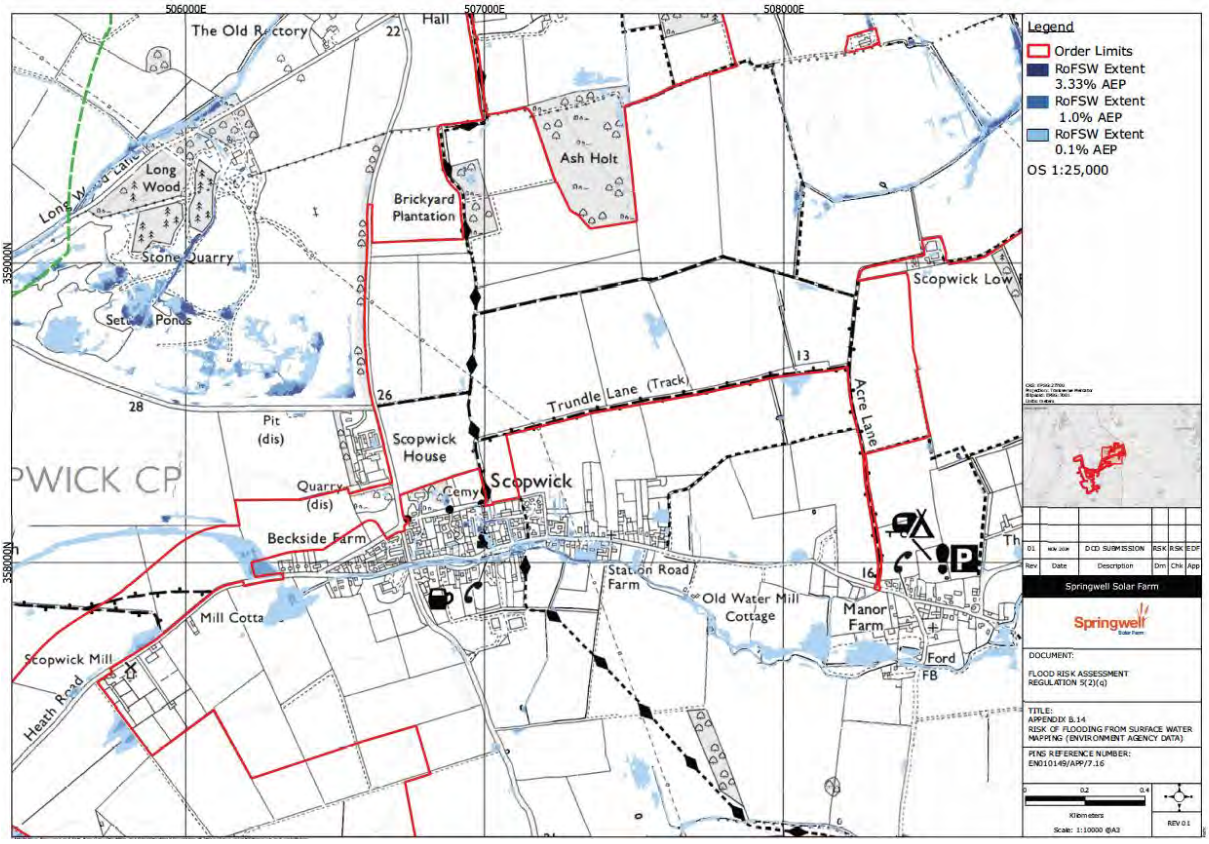


Plate 3.13: Surface water flood risk extents (5) (full map in Appendix B.14)

3.4.9. **Plate 3.14** shows the surface water flood extents within the northeastern section of the Site. There are several surface water channels within this area of the Site, and this is the part of the Site within the fluvial Flood Zones. Most of the surface water flooding within this area of the Site is contained near to these channels and is mainly present during the ‘high’ risk (greater than 3.3% annual exceedance probability) scenario, but there are some areas, mainly in the east, where the surface water exceeds the channel capacity during the ‘low’ risk (between 0.1% annual exceedance probability and 1.0% annual exceedance probability) event and spills over into the fielded regions.

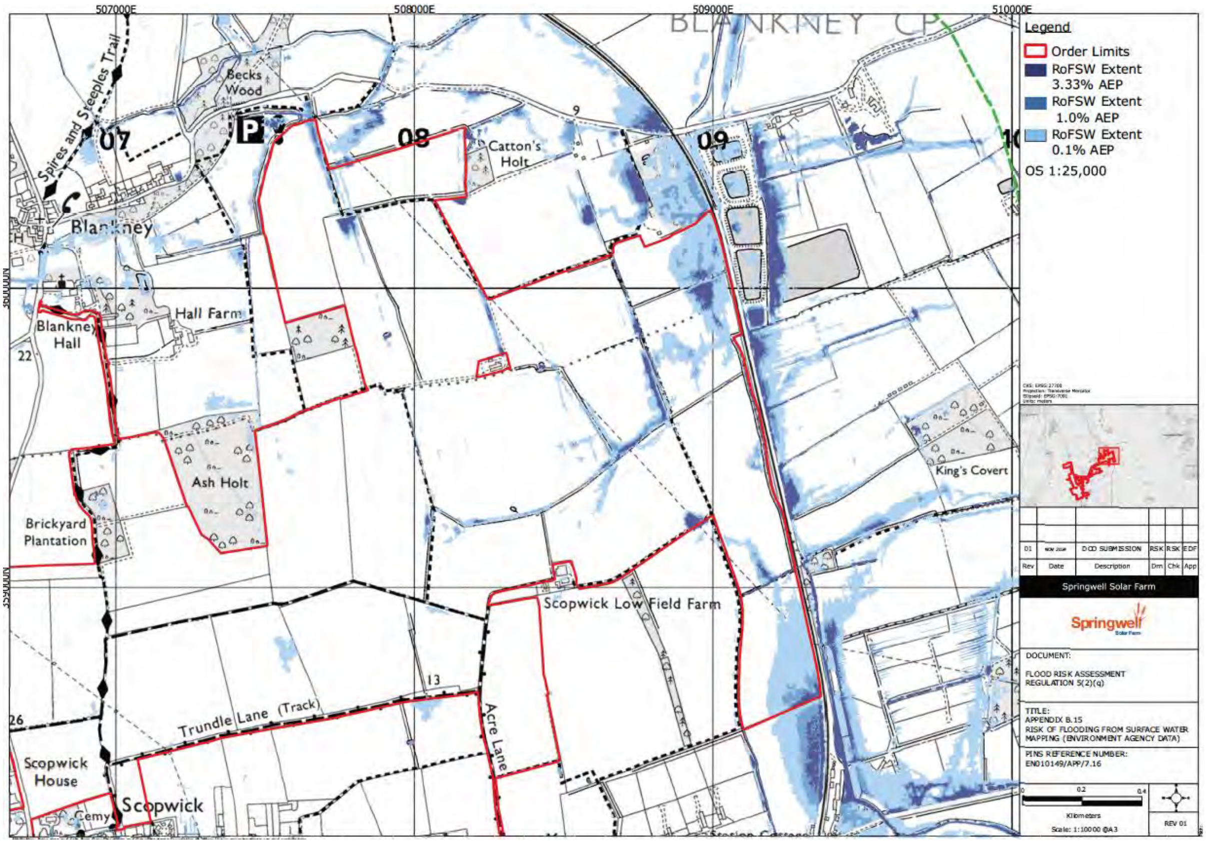


Plate 3.14: Surface water flood risk extents (6) (full map in Appendix B.15)

3.4.10. Across the entire site, surface water flood depths during the 1.0% annual exceedance probability event ('medium' risk) do not exceed depths of 300 mm.

3.4.11. Surface water flooding is likely to increase as a result of climate change in a similar ratio to fluvial flooding. Increased intensity and frequency of precipitation is likely to lead to reduced infiltration and increased overland flow. The 'low' risk or 0.1% annual exceedance probability extents are typically the best proxy as to the impacts of climate change on surface water flooding. The mapping of the 0.1% annual exceedance probability extents and depth banding is shown in **Plate 3.14** for the area of greatest risk at the east of the Site. The mapping shows surface water flooding within the flood extents within the Order Limits is predominately between 150 mm and 600 mm. There is minor encroachment of 600 mm to 900 mm depth banding inside of the Order Limits at Field Lf11.

3.4.12. A revised allowance for climate change for surface water drainage has been included in the outline drainage strategy produced (**Outline Drainage Strategy [Appendix A]**).

3.4.13. The flood risk from pluvial sources is predominately considered to be **very low.** Whilst there are minor areas of **high** surface water flood risk across the site, these are isolated features within localised low points. **Medium** to **Low** risk extents are greater at the eastern boundary of the Site, with Field Lf11 being at the highest risk.

3.5. Flooding from groundwater

3.5.1. Groundwater flooding tends to occur after long periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. In low-lying areas, the water table is usually at shallower depths anyway, but during very wet periods, with additional groundwater flowing towards these areas, the water table can rise to the surface causing groundwater flooding.

3.5.2. The Site's underlying bedrock geology is predominantly limestone. This geology is considered highly permeable and thus could allow for groundwater emergence. The Site's location on the border of a major catchment and general topography mean that any groundwater emergence is likely to occur in the eastern portion of the Site. The Lincolnshire County Council Strategic Flood Risk Assessment **[Ref. 12]** – Susceptibility to Groundwater Flooding Mapping (**Plate 3.15** and **Plate 3.16**) indicates that the Site mainly sits within an area of a less than 25% risk of groundwater flooding.

3.5.3. Climate change could increase the risk of groundwater flooding as a result of increased precipitation filtering into the groundwater body. This is less likely to cause a significant change to flood risk than from other sources, since groundwater flow is not as confined. It is probable that any locally perched aquifers may be more affected, but these are likely to be isolated. The change in flood risk as a result of climate change is likely to be low.

3.5.4. The overall groundwater flood risk is considered to be **low.**

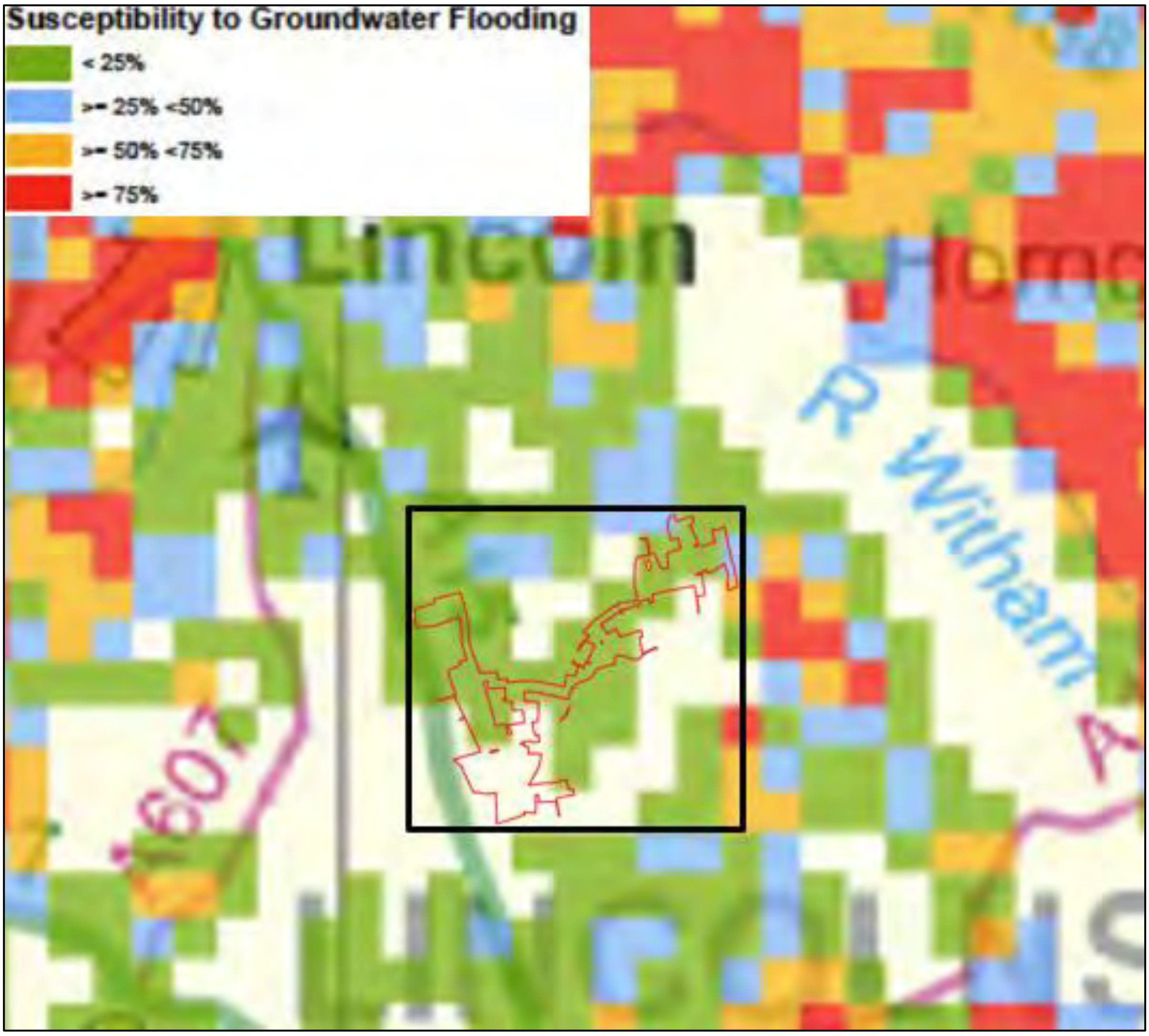


Plate 3.15: Lincolnshire County Council - Areas susceptible to groundwater flooding (close-up) with approximate overlay of the Order Limits

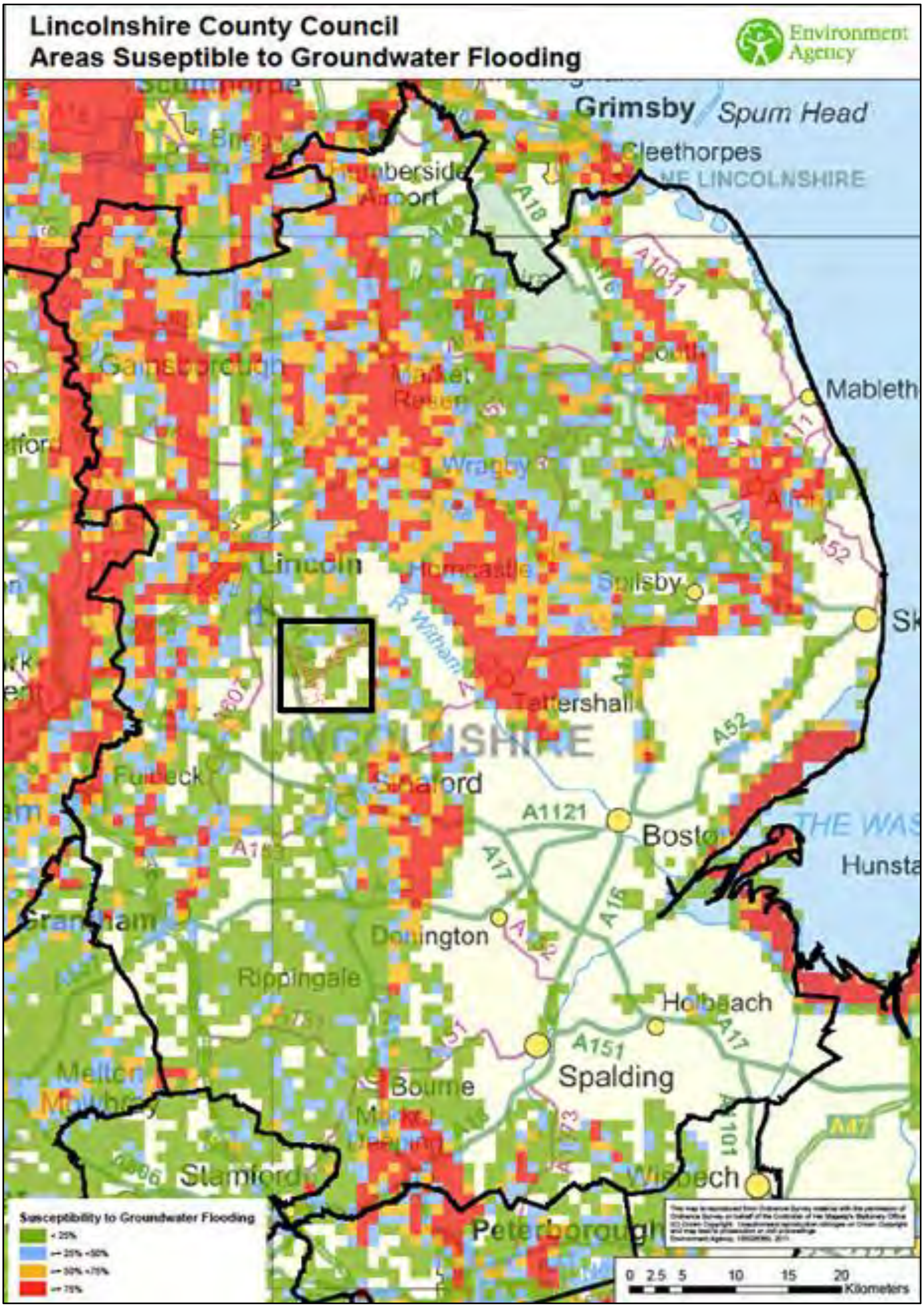


Plate 3.16: Lincolnshire County Council – Areas susceptible to groundwater flooding with approximate overlay of the Order Limits

3.6. Flooding from sewers

3.6.1. Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its conveyance capacity, the system becomes blocked, or it cannot discharge due to a high water level in the receiving watercourse. When exceeded, the surcharged pipe work could lead to flooding from backed up manholes and gully connections.

3.6.2. Sewer records were not available at the time of writing. It is considered unlikely that sewers will be a significant source of flood risk to the Proposed Development given the primarily rural nature of the existing site use. It is unlikely that significant surface water or foul sewer infrastructure exists within the Order Limits.

3.6.3. The proposed welfare facilities within the Site are proposed to discharge foul water waste to package treatment works and/or cesspits indicating there will be no proposed sewers through the site besides localised surface water drainage systems and foul water package treatment works. Further details on the proposed foul drainage are provided in **Outline Drainage Strategy [Appendix A]**

3.6.4. Climate change is likely to result in an increase in flooding from sewers. Increased rainfall and more frequent flooding put existing sewer and drainage systems under additional pressure resulting in the potential for more frequent surcharging and potential flooding. This would increase the frequency of local sewer flooding but would not be significant in terms of the Proposed Development.

3.6.5. The overall sewer flood risk to the Site is considered to be **very low**.

3.7. Flooding from reservoirs

3.7.1. Flood events can occur from a sudden release of large volumes of water from reservoirs. The Environment Agency reservoir flood map **[Ref. 13]** (reproduced as **Plate 3.17**) shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. Since this is a prediction of a worst-case scenario, it is unlikely that any actual flood would be this large.

3.7.2. The Environment Agency mapping was updated in 2021 to demonstrate the potential maximum extent of flooding for two scenarios - a "dry day scenario" in which river levels are "normal", and a "wet day scenario" where the flooding from the reservoir coincides with flooding from rivers.

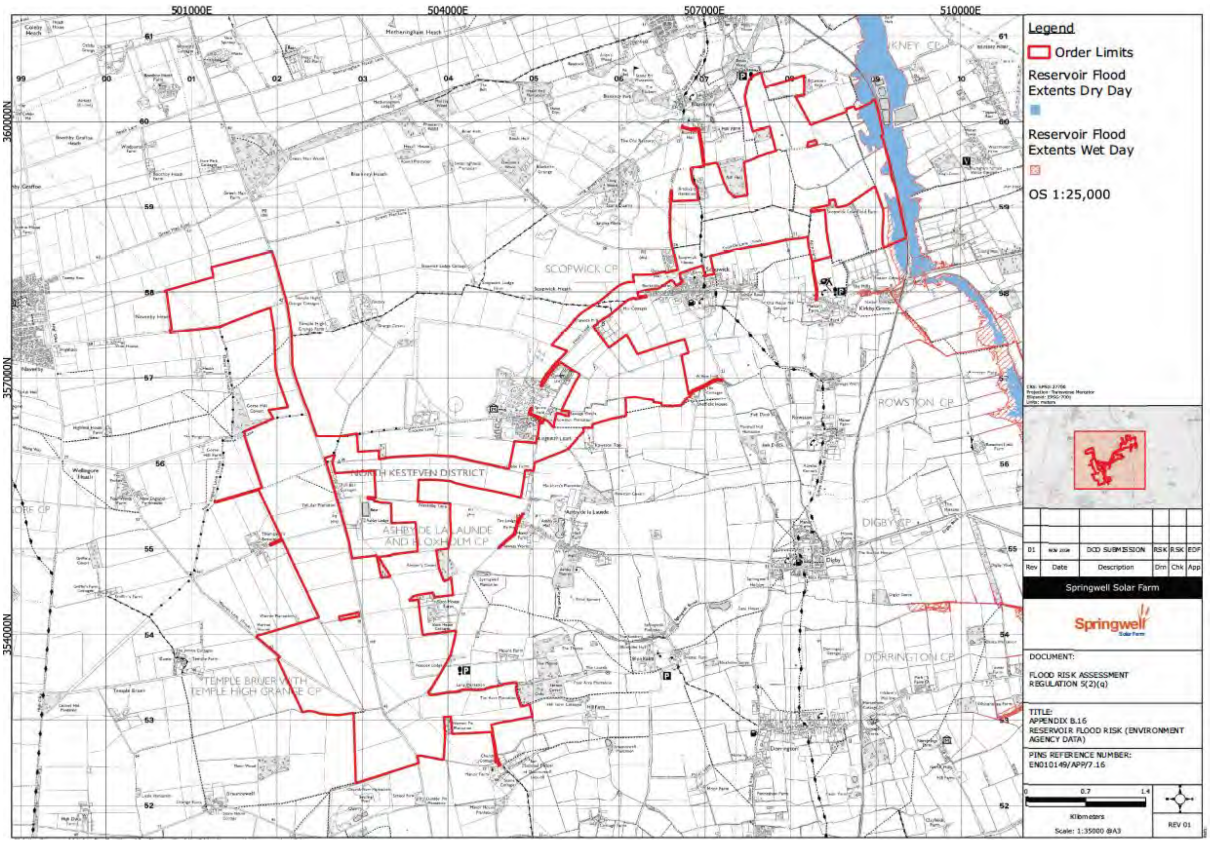


Plate 3.17: Environment Agency reservoir flood extents (model layer from Defra) (full map in Appendix B.16)

3.7.3. The map shows that the majority of the Site is not located within an area of reservoir flood risk when river levels are normal and should a peak fluvial event occur at the same time as a reservoir failure. However, there is an area along the east of the Order Limits that is considered to be at risk during both the ‘dry day’ and ‘wet day’ scenarios.

3.7.4. Reservoir flooding is extremely unlikely and there has been no loss of life in the United Kingdom (UK) from reservoir flooding since 1925. Since then, reservoir safety legislation has been introduced to ensure reservoirs are maintained.

3.7.5. Reservoirs can be managed over time, controlling inflow/outflow of water and therefore there is the capacity to manage the effects of climate change, such as increased rainfall or flood risk. Increased rainfall has the potential to increase base flow, but this should be minimal. It is unlikely that there will be a substantial change to the risk of flooding for this site as a result of climate change.

3.7.6. The resultant flood risk from reservoirs is considered to be **low.**

3.8. Other sources of flood risk

Canals

3.8.1. There are no canals which are a flood risk to the Site. The closest canal is Foss Dyke, approximately 14 km north from the Site. The River Witham, approximately 10 km east from the Site, is a navigable river but is not considered a canal for this assessment.

Artificial features

3.8.2. No other artificial features with the potential to result in a flood risk to the Site have been identified.

3.8.3. The resultant flood risk from other sources is considered to be **very low.**

3.9. Historic flood risk

3.9.1. There are no historic flooding extents identified on the Historic Flood Map **[Ref. 14]** data set within the Site or the local area.

3.9.2. A regional flood risk management programme called Project Groundwater, has identified that Scopwick village (south of the Site) has recorded incidents of flooding due to the interactions of groundwater entering the local sewer system and reducing the capacity for drainage surface water runoff. The project update notes that Anglian Water has now re-lined the sewers to reduce groundwater ingress, however the impacts of this on Scopwick are still being investigated **[Ref. 15]**. The impact of Project Groundwater is very unlikely to change the flood risk ratings within the Site as the sewer relining is within the urban extents of Scopwick, equally the Proposed Development will not change flood risk to the surrounding area.

4. Mitigation Measures

4.1. Sequential approach within Order Limits

4.1.1. The areas of the Site considered to be at fluvial flood risk are the northeastern region of the Site that is located within Flood Zone 3a and 3b as well as the areas in which pluvial overland flow paths are present.

4.1.2. As per the **ES Volume 2, Figure 1.2: Zonal Masterplan [EN010149/APP/6.2]**, only Solar PV modules will be placed within the areas of fluvial flood risk in the northeast of the Site. The Solar PV modules have been designed to be more flood resilient than the other more vulnerable equipment which will be placed within the 'safer' western regions of the Site. Only Solar PV modules are proposed to be placed in locations at extensive surface water flood risk.

4.1.3. Potentially flood sensitive infrastructure (i.e. Springwell Substation, Collector Compounds and BESS units) will be placed in the northwestern region of the Site where the flood risk from all sources is considered to be 'very low'. This area is a significant distance from the area of Flood Zone 3 and is considered to remain safe even in the extreme climate change scenario.

4.2. Finished levels

4.2.1. The Solar PV modules have been designed to sit 0.8 m above ground levels as per the **ES Volume 1, Chapter 3: Proposed Development Description [EN010149/APP/6.1]**. The 0.8m above ground level measure is above the deepest present day predicted fluvial flood depth which is approximately 549 mm and the majority of surface water flooding across the entire site does not exceed 300 mm. The 0.8m above ground level measure is also above the credible maximum scenario flood level which is estimated to be between 627 mm based on 1000 year JFlow depth mapping and 700 mm based on 0.1% AEP surface water flooding depths in the present day scenario. Given the Solar PV modules panels and String Inverters will be located above this flood level, the Proposed Development is considered to be resilient to future changes in flood risk over its lifetime.

4.2.2. Potentially flood sensitive infrastructure (i.e. the BESS units and Springwell Substation and Collector Compound components) will be located within the northwestern portion of the Site (outside of Flood Zone 2 and Flood Zone 3). The infrastructure will be on level platforms once the land within that area has undergone cutting and filling works for achieving the level platform. These methods will both raise potentially flood sensitive components above the current downslope ground levels and reduce all residual flood risk.

4.3. Overland flood paths

4.3.1. Though some areas of the Solar PV modules are within Flood Zone 2 and Flood Zone 3, the Solar PV models are not anticipated to disrupt the flooding pathways overland, therefore the extents of the Flood Zones will remain the same once the Solar PV modules are erected.

4.3.2. As discussed above in **Section 3.4** there have been multiple overland surface water flow paths identified across the Site. These flow paths are generally considered low risk. The Proposed Development will only place Solar PV modules in areas where these flow paths are present. These Solar PV modules have been designed to sit 0.8 m above ground level and will therefore result in minimal volumetric loss of flood plain capacity where Solar PV modules are sited within Flood Zone 3, and as such the overland flow paths will generally remain undisrupted and continue to flow as per the current scenario.

4.3.3. Any additional surface water runoff, up to the 1 in 100 year climate change storm, generated by the Proposed Development will be attenuated and discharged to an appropriate location, using Sustainable Drainage Systems (SuDS) and following the drainage hierarchy where possible, as per the outline drainage strategy produced by WSP (**outline Drainage Strategy [Appendix A]**).

4.4. Easements and consents

4.4.1. Under the Water Resources Act 1991 **[Ref. 16]** and associated byelaws, works in, over, under or adjacent to main rivers require the consent of the Environment Agency and works in, over, under or adjacent to Ordinary Watercourses will require Internal Drainage Board, Local Authority or Lead Local Flood Authority consent. This is to ensure that they neither interfere with the overseeing body’s work nor adversely affect the environment, fisheries, wildlife and flood defence in the locality.

4.4.2. There are a number of Ordinary Watercourses within the Order Limits. It is therefore likely that the Lead Local Flood Authority will require consents for works within the vicinity of these watercourses, and may also require a specific easement either side of the watercourses. Part of the eastern region of the Site lies within Witham First District Internal Drainage Board. Consents and easements are also likely to be required for works in and around its assets.

4.4.3. Perimeter fencing surrounding the Solar PV development will be offset at least 6m either side from all existing ditches where crossing is not required. This is secured within the **Design Commitments [EN010149/APP/7.4]** which is submitted as part of the DCO Application.

4.4.4. Any consent works usually take place post planning, prior to construction, however, the principles of any development within the appropriate easements should be agreed at the planning stage.

4.5. Floodplain compensation

4.5.1. The majority of the Site is located outside the 1 in 100 year plus climate change floodplain, as such floodplain compensatory measures are not deemed necessary within these areas.

4.5.2. Only Solar PV modules will be placed in areas within the fluvial floodplain. These panels have been designed to be elevated 0.8 m above ground level and there will be negligible loss of floodplain as a result of the stands supporting the Solar PV modules. There are no ground raising requirements in the areas of Solar PV modules. Therefore, floodplain compensation is not required.

4.6. Safe access/egress

4.6.1. The majority of the Site is located outside of the 1 in 100 year plus climate change fluvial flood extent and is not identified at being at significant risk from all other sources of flooding.

4.6.2. During the operational phase (including maintenance) the Site has a capacity for 24 permanent staff members within the Springwell Substation and BESS areas. The rest of the Site has been designed to be unmanned and operated remotely. The BESS and Springwell Substation areas are located within areas of 'very low' flood risk from all sources and as such safe access and egress will be available during a 'design' event.

4.6.3. Some areas in the northeast of the Site are located within a fluvial Flood Zone. These areas will generally only be occupied during the construction phase. Based on the DCO Zonal Masterplan (**ES Volume 2, Figure 1.2: Zonal Masterplan [EN010149/APP/6.2]**), all of the primary and secondary (emergency) access locations are located in areas at 'very low' flood risk from all sources.

4.7. Flood awareness

4.7.1. Since parts of the northeastern corner are considered to be at fluvial flood risk, during the construction phase it would be necessary for workers to understand what to do in the event of a fluvial flood event.

4.7.2. It is recommended that site managers during the construction phase of the Site ensure they are registered with the Environment Agency's Flood Warning system (Floodline Warning Direct). This will provide adequate forewarning in the event of a predicted flood in the neighbourhood in order to decrease the overall risk to a 'safe' level for those construction works undertaken in Flood Zone 2 and Flood Zone 3.

4.7.3. The Environment Agency charter is to provide a minimum 2 hour advance warning, which would provide sufficient time for site personal within the northeastern region of the Site to evacuate to an area of safe refuge, upgradient, to the west.

4.7.4. The management of flood awareness will the provided within the following management plans; **Outline Construction Environmental Management Plan [EN010149/APP/7.7]**, **Outline Operational Environmental Management Plan** [**EN010149/APP/7.10**] and the **Outline Decommissioning Environmental Management Plan** [**EN010149/APP/7.13**]. To ensure water quality is not degraded the management and mitigation of potential sources of pollution are discussed within **ES Volume 1, Chapter 15: Water [EN010149/APP/6.1]**.

4.8. Overall flood risk from development

4.8.1. The Proposed Development will mainly consist of Solar PV modules, but will also have areas for BESS units, Springwell Substation, grid connection, green infrastructure and other compounds as per **ES Volume 1, Chapter 3: Proposed Development Description [EN010149/APP/6.1]**. The majority of the Site is located within Flood Zone 1 and is not considered at significant flood risk from all other sources. There are some locations in the east of the Site that are deemed to be within Flood Zone 3 and areas with pluvial overland flow paths. Within these areas, only raised Solar PV modules will be placed and these will have been designed to not increase the flood risk elsewhere. Due to the relatively small cross-sectional area of the panel supports into the ground it is deemed to be a negligible displacement of flood water. There are no inverter cabins to be located within the Flood Zone 3, if string inverters are chosen then the string inverters will be mounted on Solar PV modules within the Flood Zone 3, however these will be raised above the estimated flood depths.

4.8.2. According to the principles of the BRE planning guidance **[Ref. 17]** for the development of large-scale ground mounted Solar PV systems, Solar PV modules do not materially increase the impermeable area of a site as the ground remains permeable and it is considered that they do not contribute to an increase in surface water runoff from the Site. The Solar PV modules will not materially increase the impermeable area across the Site; therefore, no formal drainage is required for the areas of solar PV modules. However, a pragmatic approach has been developed to promote infiltration and provide water storage areas across the Site. This will involve the management and maintenance of vegetated and grassed areas surrounding the panels (particularly at the low edge) and the design of gravel subbase for the onsite units i.e. cabinets / containers / structures. These features will intercept and attenuate runoff, promoting infiltration across the Site.

4.8.3. The Springwell Substation and BESS units will result in an increase in impermeable area as the current land use changes from agricultural. Within the outline drainage strategy (**Outline Drainage Strategy [Appendix A]**) a number of Sustainable Drainage Systems features are recommended, including basins and swales in order to attenuate additional runoff generated from the BESS and Springwell Substation compound areas and discharge to the various watercourses around the units at a rate of 1.4l/s/ha; these drainage principles are outlined further in **Section 6** below. The Proposed Development will also incorporate various areas of green infrastructure.

4.8.4. Fencing around the Solar PV modules will be permeable, therefore flood water will be able to freely flow through fencing with no increase flood risk elsewhere.

4.8.5. The overall flood risk from the Proposed Development is considered to be **low.**

5. Planning policy context

5.1. National Planning Policy Framework

5.1.1. Section 14 of the NPPF details the overarching requirements relating to flood risk for any development. The key message is 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.

5.1.2. In areas at risk of flooding, the NPPF requires that the following criteria are met:

a) Within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

b) The development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment;

c) It incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

d) Any residual risk can be safely managed; and

e) Safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

5.1.3. The Planning Practice Guidance (PPG) supports the NPPF and provides further advice regarding the assessment of flood risk and the application of the Sequential and Exception Tests.

Land use classification

5.1.4. Table 2 of the PPG indicates the compatibility of various land uses in each Flood Zone, dependent on their vulnerability to flooding. **Table 5.1** below is reproduced from Table 2 of the PPG.

Table 5.1: Flood risk vulnerability and Flood Zone 'compatibility'

Flood risk vulnerability classification	Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Zone 1	Appropriate	Appropriate	Appropriate	Appropriate	Appropriate

Flood risk vulnerability classification		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood Zone	Zone 2	Appropriate	Appropriate	Exception Test Required	Appropriate	Appropriate
	Zone 3a	Exception Test Required	Appropriate	Should not be permitted	Exception Test Required	Appropriate
	Zone 3b functional floodplain	Exception Test Required	Appropriate	Should not be permitted	Should not be permitted	Should not be permitted

5.1.5. With reference to Annex 3 of the NPPF, the Proposed Development, based on its utilities use, is classed as 'essential infrastructure'. This classification of development is appropriate for areas within Flood Zone 1 and Flood Zone 3a (if the exception test is passed).

Sequential test

5.1.6. The Sequential Test aims to direct new development to areas with the lowest probability of flooding. The Sequential Test has been considered further within the **Planning Statement [EN010149/APP/7.2]** being submitted as part of the DCO Application. The test is deemed to have been passed.

Exception test

5.1.7. In accordance with **Table 5.1**, in order for an 'essential infrastructure' development to be considered acceptable within Flood Zone 3, the Exception Test must be passed.

5.1.8. The stipulations of the Exception Test (reproduced from Paragraph 164 within NPPF), both of which will have to be passed for development to be allocated or permitted, are as follows (together with reasons why these criteria are considered to be met in respect of the Proposed Development):

- Development that has to be in a flood risk area will provide wider sustainability benefits to the community that outweigh flood risk.
    - Solar energy is essential energy infrastructure and is a key component of the UK's switch to renewable sources and the achievement of net zero.

- The Proposed Development will provide direct capital investment, with direct additional jobs for the North Kesteven Economy.
- The Proposed Development will include ecological mitigation and enhancements.

- The development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.
  - The proposed mitigation measures set out in Section 4 above will ensure the Site does not increase fluvial and surface water flood risk when infrastructure is placed within areas considered to be at risk.
  - The Proposed Development will provide controls on surface water drainage thereby reducing the risk of flooding.
  - The areas of the Site at flood risk will be unmanned and monitored remotely, hence minimal vulnerability to users.

5.2. Overarching National Policy Statement for Energy (EN-1)

5.2.1. Section 5.8 of NPS EN-1 relates to flood risk for proposed energy infrastructure. The main aims of NPS EN-1 are to ensure that flood risk from all sources is taken into account at all stages of the planning process and during the development, with the goal to steer potential infrastructure to the areas at lowest risk of flooding. It also aims to facilitate the relocation of existing energy infrastructure to more suitable locations in order to combat the effects of climate change.

5.2.2. Section 5.8.15 of NPS EN-1 also states the minimum requirements for a FRA, these are:

- "*Be proportionate to the risk and appropriate to the scale, nature and location of the project;*
- *Consider the risk of flooding arising from the project in addition to the risk of flooding to the project;*
- *Take the impacts of climate change into account, across a range of climate scenarios, clearly stating the development lifetime over which the assessment has been made;*
- *Be undertaken by competent people, as early as possible in the process of preparing the proposal;*
- *Consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure and exceedance;*

- *Consider the vulnerability of those using the Site, including arrangements for safe access and escape;*
- *Consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and include information on flood likelihood, speed-of-onset, depth, velocity, hazard and duration;*
- *Identify and secure opportunities to reduce the causes and impacts of flooding overall, making as much use as possible of natural flood management techniques as part of an integrated approach to flood risk management;*
- *Consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes;*
- *Include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that these risks can be safely managed, ensuring people will not be exposed to hazardous flooding;*
- *Consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems. Information should include:*
    i. *Describe the existing surface water drainage arrangements for the Site.*
    ii. *Set out (approximately) the existing rates and volumes of surface water run-off generated by the Site. Detail the proposals for restricting discharge rates.*
    iii. *Set out proposals for managing and discharging surface water from the Site using sustainable drainage systems and accounting for the predicted impacts of climate change. If sustainable drainage systems have been rejected, present clear evidence of why their inclusion would be inappropriate.*
    iv. *Demonstrate how the hierarchy of drainage options has been followed.*
    v. *Explain and justify why the types of SuDS and method of discharge have been selected and why they are considered appropriate.*
    vi. *Explain how sustainable drainage systems have been integrated with other aspects of the development such as open space or green infrastructure, so as to ensure an efficient use of the Site.*
    vii. *Describe the multifunctional benefits the sustainable drainage system will provide.*

viii. Set out which opportunities to reduce the causes and impacts of flooding have been identified and included as part of the proposed sustainable drainage system.

ix. Explain how run-off from the completed development will be prevented from causing an impact elsewhere.

x. Explain how the sustainable drainage system been designed to facilitate maintenance and, where relevant, adoption. Set out plans for ensuring an acceptable standard of operation and maintenance throughout the lifetime of the development.

- *Detail those measures that will be included to ensure the development will be safe and remain operational during a flooding event throughout the development's lifetime without increasing flood risk elsewhere;*
- *Identify and secure opportunities to reduce the causes and impacts of flooding overall during the period of construction; and*
- *Be supported by appropriate data and information, including historical information on previous events."*

5.2.3. Each of these points of Section 5.8.15 of NPS EN-1 has been addressed as part of this flood risk assessment and further details for the additional points on information for drainage systems are outlined in **Section 6** of this report and supported by the **Outline Drainage Strategy [Appendix A]**.

5.3. Overarching National Policy Statement for Energy (EN-3

5.3.1. Section 2.10 of NPS EN-3 relates to Applicant assessments and impacts of the proposed energy infrastructure. In relation to flood risk and drainage, NPS EN-3 notes the following:

- *"Water management is a critical component of site design for ground mount solar plants. Where previous management of the site has involved intensive agricultural practice, solar sites can deliver significant ecosystem services value in the form of drainage, flood attenuation, natural wetland habitat, and water quality management."*
- "*Where a Flood Risk Assessment has been carried out this must be submitted alongside the applicant's ES. This will need to consider the impact of drainage. As solar PV panels will drain to the existing ground, the impact will not, in general, be significant.* "
- *"Where access tracks need to be provided, permeable tracks should be used, and localised Sustainable Drainage Systems (SuDS), such as swales and infiltration trenches, should be used to control any run-off where recommended. "*

- *"Given the temporary nature of solar PV farms, sites should be configured or selected to avoid the need to impact on existing drainage systems and watercourses*."
- *"Culverting existing watercourses/drainage ditches should be avoided."*
- *"Where culverting for access is unavoidable, applicants should demonstrate that no reasonable alternatives exist and where necessary it will only be in place temporarily for the construction period."*

5.4. Local Planning Policy

Central Lincolnshire Local Plan 2018-2040 (adopted 2023), Policy S21: Flood Risk and Water resources

5.4.1. The Central Lincolnshire Local Plan policy on flood risk states the following as set out in *"Policy S21: Flood Risk* **[Ref. 18]**":

5.4.2. "*All development proposals will be considered against the NPPF, including application of the sequential and, if necessary, the exception test.*

5.4.3. *Through appropriate consultation and option appraisal, development proposals should demonstrate:*

a) that they are informed by and take account of the best available information from all sources of flood risk and by site specific flood risk assessments where appropriate;

b) that the development does not place itself or existing land or buildings at increased risk of flooding;

c) that the development will be safe during its lifetime taking into account the impacts of climate change and will be resilient to flood risk from all forms of flooding such that in the event of a flood the development could be quickly brought back into use without significant refurbishment;

d) that the development does not affect the integrity of existing flood defences and any necessary flood mitigation measures have been agreed with the relevant bodies, where adoption, ongoing maintenance and management have been considered and any necessary agreements are in place;

e) how proposals have taken a positive approach to reducing overall flood risk and have considered the potential to contribute towards solutions for the wider area; and

f) that they have incorporated Sustainable Drainage Systems (SuDS)/ Integrated Water Management into the proposals unless they can be shown to be inappropriate."

5.4.4. *"Protecting the Water Environment"*

5.4.5. *"Development proposals that are likely to impact on surface or ground water should consider the requirements of the Water Framework Directive.*

5.4.6. *Development proposals should demonstrate:*

a) that water is available to support the development proposed;

b) that adequate mains foul water treatment and disposal already exists or can be provided in time to serve the development. Non mains foul sewage disposal solutions should only be considered where it can be shown to the satisfaction of the local planning authority that connection to a public sewer is not feasible;

c) that they meet the Building Regulation water efficiency standard of 110 litres per occupier per day or the highest water efficiency standard that applies at the time of the planning application (see also Policy S12);

d) that water reuse and recycling and rainwater harvesting measures have been incorporated wherever possible in order to reduce demand on mains water supply as part of an integrated approach to water management (see also Policy S11);

e) that they have followed the surface water hierarchy for all proposals:

i. surface water runoff is collected for use;

ii. discharge into the ground via infiltration;

iii. discharge to a watercourse or other surface water body;

iv. discharge to a surface water sewer, highway drain or other drainage system, discharging to a watercourse or other surface water body;

v. discharge to a combined sewer;

f) that no surface water connections are made to the foul system;

g) that surface water connections to the combined or surface water system are only made in exceptional circumstances where it can be demonstrated that there are no feasible alternatives (this applies to new developments and redevelopments) and where there is no detriment to existing users;

h) that no combined sewer overflows are created in areas served by combined sewers, and that foul and surface water flows are separated;

i) that development contributes positively to the water environment and its ecology where possible and does not adversely affect surface and ground water quality in line with the requirements of the Water Framework Directive;

j) that development with the potential to pose a risk to groundwater resources is not located in sensitive locations to meet the requirements of the Water Framework Directive;

k) how Sustainable Drainage Systems (SuDS)/ Integrated Water Management to deliver improvements to water quality, the water environment and to improve amenity and biodiversity net gain wherever possible have been incorporated into the proposal unless they can be shown to be impractical;

l) that relevant site investigations, risk assessments and necessary mitigation measures for source protection zones around boreholes, wells, springs and water courses have been agreed with the relevant bodies (e.g. the Environment Agency and relevant water companies);

m) that suitable access is safeguarded for the maintenance of watercourses, water resources, flood defences and drainage infrastructure; and

n) that adequate provision is made to safeguard the future maintenance of water bodies to which surface water and foul water treated on the Site of the development is discharged, preferably by an appropriate authority (e.g. Environment Agency, Internal Drainage Board, Water Company, the Canal and River Trust or local Council).

5.4.7. *In order to allow access for the maintenance of watercourses, development proposals that include or abut a watercourse should ensure no building, structure or immovable landscaping feature is included that will impede access within 8m of a watercourse, or within 16m of a tidal watercourse. Conditions may be included where relevant to ensure this access is maintained in perpetuity and may seek to ensure responsibility for maintenance of the watercourse including land ownership details up to and of the watercourse is clear and included in maintenance arrangements for future occupants*."

6. Outline Drainage Strategy

6.1. Scope

6.1.1. This section discusses the potential quantitative effects of the Proposed Development on both the risk of surface water flooding onsite and elsewhere within the catchment, as well as the type of potential SuDS features that could be incorporated as part of the masterplan. This section places particular emphasis on the information provided within the **Outline Drainage Strategy [Appendix A]** which is being submitted in support of the DCO Application.

6.1.2. The list of requirements outlined in Section 5.8.15 of NPS EN-1 for the surface water drainage strategy has been addressed directly below.

6.1.3. "*Describe the existing surface water drainage arrangements for the site*": The existing drainage of the Site has been described in **Section 2** of this report, with the probable overland surface water flow routes identified in **Section 3.4**. In summary the Site is likely to drain to nearby Ordinary Watercourses, whilst there is likely to be some infiltration into the ground. There are no known formalised drainage structures, though given the nature of the Site it is likely some fields may be underlain with land drains.

6.1.4. "*Set out (approximately) the existing rates and volumes of surface water run-off generated by the Site. Detail the proposals for restricting discharge rates*": Greenfield runoff rates are outlined in Table 1 of the **Outline Drainage Strategy [Appendix A]**. The table indicates very low rates of greenfield runoff from the Site which may indicate a high infiltration rate of rainfall into the ground. The drainage document outlines in **Section 3.4** that surface water drainage discharge rates are likely to be limited to 1.4l/s/ha subject to agreement from the Lead Local Flood Authority and Internal Drainage Board.

6.1.5. "*Set out proposals for managing and discharging surface water from the site using sustainable drainage systems and accounting for the predicted impacts of climate change. If sustainable drainage systems have been rejected, present clear evidence of why their inclusion would be inappropriate"*: As per **Section 3.7** of the **Outline Drainage Strategy [Appendix A]**, the Solar PV modules will drain freely to the ground as they are not considered as impermeable areas. The small, isolated areas of hardstanding associated with inverter station cabinets are proposed to drain to a gravel subbase where surface water runoff can attenuate and either infiltrate or evaporate between rainfall events. Access tracks (part of the ancillary works) are considered to be permeable as they are gravel bound, however as precautionary mitigation the access tracks are proposed to have parallel swales which will intercept surface water runoff and will promote attenuation and infiltration.

6.1.6. The larger areas of hardstanding will be treated separately and are proposed to be designed with formalised surface water drainage systems, indicative dimensions of the attenuation for the 100 year plus 25% climate change rainfall event are outlined in **Section 3.8** for Collector Compounds, **Section 3.9** for the Springwell Substation, and **Section 3.10** for the BESS compound of the **Outline Drainage Strategy [Appendix A]**. The conclusion in Section 4 outlined that it is proposed for the Springwell Substation and the BESS compound to drain towards attenuation basins, however it is noted that storage features will be confirmed at detailed design.

6.1.7. "*Demonstrate how the hierarchy of drainage options has been followed*": The drainage hierarchy is assessed in **Section 3.2** of the **Outline Drainage Strategy [Appendix A]**. The section notes that infiltration is likely to 'free draining' soils, however at the time of writing no infiltration testing had been undertaken and therefore drainage to the local watercourses has been considered as the worst case scenario should infiltration be later disproven as a viable means of surface water disposal from the Site.

6.1.8. *"Explain and justify why the types of SuDS and method of discharge have been selected and why they are considered appropriate."*: In **Outline Drainage Strategy [Appendix A]**, **Section 3.6** outlines a list of viable SuDS options which are to be considered further for detailed design of the Springwell Substation and BESS compound detailed designs. These components include ponds, detention basins, bioretention systems, swales, filter drains, filter strips, green roofs, infiltration systems and permeable paving. The method of discharge has not been confirmed at the time of writing, though is identified to either be via infiltration and/or discharge to local watercourses.

6.1.9. *"Explain how sustainable drainage systems have been integrated with other aspects of the development such as open space or green infrastructure, so as to ensure an efficient use of the site"*: As the locations of the SuDS features are unconfirmed at the time of writing, this will be subject to detailed design of the surface water drainage strategy. The **Outline Drainage Strategy [Appendix A]** notes that until infiltration is confirmed as a viable means of surface water disposal, the most appropriate drainage components to facilitate drainage are likely to be permeable paving, bioretention systems, tree pits, swales and detention basins.

6.1.10. *"Describe the multifunctional benefits the sustainable drainage system will provide."* Within the conclusion of the **Outline Drainage Strategy [Appendix A]**, it is outlined that the SuDS will assist in playing a role for flood and pollution prevention. The SuDS will provide benefits of: reducing volumes, providing treatment of surface water, contributing to improved landscaping, and protecting and enhancing natural capital.

6.1.11. “*Set out which opportunities to reduce the causes and impacts of flooding have been identified and included as part of the proposed sustainable drainage system*.”. As outlined in the **Outline Drainage Strategy [Appendix A]**, infiltration rates will be tested for the detailed design of the surface water drainage strategy. If infiltration rates are proven as a viable means of drainage, then by capturing surface water runoff and directing it towards attenuation features for controlled discharge to the ground will reduce the potential for fluvial and overland surface water flooding. If, however, infiltration is disproven as a viable means of drainage, then surface water runoff will be controlled via attenuation within the Site and a restricted discharge to the local watercourses. To alleviate any flooding concerns associated surface water runoff from Solar PV modules, it is proposed that perimeter swales downslope of the Solar PV arrays will provide additional surface water attenuation and promote infiltration into the ground. This is outlined in **Section 3.7.3** of the **Outline Drainage Strategy [Appendix A]**.

6.1.12. “*Explain how run-off from the completed development will be prevented from causing an impact elsewhere*”: The run-off from the completed Proposed Development will not cause an impact elsewhere as it is proposed to control surface water runoff via attenuation and restricted discharge rates when assessing the worst case scenario of discharge to watercourse. If infiltration is a viable means of surface water disposal, then this will significantly reduce the overall runoff leaving the Site compared to the existing scenario.

6.1.13. “*Explain how the sustainable drainage system been designed to facilitate maintenance and, where relevant, adoption. Set out plans for ensuring an acceptable standard of operation and maintenance throughout the lifetime of the development*”: As the surface water drainage strategy is subject to change following detailed design, details regarding maintenance and adoption cannot be confirmed at the time of writing. However, these will be considered and confirmed as part of the detailed design.

7. Conclusions and recommendations

7.1.1. This FRA complies with the NPPF, PPG and NPS EN-1, and demonstrates that flood risk from all sources has been considered in the Proposed Development. It is also consistent with the Local Planning Authority requirements with regard to flood risk.

7.1.2. The majority of the Site lies in an area designated by the Environment Agency as Flood Zone 1 and is outlined to have a chance of flooding of less than 1 in 1,000 (<0.1%) in any year from fluvial sources. There is a region in the northeastern corner of the Site that lies within Flood Zone 3 and therefore has an annual probability of fluvial flooding of 1 in 100 or greater in any year. There are also areas of surface water flood risk throughout the Site, but these are not considered to represent a significant risk to the Proposed Development due to the sequential location of infrastructure (and particularly sensitive elements) outside the areas of risk, as well as the proposed raising of Solar PV panels above worse-case anticipated flood levels. There is also some residual risk associated with reservoir flooding but again this is mitigated by the raising of Solar PV module and String Inverters in these areas.

7.1.3. The Sequential Test is deemed to have been passed as set out in the **Planning Statement [EN010149/APP/7.2]**.

7.1.4. The Proposed Development is classified as 'essential infrastructure' and therefore considered appropriate within Flood Zone 1 and Flood Zone 2 without application of the Exception Test; and within Flood Zone 3 if it is shown to pass the Exception Test. This was achieved as the Proposed Development will provide wider sustainability benefits as solar farms are a key component in the UK's switch to renewable sources and the achievement of net zero. The Proposed Development will also be safe for its lifetime and not increase flood risk elsewhere as demonstrated within this report.

7.1.5. This FRA has considered multiple sources of flooding. A summary of the conclusions is outlined in **Table 7.1**.

Table 7.1: Flood risk summary

Source	Level of risk	Mitigation
Fluvial	**Very low** (Flood Zone 1) to **high** (Flood Zone 3a and 3b)	- More vulnerable equipment to be placed outside of areas at fluvial flood risk. - Solar panels designed to sit 0.8m above ground level, which is above the credible maximum scenario

Source	Level of risk	Mitigation
		outlined in this report for both Flood Zone 3a and 3b (Plate 3.8 for Flood Zone 3b flood depths). - 6 m easement distance from all ditches. - Lead Local Flood Authority and Internal Drainage Board consents will be obtained for all works within the vicinity of watercourses. - Loss of floodplain storage considered to be negligible as a result of siting Solar PV modules in Flood Zone 2 and Flood Zone 3. - As only Solar PV modules will be located within Flood Zone 2 and Flood Zone 3, this equipment is generally unmanned and monitored remotely. - Safe access and egress will be available during 'design' event.
Tidal	**Very Low** Inland Location	- No mitigation required.
Surface water	**Very Low** to **Medium**	- More vulnerable equipment will be placed in areas of reduced surface water flood risk. - Greatest depth of surface water flooding throughout the Site during the 1 in 100 year event is 300 mm, all solar panels will therefore have a 700mm freeboard above this. - The Environment Agency 0.1% flood depths have been mapped and show flood depths predominately within 150 mm and 600 mm. There is minor encroachment of the 600mm to 900mm banding within the boundary of Field Lf11. If the 0.1% flood depths are used a proxy for 1% climate change scenario then it

Source	Level of risk	Mitigation
		is shown that panel heights remain above the anticipated flood depths. - Vulnerable equipment will be placed on raised concrete bases and make use of regrading of land levels to mitigate against residual surface water ingress. - No overland flow paths will be disrupted meaning no increase in flood risk elsewhere. - The Proposed Development will incorporate a surface water drainage strategy to accommodate surface water generated on site. Surface water will be attenuated on site and discharged directly to an appropriate location and an agreed rate with the Lead Local Flood Authority/Internal Drainage Board. - SuDS will be utilised to control surface water flows, designed to store the volume of water associated with a 1 in 100 year rainfall event (including an allowance for climate change), providing a betterment over the existing scenario.
Groundwater	**Low**	- No mitigation required.
Sewers	**Very Low**	- As the design of the Proposed Development progresses, it will be ensured safe easements from any existing sewers are maintained.
Reservoir	**Low**	- No mitigation required.
Other sources	**Very Low**	- No mitigation required.
From development	**Low**	- No mitigation required.

7.1.6. Overall, taking into account the above points, the Proposed Development should not be precluded on flood risk grounds.

8. References

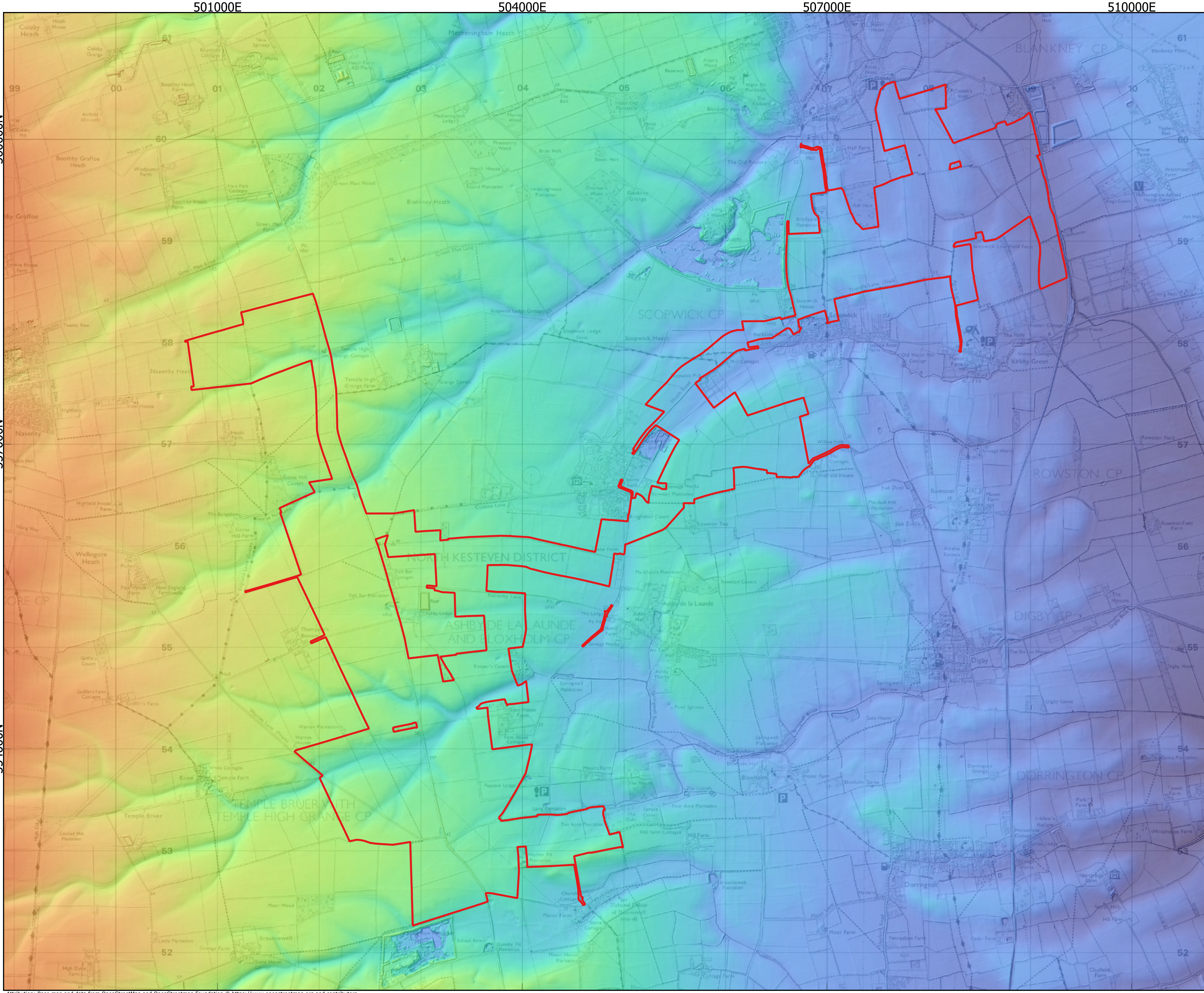
- **Ref. 1**: National Planning Policy Framework (2023), accessible at: https://assets.publishing.service.gov.uk/media/669a25e9a3c2a28abb50d2b4/NPPF_December_2023.pdf
- **Ref. 2**: Planning Practice Guidance – flood risk and coastal change (2022), accessible at: https://www.gov.uk/guidance/flood-risk-and-coastal-change
- **Ref. 3**: Overarching National Policy Statement for Energy (EN-1) (2023), accessible at: https://assets.publishing.service.gov.uk/media/65bbfbdc709fe1000f637052/overarching-nps-for-energy-en1.pdf
- **Ref. 4**: Department for Environment, Food & Rural Affairs/Environment Agency, National LIDAR Programme (June 2024), accessible at: https://www.data.gov.uk/dataset/f0db0249-f17b-4036-9e65-309148c97ce4/national-lidar-programme#licence-info
- **Ref. 5**: British Geological Survey (BGS) online mapping (June 2024), accessible at: [redacted]
- **Ref. 6**: Ordnance Survey (2022), 1:25,000 Scale Colour Raster 919928 1170413
- **Ref. 7**: Magic Maps, accessible at: https://magic.defra.gov.uk/MagicMap.aspx
- **Ref. 8**: Environment Agency, 'Guidance: Flood risk assessments: climate change allowances', (May 2022), accessible at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances
- **Ref. 9**: BSI, 'BS 8533-2017 Assessing and managing flood risk in development Code of practice', December 2017.
- **Ref. 10**: Flood Map for Planning, Environment Agency (July 2024). Available at: https://flood-map-for-planning.service.gov.uk/
- **Ref. 11**: Estimating flood peaks and hydrographs for small catchments: R2 – performance of FEH peak flow estimation methods in small catchments FCERM Research & Development Programme Research Report Date: March 2024 Version: SC090031/R2
- **Ref. 12**: Lincolnshire County Council Preliminary Flood Risk Assessment (2011), accessible at: https://www.lincolnshire.gov.uk/downloads/file/4382/preliminary-flood-risk-assessment-report

- **Ref. 13**: Defra, Risk of Flooding from Reservoirs – Maximum flood Extent, (November 2021) accessible at: https://www.data.gov.uk/dataset/44b9df6e-c1d4-40e9-98eb-bb3698ecb076/risk-of-flooding-from-reservoirs-maximum-flood-extent-web-mapping-service
- **Ref. 14**: Defra, Historic Flood Map, (June 2024) accessible at: https://environment.data.gov.uk/dataset/889885c0-d465-11e4-9507-f0def148f590
- **Ref 145** Environment Agency, Project Groundwater (no date), accessible at: [redacted]
- **Ref. 16**: Water Resources Act 1991
- **Ref. 17**: BRE Planning guidance for the development of large scale ground mounted solar PV systems (no date), accessible at: [redacted]
- **Ref. 178** Central Lincolnshire Local Plan 2018-2040 (adopted 2023), accessible at: https://www.n-kesteven.gov.uk/sites/default/files/2023-04/Local%20Plan%20for%20adoption%20Approved%20by%20Committee.pdf

Flood Risk Assessment

Supporting Figures

Application Document Ref: EN010149/APP/7.16
Planning Inspectorate Scheme Ref: EN010149



Legend

Order Limits

DTM LiDAR (mAOD)

100

0

OS 1:25,000

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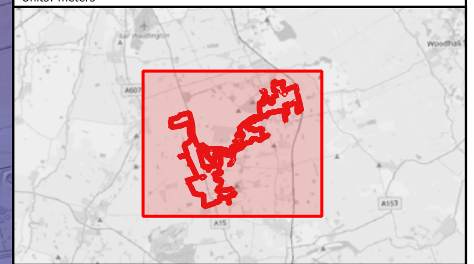
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters



01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF
Rev	Date	Description	Drn	Chk	App

Springwell Solar Farm

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.1
LIDAR ANALYSIS

PINS REFERENCE NUMBER:
EN010149/APP/7.16

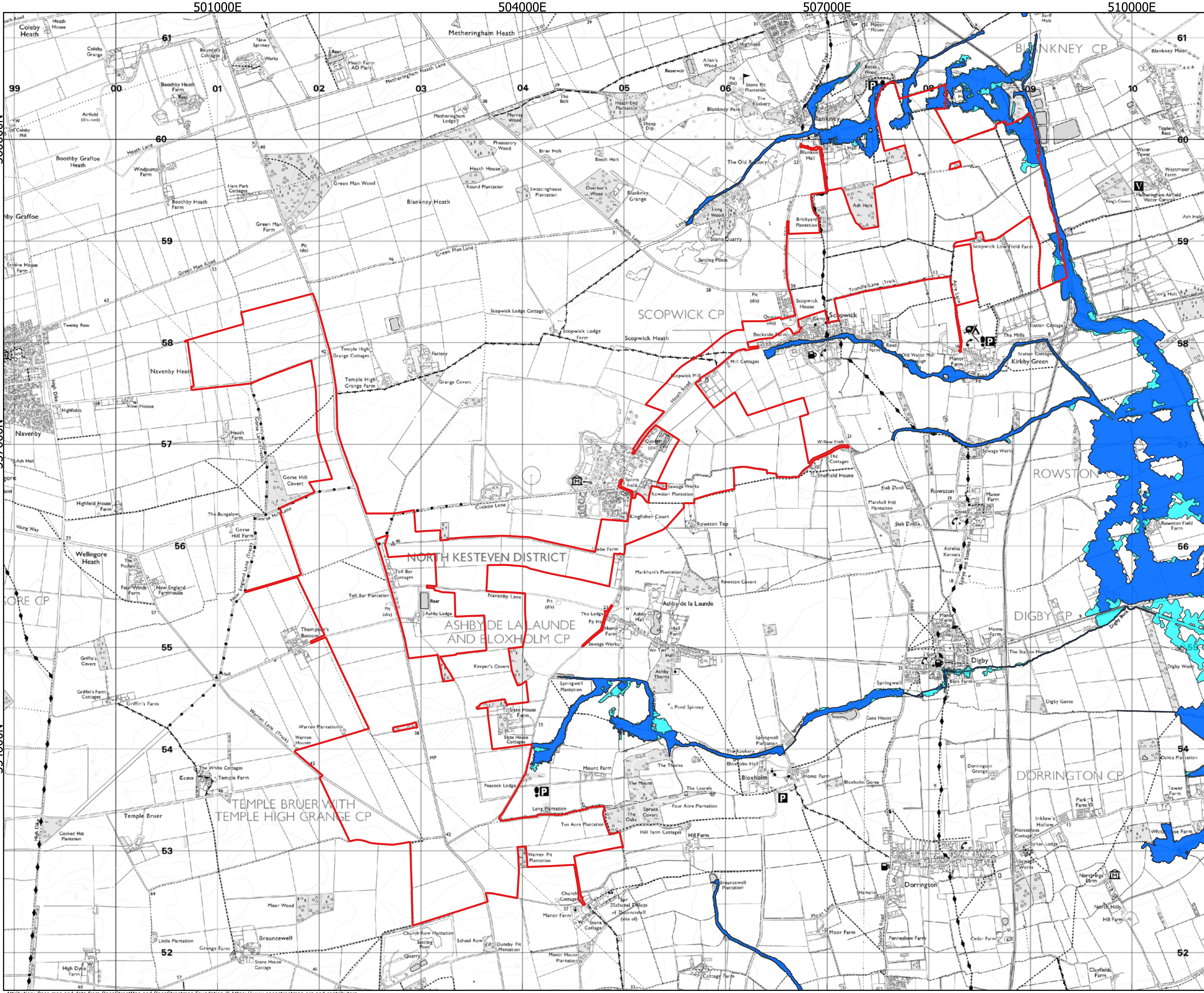
0 0.7 1.4

Kilometers

Scale: 1:35000 @A3

REV 01

Path:



Legend

- Order Limits
- Flood Zone 3
- Flood Zone 2

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

Rev	Date	Description	Drn	Chk	App
01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF

Springwell Solar Farm

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DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.2
FLOOD ZONE (WHOLE SITE)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

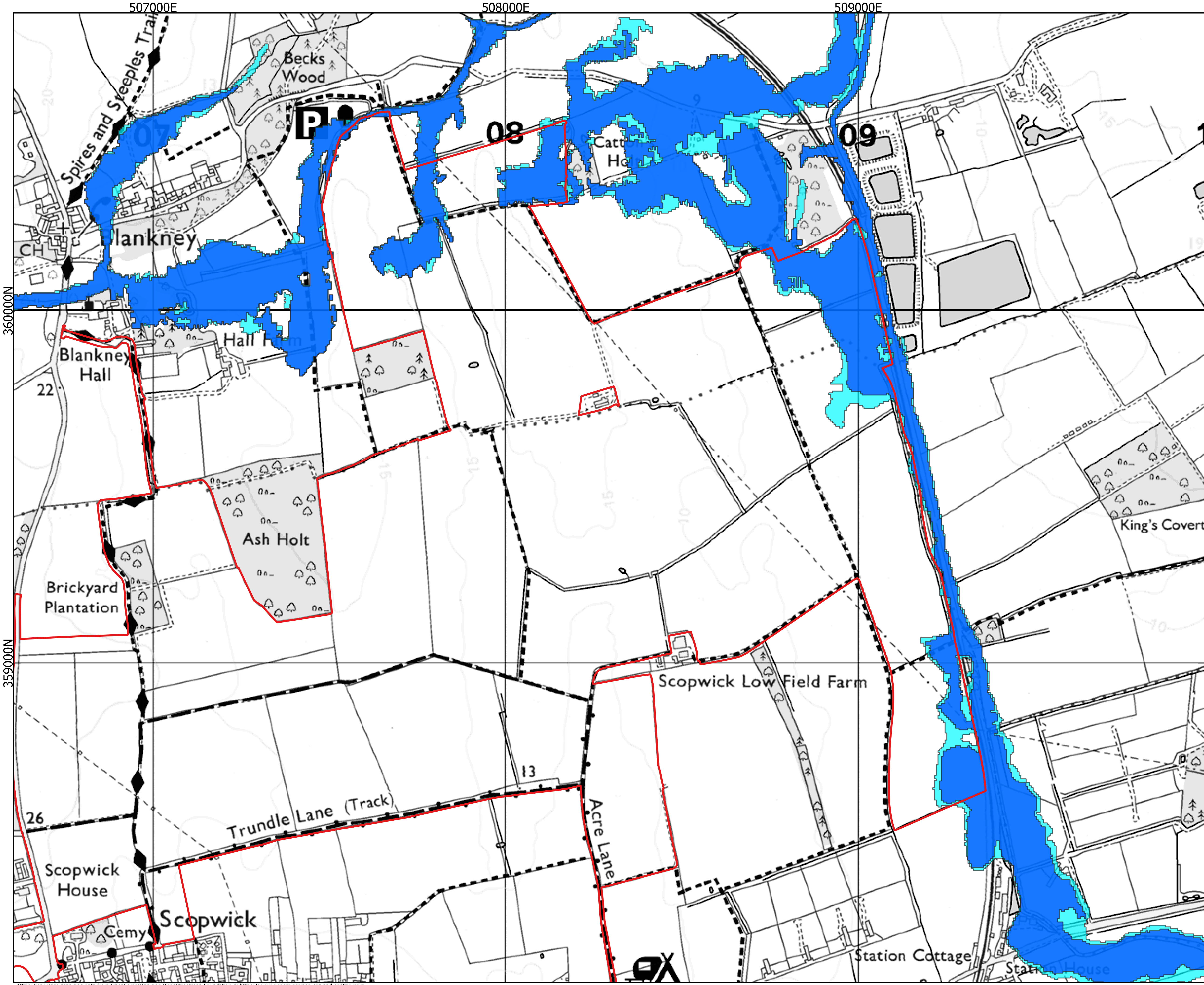
0 0.7 1.4

Kilometers

Scale: 1:35000 @A3

REV 01

Path:

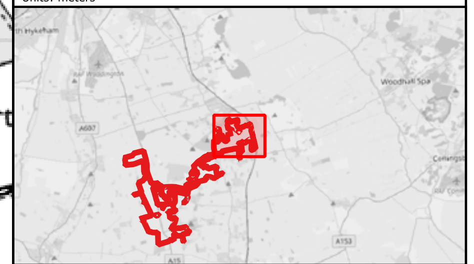


Legend

- Order Limits
- Flood Zone 3
- Flood Zone 2

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters



01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF
Rev	Date	Description	Drn	Chk	App

Springwell Solar Farm

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

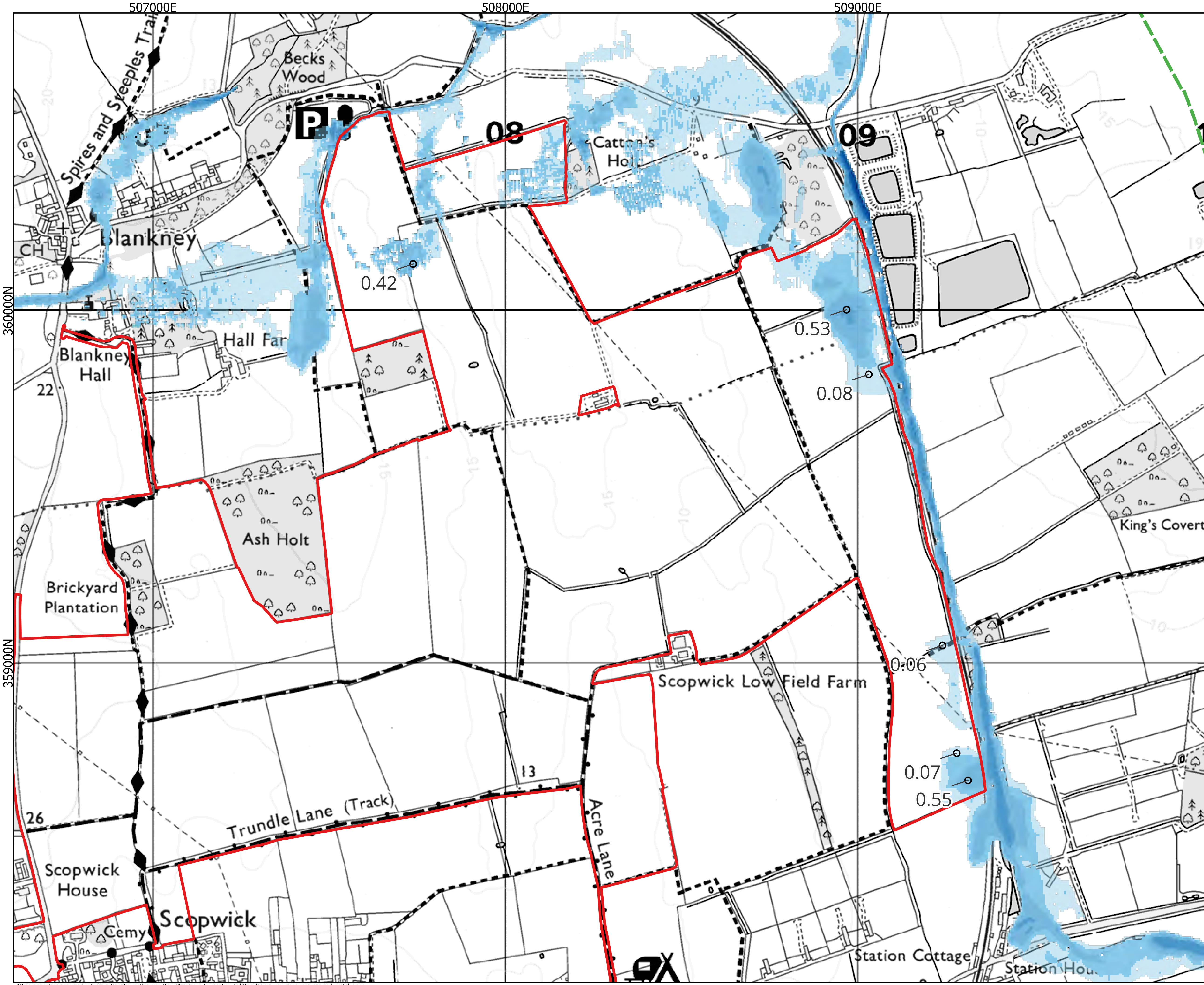
TITLE:
APPENDIX B.3
FLOOD ZONE (AREA AT RISK)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

0 0.2 0.4
Kilometers
Scale: 1:10000 @A3

REV 01

Path:



Legend

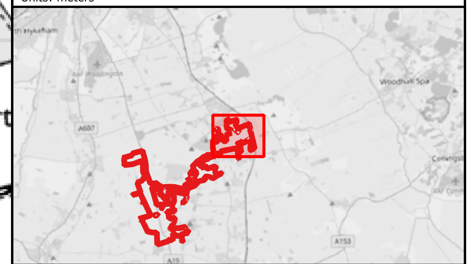
- Order Limits
- Q100 JFLOW Depth (meters)

Q100 JFLOW Depth Grid

- <=0.10 (transparent)
- 0.1000 - 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.4000
- 0.4000 - 0.5000
- 0.5000 - 0.6000
- 0.6000 - 0.7000
- 0.7000 - 0.8000
- 0.8000 - 0.9000
- 0.9000 - 1.0000
- >1.000

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters



01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF
Rev	Date	Description	Drn	Chk	App

Springwell Solar Farm

DOCUMENT:
FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.4
Q100 JFLOW DEPTHS (FLOOD ZONE 3)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

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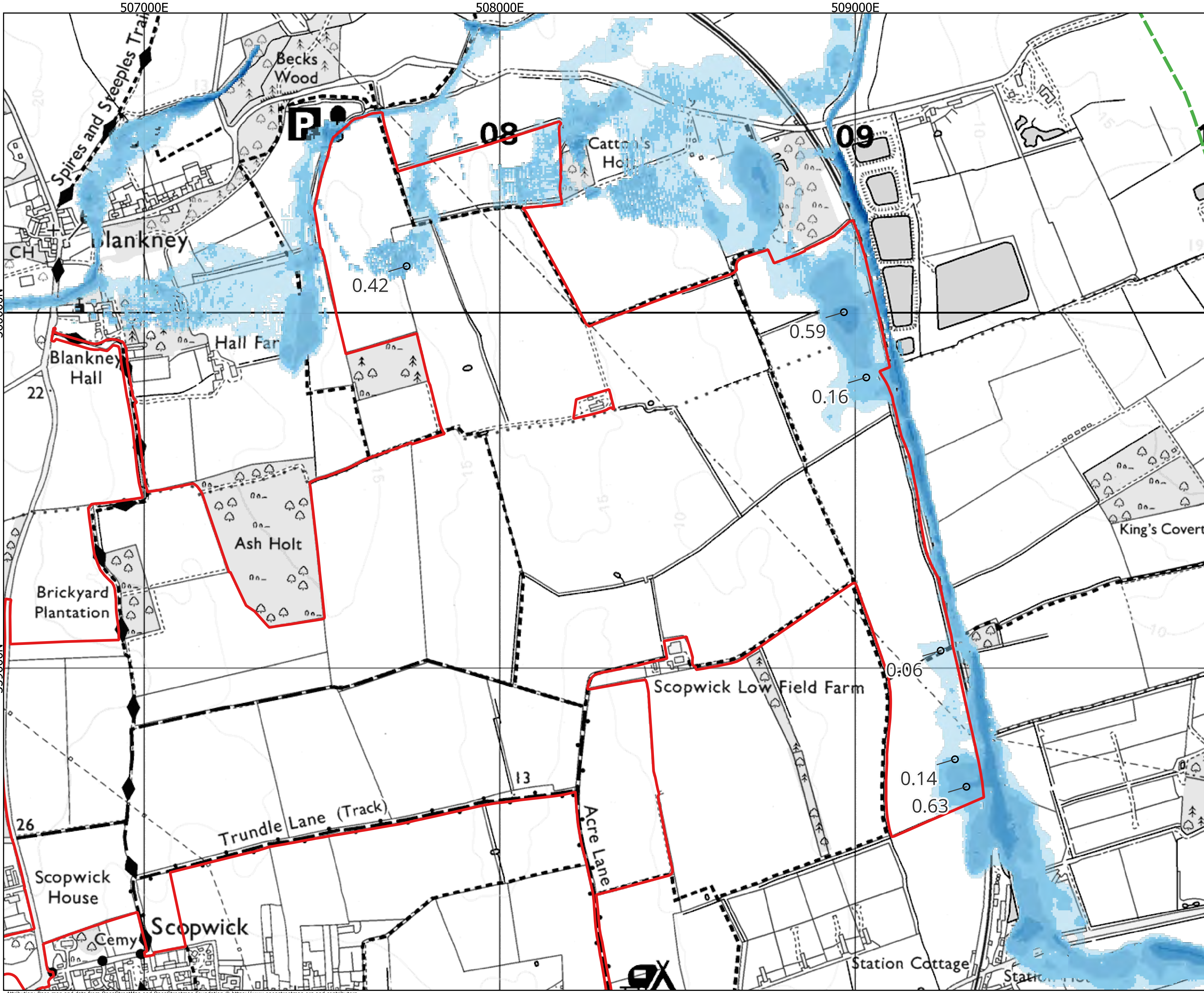
Kilometers
Scale: 1:10000 @A3

REV 01



Legend

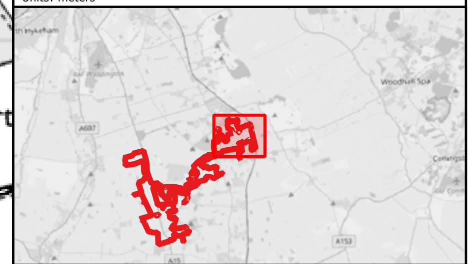
- Order Limits
- Q1000 JFLOW Depth (meters)

Q1000 JFLOW Depth Grid

- <=0.10 (transparent)
- 0.1000 - 0.2000
- 0.2000 - 0.3000
- 0.3000 - 0.4000
- 0.4000 - 0.5000
- 0.5000 - 0.6000
- 0.6000 - 0.7000
- 0.7000 - 0.8000
- 0.8000 - 0.9000
- 0.9000 - 1.0000
- >1.000

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters



Rev	Date	Description	Drn	Chk	App
01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF

Springwell Solar Farm

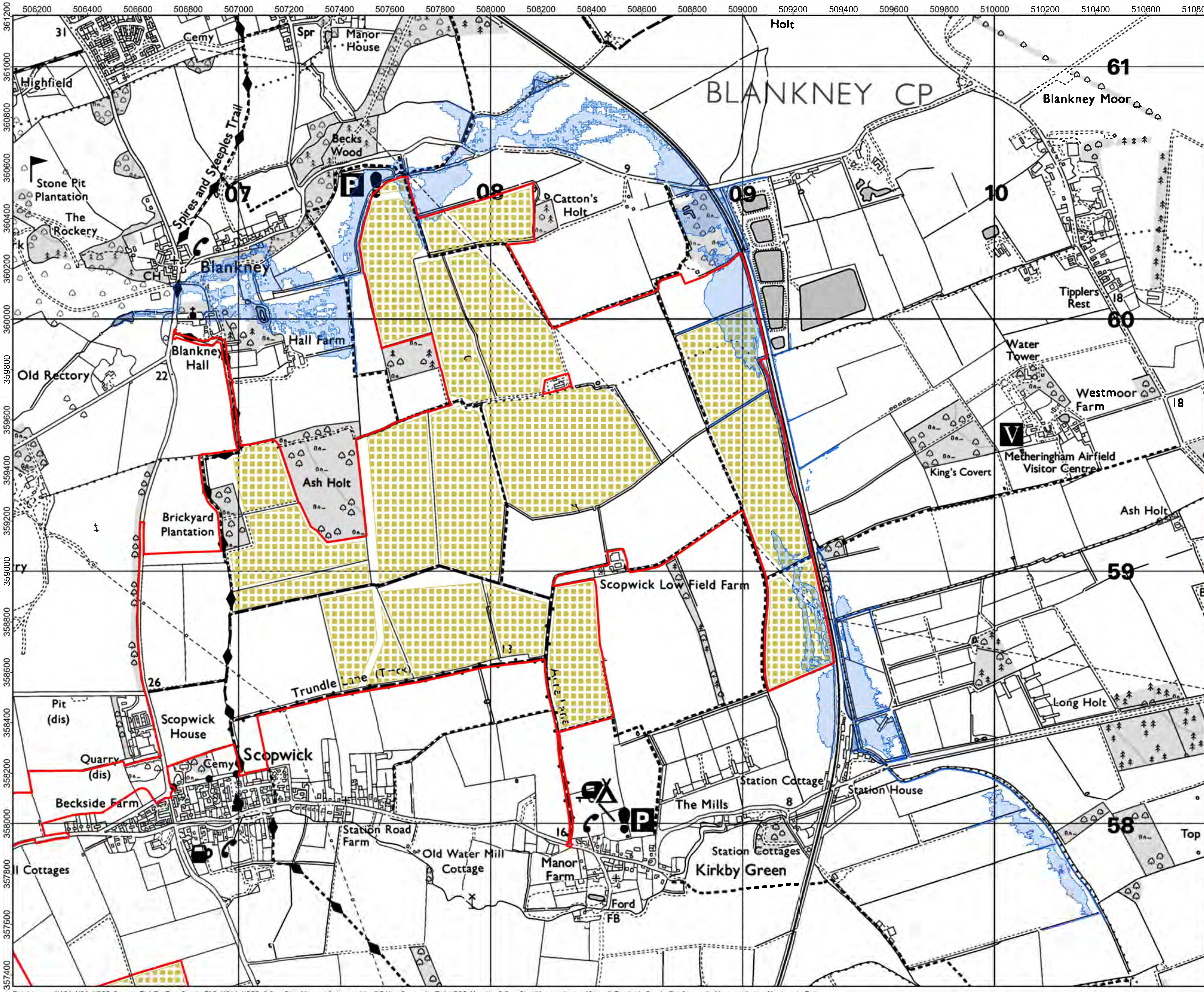
DOCUMENT:
FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.5
Q1000 JFLOW DEPTHS (FLOOD ZONE 2)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

0 0.2 0.4
Kilometers
Scale: 1:10000 @A3

REV 01



Esri, Intermap, NASA, NGA, USGS; Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, Esri, USGS, Map data © OpenStreetMap contributors, Microsoft, Facebook, Google, Esri Community Maps contributors, Map layer by Esri

LEGEND:
- Order Limits
- Flood Zone 3b
- Solar PV Development

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

Rev	Date	Description	Drn	Chk	App
01	Jan 2025	New figure based on S55 advice	RSK	RSK	EDF

Springwell Solar Farm

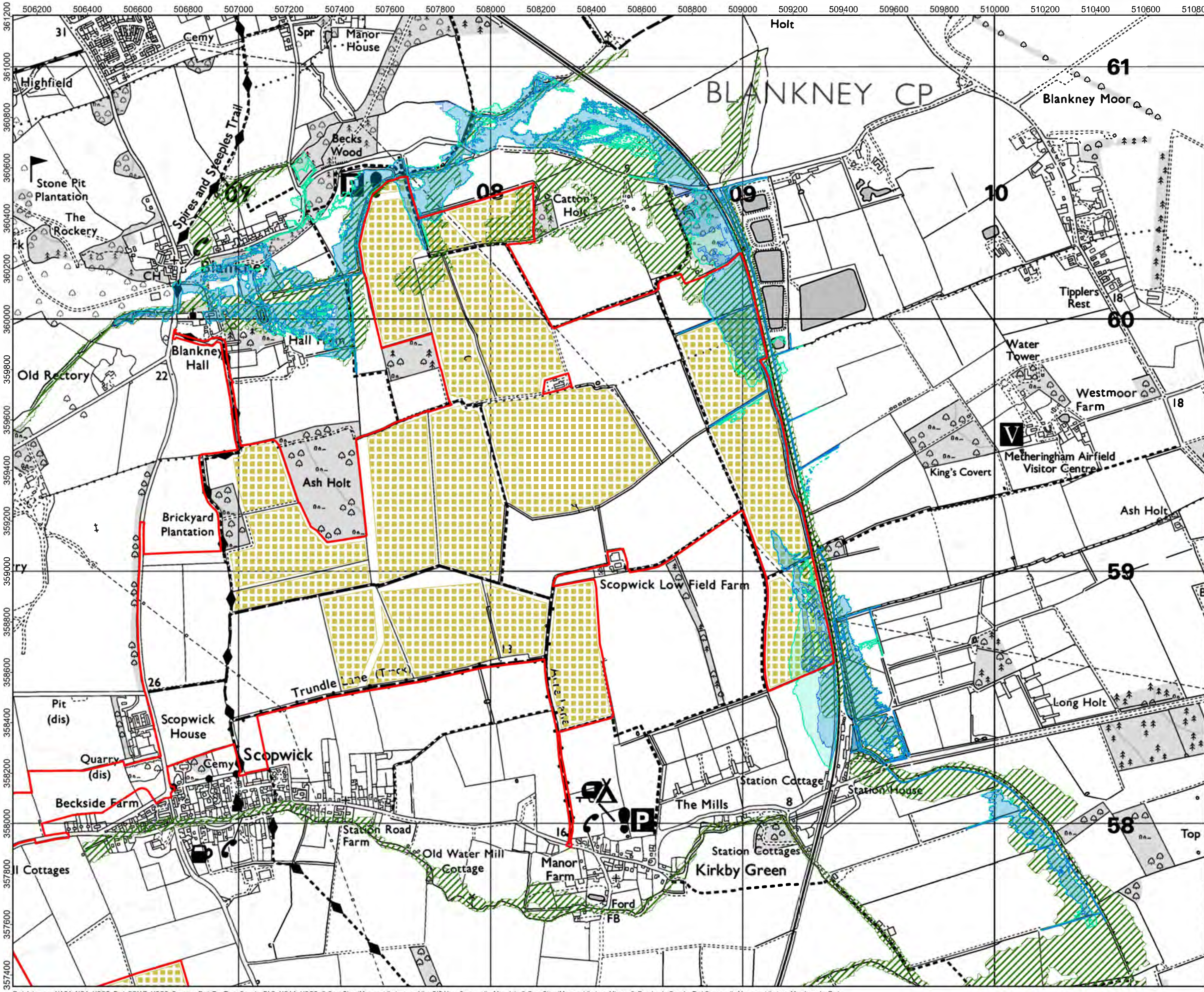
DOCUMENT: Flood Risk Assessment Regulation 5 (2)(q)

TITLE: Appendix B.6: Flood Zone 3b

PINS REFERENCE NUMBER: EN010149/APP/7.16

Scale: 1:14,000 @ A3

REV 01



LEGEND:

- Order Limits
- Flood Zone 3b
- Flood Zone 3a
- Flood Zone 3 (Environment Agency)
- Solar PV Development

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

Rev	Date	Description	Drn	Chk	App
01	Jan 2025	New figure based on S55 advice	RSK	RSK	EDF

Springwell Solar Farm

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DOCUMENT: Flood Risk Assessment Regulation 5 (2)(q)

TITLE: Appendix B.7: Flood Zone 3, 3a and 3b

PINS REFERENCE NUMBER: EN010149/APP/7.16

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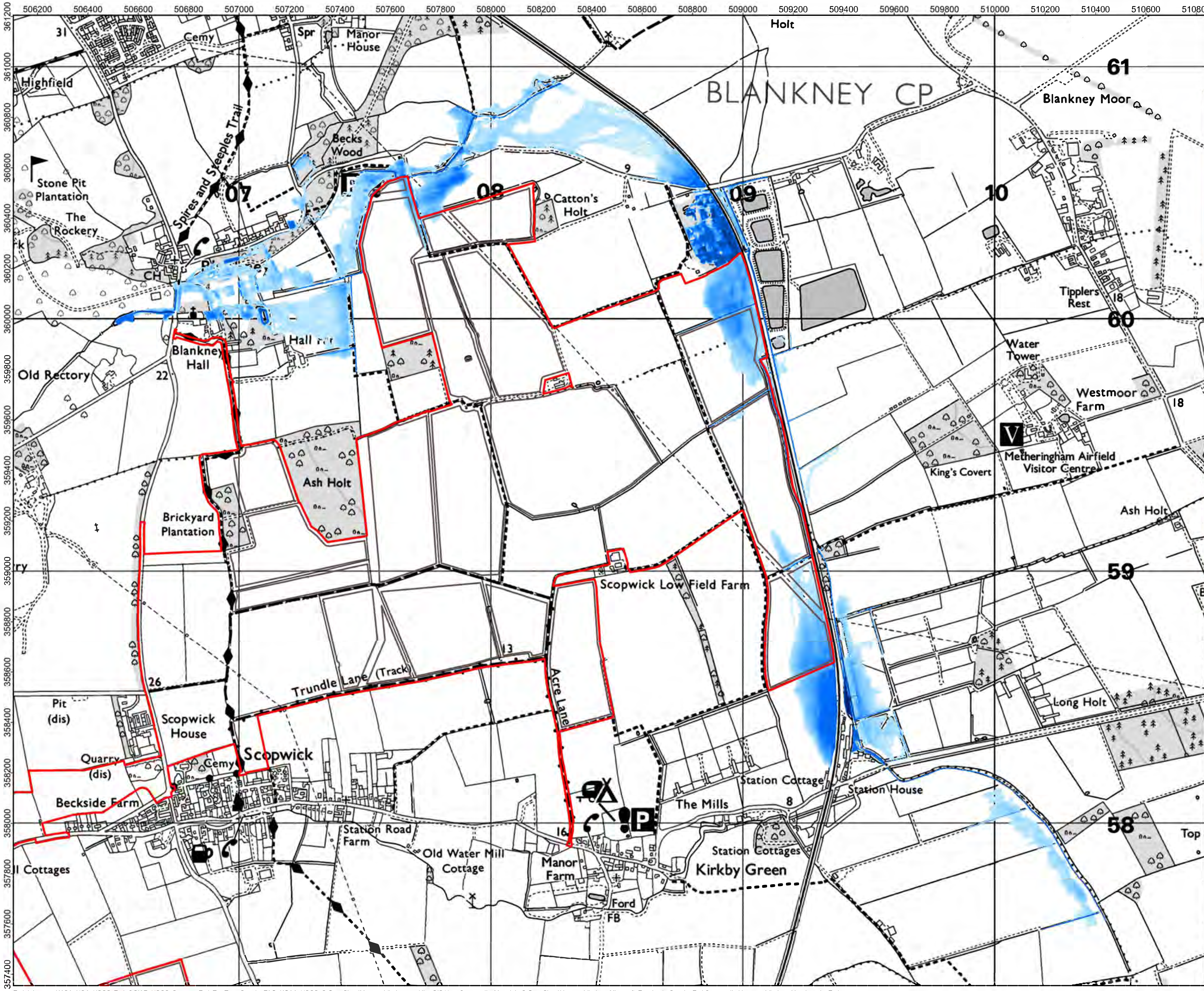
Scale: 1:14,000 @ A3

REV 01



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LEGEND:
- Order Limits
- Solar PV Development

Flood Zone Depth (m)
- 2
- 0.01

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

Rev	Date	Description	Drn	Chk	App
00	Jan 2025	New figure based on S55 advice	RSK	RSK	EDF

Springwell Solar Farm

DOCUMENT: Flood Risk Assessment Regulation 5 (2)(q)

TITLE: Appendix B.8: Flood Zone Depth

PINS REFERENCE NUMBER: EN010149/APP/7.16

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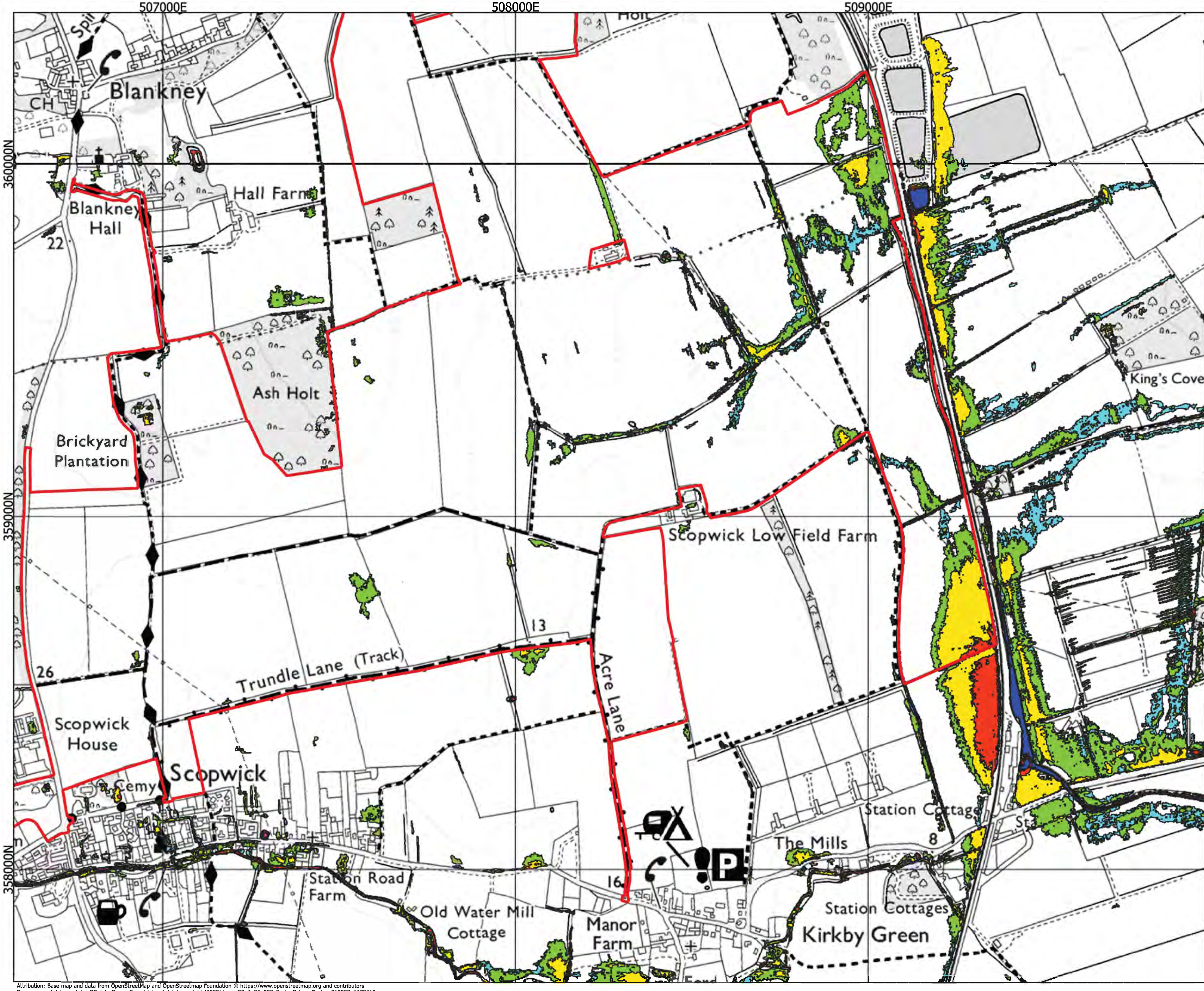
Kilometers
Scale: 1:14,000 @ A3

REV 00



Legend

Order Limits

0.1% AEP RISK OF FLOODING FROM SURFACE WATER DEPTHS (METERS)

- 0.00 - 0.15
- 0.15 - 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

Rev	Date	Description	Drn	Chk	App
01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF

Springwell Solar Farm

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.9
0.1% AEP SURFACE WATER DEPTH MAPPING (ENVIRONMENT AGENCY DATA)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

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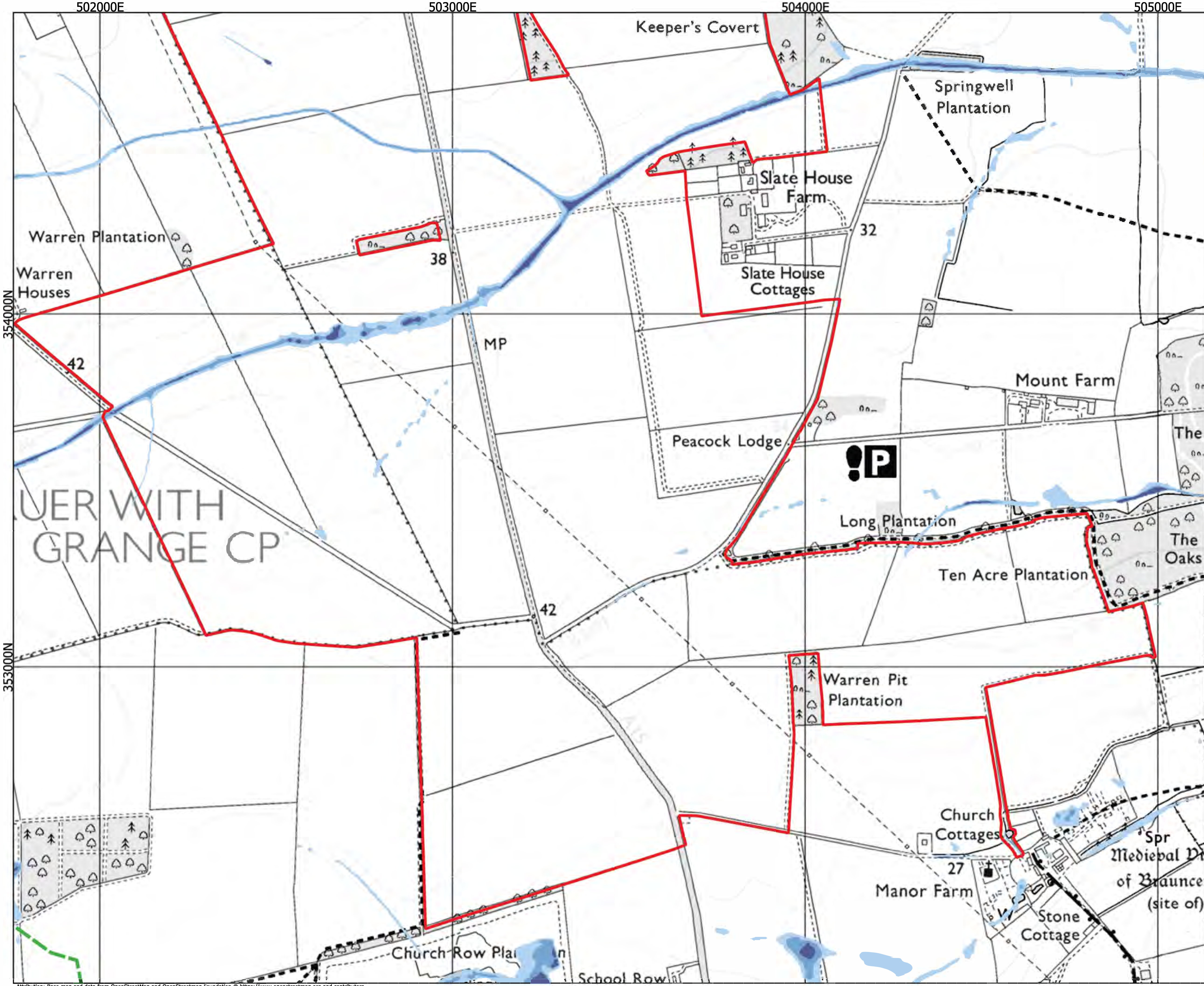
Kilometers
Scale: 1:10000 @A3

REV 01

Path:



Legend

- Order Limits
- RoFSW Extent 3.33% AEP
- RoFSW Extent 1.0% AEP
- RoFSW Extent 0.1% AEP

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF
Rev	Date	Description	Drn	Chk	App

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.10
RISK OF FLOODING FROM SURFACE WATER MAPPING (ENVIRONMENT AGENCY DATA)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

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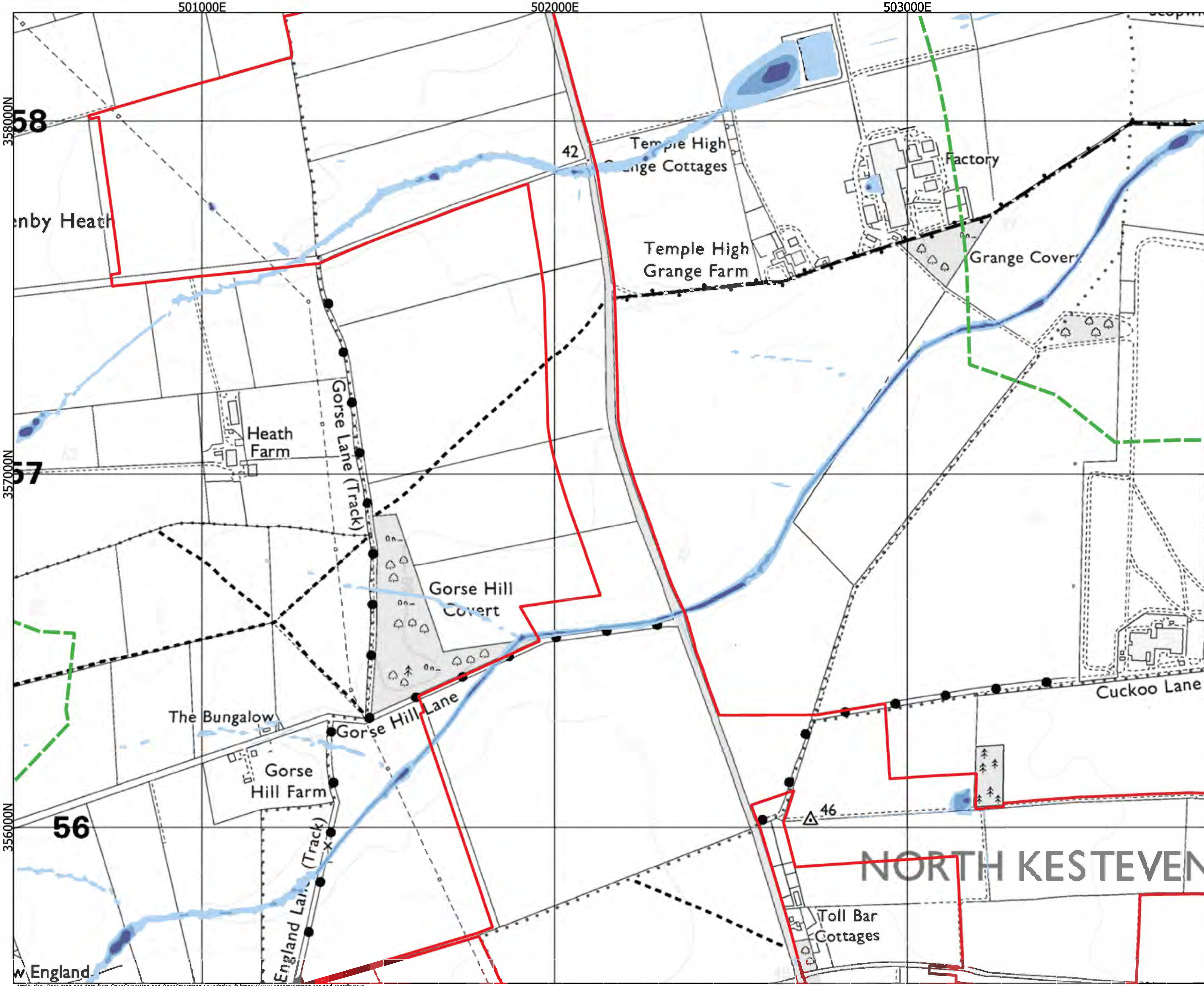
Kilometers
Scale: 1:10000 @A3

REV 01



Legend

- Order Limits
- RoFSW Extent 3.33% AEP
- RoFSW Extent 1.0% AEP
- RoFSW Extent 0.1% AEP

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

Rev	Date	Description	Drn	Chk	App
01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.11
RISK OF FLOODING FROM SURFACE WATER MAPPING (ENVIRONMENT AGENCY DATA)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

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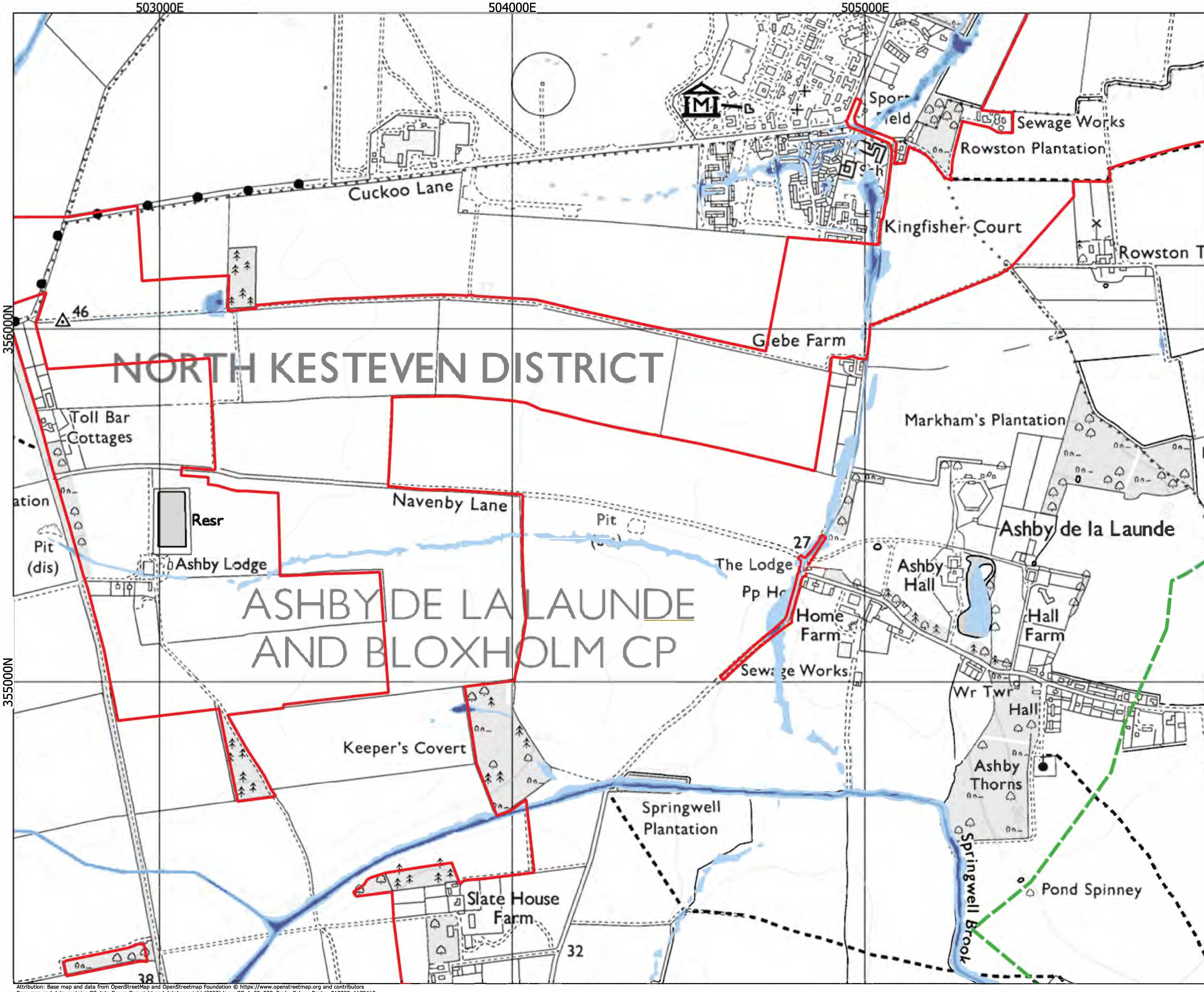
Kilometers

Scale: 1:10000 @A3

REV 01

Path:



Legend

- Order Limits
- RoFSW Extent 3.33% AEP
- RoFSW Extent 1.0% AEP
- RoFSW Extent 0.1% AEP

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

Rev	Date	Description	Drn	Chk	App
01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.12
RISK OF FLOODING FROM SURFACE WATER MAPPING (ENVIRONMENT AGENCY DATA)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

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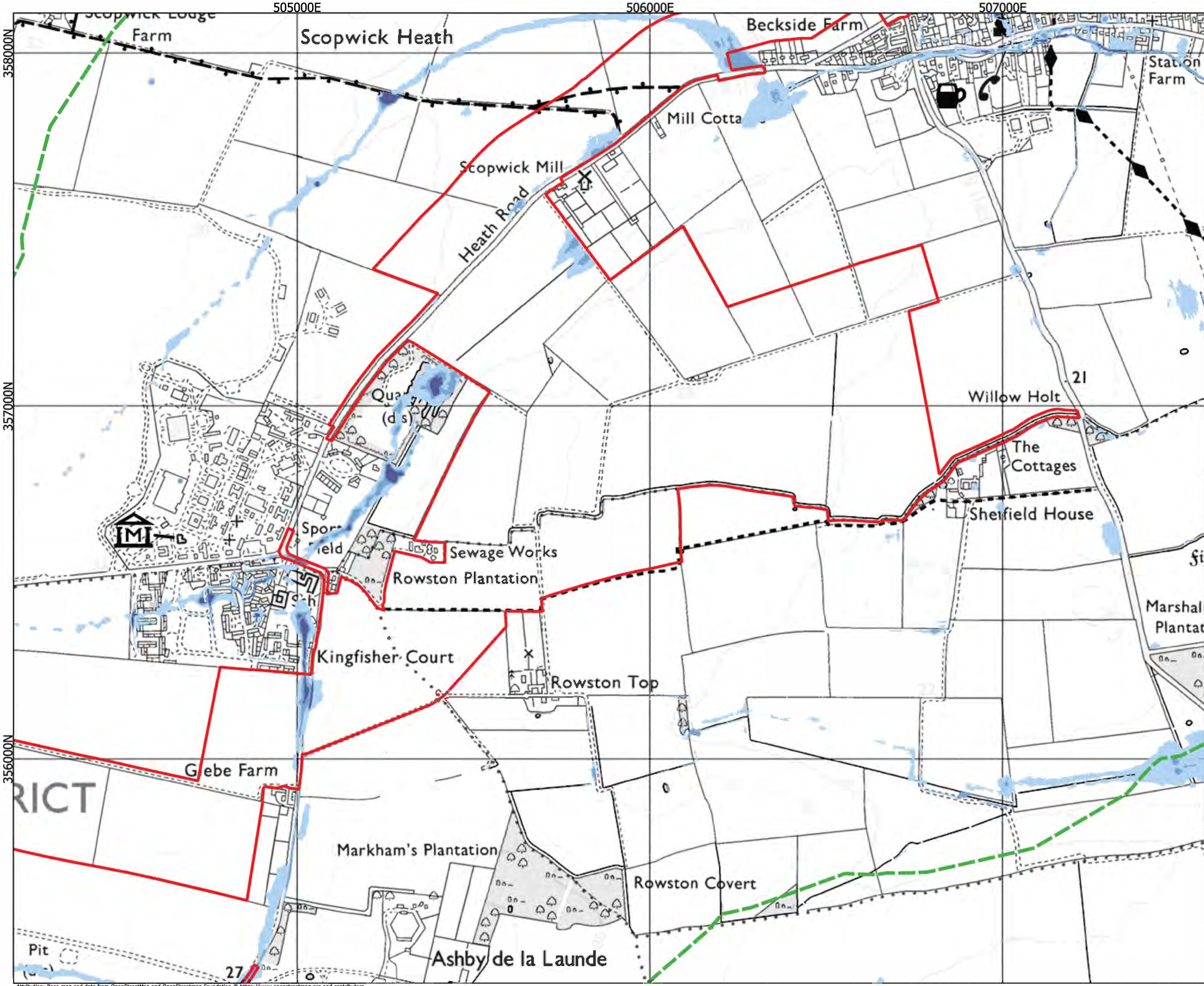
Kilometers
Scale: 1:10,000 @ A3

REV 01

Path:



Legend

- Order Limits
- RoFSW Extent 3.33% AEP
- RoFSW Extent 1.0% AEP
- RoFSW Extent 0.1% AEP

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

Rev	Date	Description	Drn	Chk	App
01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF

Springwell Solar Farm

DOCUMENT:
FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.13
RISK OF FLOODING FROM SURFACE WATER MAPPING (ENVIRONMENT AGENCY DATA)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

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Kilometers
Scale: 1:10000 @A3

REV 01

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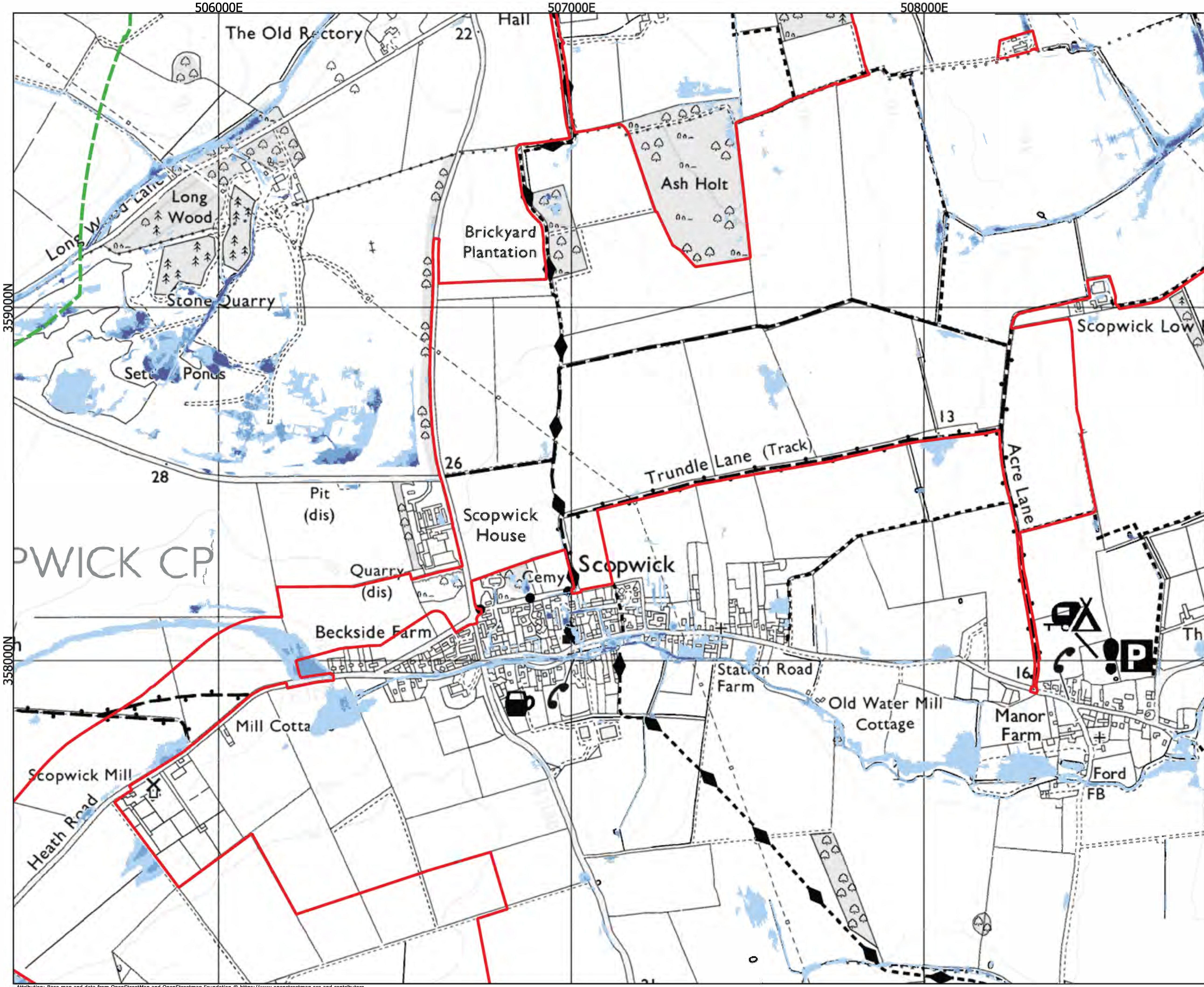

Legend

- Order Limits
- RoFSW Extent 3.33% AEP
- RoFSW Extent 1.0% AEP
- RoFSW Extent 0.1% AEP

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

Rev	Date	Description	Drn	Chk	App
01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.14
RISK OF FLOODING FROM SURFACE WATER MAPPING (ENVIRONMENT AGENCY DATA)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

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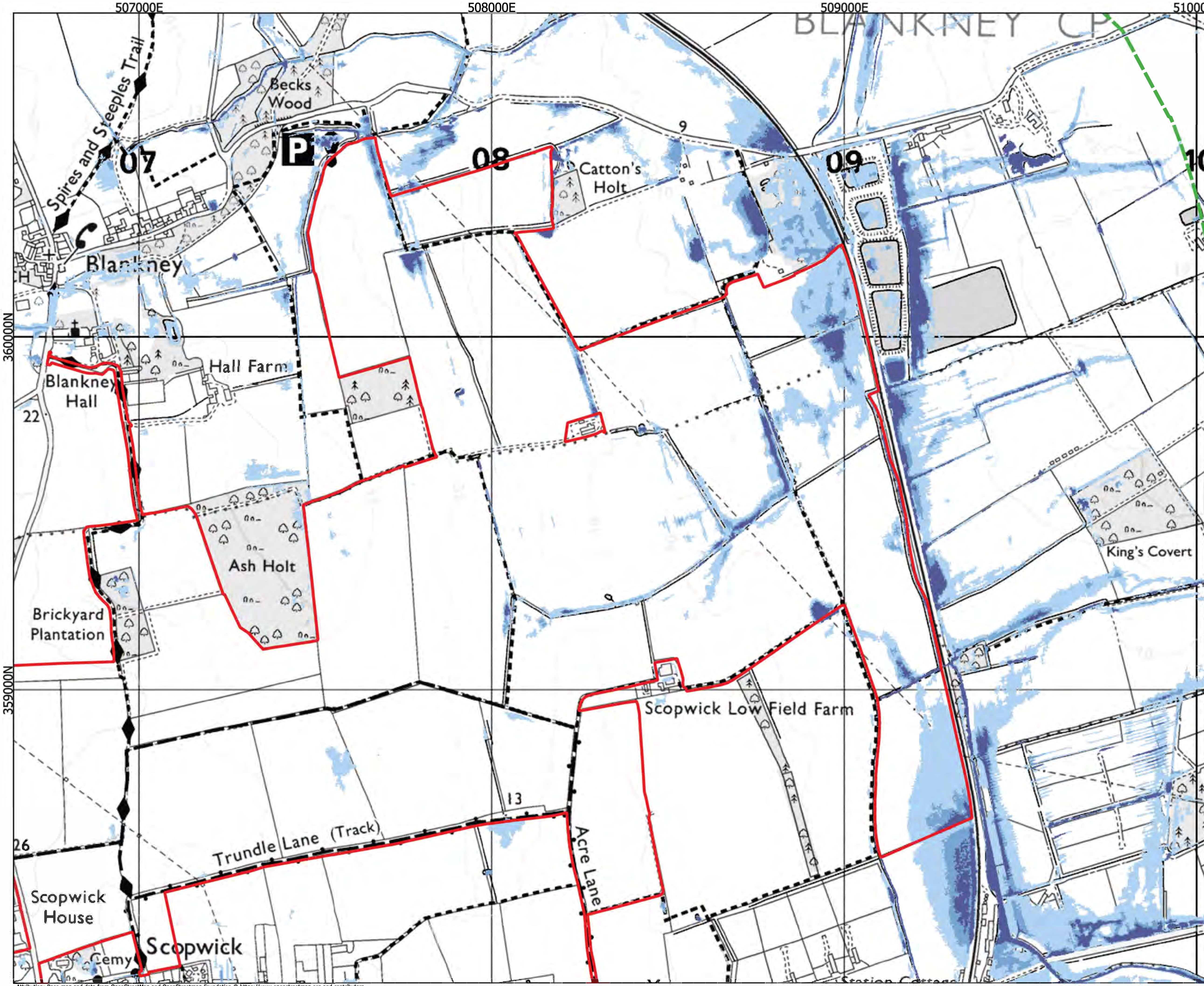
Kilometers

Scale: 1:10000 @A3

REV 01



Legend

- Order Limits
- RoFSW Extent 3.33% AEP
- RoFSW Extent 1.0% AEP
- RoFSW Extent 0.1% AEP

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF
Rev	Date	Description	Drn	Chk	App

Springwell Solar Farm

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.15
RISK OF FLOODING FROM SURFACE WATER MAPPING (ENVIRONMENT AGENCY DATA)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

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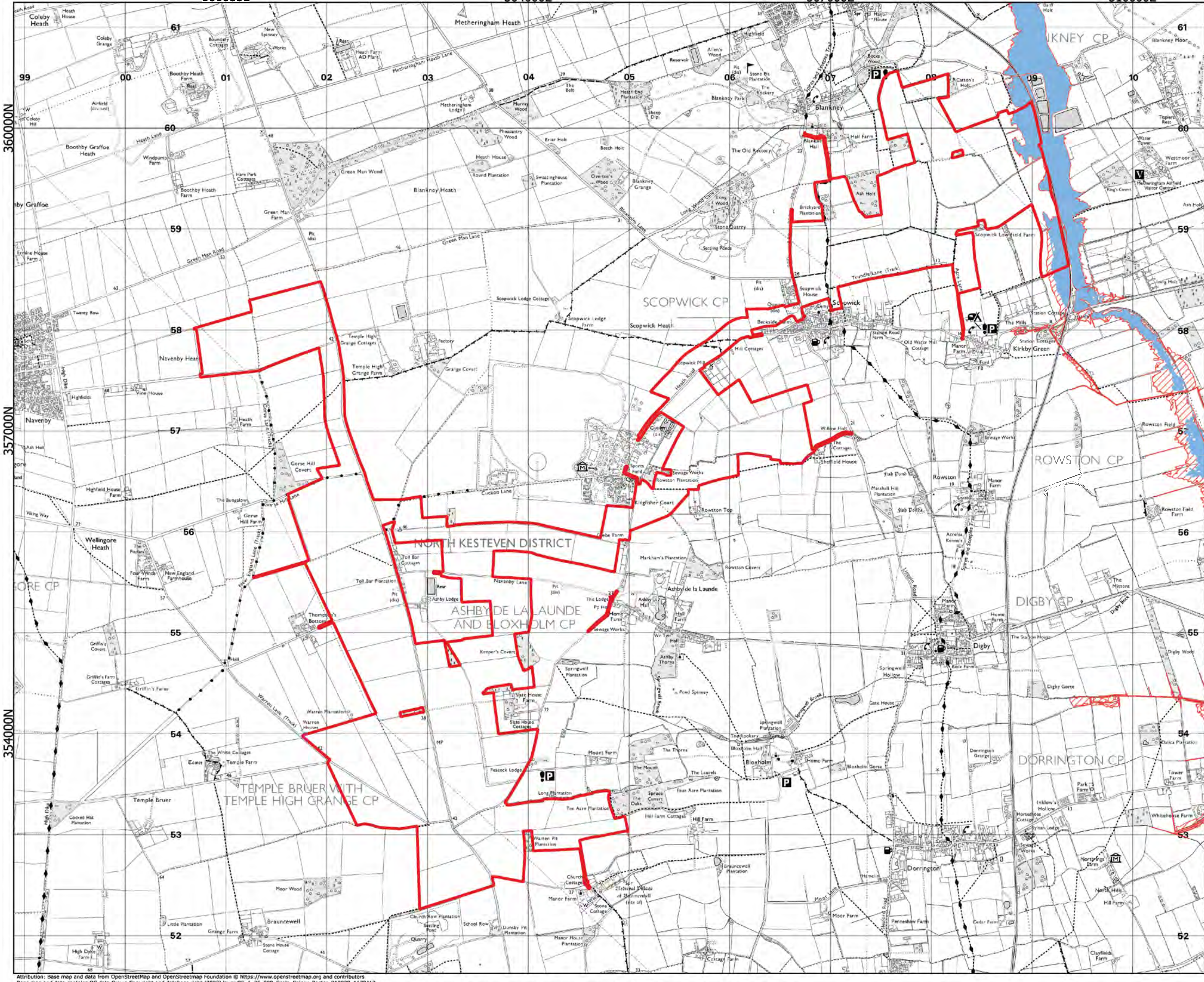
Kilometers
Scale: 1:10000 @A3

REV 01

Path:



Legend

Order Limits

Reservoir Flood Extents Dry Day

Reservoir Flood Extents Wet Day

OS 1:25,000

CRS: EPSG:27700
Projection: Transverse Mercator
Ellipsoid: EPSG:7001
Units: meters

Rev	Date	Description	Drn	Chk	App
01	NOV 2024	DCO SUBMISSION	RSK	RSK	EDF

Springwell Solar Farm

Springwell Solar Farm

DOCUMENT:

FLOOD RISK ASSESSMENT
REGULATION 5(2)(q)

TITLE:
APPENDIX B.16
RESERVOIR FLOOD RISK (ENVIRONMENT AGENCY DATA)

PINS REFERENCE NUMBER:
EN010149/APP/7.16

0 0.7 1.4
Kilometers

Scale: 1:35000 @A3

REV 01

Appendix A

Outline Drainage Strategy

Application Document Ref: EN010149/APP/7.16
Planning Inspectorate Scheme Ref: EN010149

Springwell Solar Farm

Outline Drainage Strategy

APFP Regulation 5(2)(q)
Planning Act 2008
Infrastructure Planning
(Applications: Prescribed Forms
and Procedure) Regulations 2009

EN010149/APP/7.16
November 2024
Springwell Energyfarm Ltd

Table of Contents

1. Introduction

1.1. Objectives

1.1.1. The aim of this report is to present a high level drainage strategy for the Proposed Development and provide recommendations on how surface water runoff from the Proposed Development will be managed.

1.1.2. The objectives of this drainage strategy, in order to satisfy Lincolnshire County Council as the Local Planning Authority and Lead Local Flood Authority (LLFA), are summarised below:

- Submit a Drainage Strategy as part of the DCO application.
- Undertake an initial assessment of surface water runoff to confirm site discharge rates and attenuation requirements.
- Include advice on SuDS measures within the drainage proposals to suitably control surface water runoff.

2. Existing Site

2.1. Location and Proposed Development

2.1.1. The Proposed Development comprises the development of a large scale Solar Farm with associated infrastructure including a new Springwell Substation, a Battery Energy Storage System (BESS) facility and Satellite Collector Compounds. A summary of the description of the Proposed Development can be found in **Section 3.1 of the Environmental Statement (ES) Volume 1, Chapter 3: Proposed Development Description [EN010149/APP/6.1].**

2.1.2. The Proposed Development is located in North Kesteven, Lincolnshire. The outlined area of the Proposed Development is presented in **Location, Order Limits and Grid Coordinate Plans [EN010149/APP/2.1].** The area surrounding the Proposed Development is rural with a mixture of small villages and current / former RAF facilities / bases.

2.2. Topography

2.2.1. Following a review of the freely available LiDAR data for the area, the general fall across the region is in an easterly direction. Levels to the west of the A15 (within the Springwell West area) are typically 40 - 60mAOD with levels in the Springwell East area, immediately to the west of the railway line connecting Metheringham and Ruskington, falling to 5 to 10m AOD.

2.3. Geology

2.3.1. The area of the Order Limits is recorded on the British Geological Survey (BGS) online mapping [**Ref. 1**] as typically lying above limestone bedrock in the form of:

- Lincolnshire Limestone Formation;
- Blisworth Limestone Formation;
- Upper Lincolnshire Limestone Member;
- Lower Lincolnshire Limestone Member;
- Cornbrash Formation; and
- Occasional areas of Blisworth Clay Formation - mudstone.

2.3.2. The BGS mapping highlights minimal superficial deposits in the area, with isolated areas of Tidal Flat Deposits, 1- Clay and Silt and Sleaford Sand and Gravel present around the local watercourses.

2.4. Hydrology

2.4.1. There are two Main Rivers that are located in close proximity to the Proposed Development, Springwell Brook / Digby Beck and New Cut Drain, alongside several small field drains and drainage ditches. Springwell Brook is located at Digby, approximately 2 km east of Field Bcd141. This Main River is fed by several small field drains and drainage ditches. New Cut Drain is located approximately 2 km south of Field Lf11. Springwell Brook is located within and to the east of Springwell West and is shown as a main river on the Environment Agency Mapping extending from Bloxham in an easterly direction until it reaches Dorrington Dike. New Cut Drain, located south of Springwell East, is located to the east of Kirkby Green.

2.4.2. Further 'named' watercourses in the area include Metheringham Beck, which flows through the northernmost fields of the Proposed Development, Dorrington Dike, which is fed by Springwell Brook / Digby Beck, and Ruskington Beck, which is located to the south east of the Order Limits.

2.4.3. All watercourses not deemed to be Main River would fall under the jurisdiction of Lincolnshire County Council as LLFA or the Witham First Internal Drainage Board (IDB). Based on the OS mapping, the mapped watercourses in the area typically extend to the B1191 (west of Scopwick / Ashby de la Launde) and the B1180 (west of Blankney), though there are numerous small field drains and ditches which are aligned along the perimeters of a number of the fields within the Order Limits.

2.4.4. The majority of the area of the Proposed Development is predominantly within Flood Zone 1, though some fields, particularly at the northeastern extent of Springwell East are located in Flood Zone 3.

2.4.5. The Proposed Development largely falls outside of any Source Protection Zone (SPZ) [**Ref. 2**], except for a small area to the west of Scopwick. This area falls within a localised inner zone (SPZ 1) which provides protection around a groundwater abstraction source located to the west of Scopwick, adjacent to Springwell Central. There are no outer catchments associated with this SPZ 1. There is also a total catchment zone (SPZ 3) located across the southern extent of Springwell West.

3. Outline Drainage Strategy

3.1. Introduction

3.1.1. During detailed design each sub-plot is to be assessed individually, and suitable provision for attenuation provided before being discharged to an outfall point, utilising the network of ditches and water courses within the local area. This section provides a holistic overview of the potential surface water drainage arrangements for the Proposed Development including the Springwell Substation and BESS during the operation of the Proposed Development.

3.2. Design criteria

3.2.1. The drainage network for the Proposed Development should adhere to the following criteria as set out in Section C of the Design and Construction Guidance [**Ref. 3**]:

- No surcharging in pipes, channels, chambers, swales, and soakaways in a 1 in 1-year design storm.
- No flooding from the highway drainage system in a 1 in 30-year design storm.

3.2.2. The drainage network should also comply with DEFRA's Non-statutory technical standards for Sustainable drainage systems [**Ref. 4**], section S4:

- Runoff volume from the development in the 1 in 100-year, 6 hours rainfall event should not exceed the greenfield/brownfield runoff volume for the same event.

3.2.3. To manage the risks associated with the long-term impacts of climate change, the peak rainfall intensity of the 1:1 year, 1:30 year and 1:100 year rainfall events will be increased by climate change allowances in accordance with the current Environment Agency's peak rainfall intensity climate change allowances (May 2022) [**Ref. 5**]. In this case the Witham Management Catchment requires the central level of 25% (central allowance 2070s) to be added to the 1% annual exceedance probability (AEP) storm event - considering a lifetime for the development of 50 years.

3.3. Drainage hierarchy

3.3.1. In line with National Policy Statements, the National Planning Policy Framework (NPPF), Planning Practice Guidance and associated guidance, drainage from new development should incorporate storage, with residual discharge of surface water to the following networks in order of preference:

- Infiltration drainage (e.g., soakaways);
- Discharge to a watercourse;
- Discharge to a highway drain

- Discharge to a public surface water sewer
- Discharge to a public combined sewer.

3.3.2. The choice of system will be determined by local ground conditions (including groundwater levels).

Infiltration Drainage

3.3.3. As noted, the Order Limits area is recorded on the BGS geology online mapping as typically lying above Limestone bedrock (Lincolnshire Limestone Formation, Blisworth Limestone Formation, Upper Lincolnshire Limestone Member, Lower Lincolnshire Limestone Member, Cornbrash Formation), with occasional areas of Blisworth Clay Formation - mudstone.

3.3.4. The BGS mapping highlights minimal superficial deposits in the area, with isolated areas of Tidal Flat Deposits, 1- Clay and Silt and Sleaford Sand and Gravel present around the local watercourses.

3.3.5. The Landis Soilscapes [**Ref. 6**] mapping suggests that the Proposed Development is underlain by 'Freely draining […] Shallow lime-rich soils over chalk or limestone' or ' Freely draining lime-rich loamy soils'.

3.3.6. No infiltration testing has been undertaken at the Proposed Development to date, though anecdotal information (soilscape and runoff rates) suggests a measure of infiltration may be viable. The current high level overview considers the current worst case scenario where (for the BESS and Springwell Substation) infiltration is not a viable drainage option. Should (following onsite investigations) infiltration be deemed a viable discharge option (for the BESS and Springwell Substation) then this will be factored into the future design.

Discharge to a Watercourse

3.3.7. There are numerous west to east aligned watercourses in the local area, with a number of the fields proposed for Solar Photovoltaic (PV) modules bounded by field drainage ditches. Based on the nature of the Proposed Development, this is considered a viable option for surface water discharge, though this is subject to both location of the ditches and the respective levels of the receiving watercourses.

Discharge to a Public Sewer

3.3.8. Due to the rural nature of the Proposed Development, discharge of surface water to the public sewer network is not being sought as part of the DCO Application.

3.4. Surface Water Runoff Assessment

3.4.1. The runoff discharge from the existing site has been assessed and the storage requirement determined from the 1 in 100-year Return Period (RP) 6-hour duration event, as per DEFRA non-statutory technical standards for sustainable drainage systems.

3.4.2. The following run off rates (based on a pro rata 1ha development site), shown in Table 1, have been calculated using HR Wallingford's greenfield runoff rate estimation tool [**Ref. 7**] - the full calculations are provided in **Appendix A** of this report.

Return Period	Greenfield runoff rate (l/s/ha)
QBar	0.14
1:1 Year	0.12
1:30 Year	0.33
1:100 Year	0.49

Table 1 Greenfield Runoff Rates and Storage Volume Required (note calculations suggest a soil type of 1 in this location leading to very low runoff rates)

3.4.3. According to the principles of the BRE planning guidance for the development of large-scale ground mounted solar PV systems [**Ref. 8**], Solar PV modules do not increase the impermeable area of a site as the ground remains permeable and it is considered that they do not contribute to an increase in surface water runoff from the Site.

3.4.4. The Solar PV modules will not materially increase the impermeable area across the Site; therefore, no formal drainage is required for the areas of solar PV modules. However, a pragmatic approach has been developed to promote infiltration and provide water storage areas across the Site. This will involve the management and maintenance of vegetated and grassed areas surrounding the panels (particularly at the low edge) and the design of gravel subbase for the onsite units i.e. cabinets / containers / structures. These features will intercept and attenuate runoff, promoting infiltration across the Site.

3.5. Discharge rates and catchment characteristics

3.5.1. It is anticipated that surface water discharges from the Proposed Development will be restricted to pre-development greenfield runoff rates in accordance with DEFRA's Non-Statutory Technical Standards (NSTS) for Sustainable Drainage Systems where relevant. Greenfield runoff rates will be achieved through use of the long-term storage or the mean annual flood (QBAR) approach.

3.5.2. The drainage strategy assumed the greenfield runoff rate will be achieved through use of the mean annual flood (QBAR) approach. The QBAR rate has been estimated for the Proposed Development based on a per hectare basis using the Institute of Hydrology IH124 methodology. The estimated QBAR runoff rate is 0.14 l/s/ha which may present design implications for the drainage network when trying to limit a drainage scheme to a negligible rate (i.e. inability to achieve self cleansing velocity and impractically large attenuation structures). Based on the low QBar rate and the upstream location of the Proposed Development to the Witham First IDB, it is noted that surface water discharge rates are likely to be restricted to 1.4l/s/ha. The final discharge rates would be subject to consultation with LCC and the Witham First IDB.

3.6. Surface Water Collection Strategy

3.6.1. The following strategy is recommended for the surface water collection:

3.6.2. Best practice for drainage designs on new developments should prioritise SuDS solutions. SuDS aim to reduce the risk of flooding on a site by imitating natural drainage and managing surface water runoff in a more sustainable way. The four pillars of SuDS refer to the benefits that can be provided using sustainable design as shown in Figure 1. The four pillars of SuDS: Water Quantity, Water Quality, Amenity and Biodiversity will be used to ascertain the most effective drainage design.

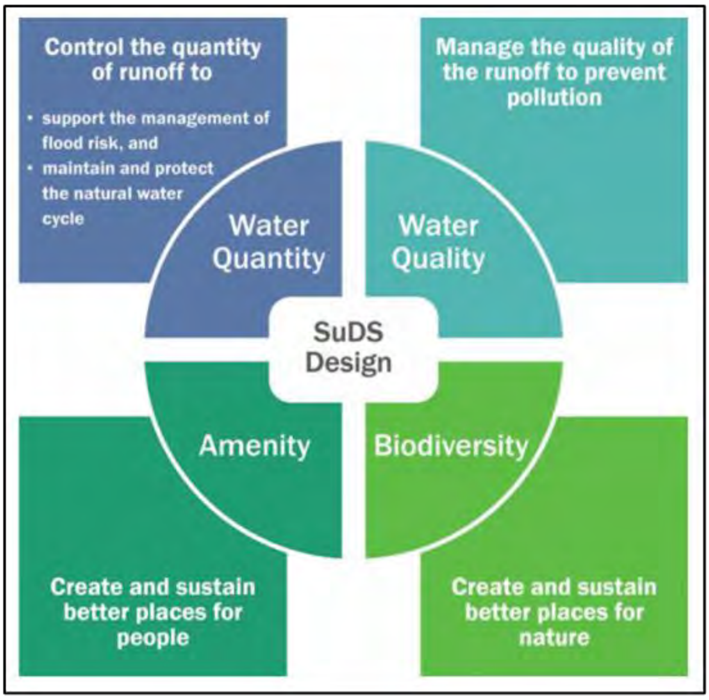


Figure 1 The Four Pillars of SuDs (Source: CIRIA report C753 the SuDS Manual [**Ref. 9**])

3.6.3. The drainage system has been split into different components although some may overlap. The components can be classified as:

SOURCE CONTROL: Slow down and store runoff at source.

INFILTRATION: Allow runoff to infiltrate on site.

CONVEYANCE: Transfer runoff across the site and between components.

RETENTION: Provide final storage before discharge into existing network / watercourse.

3.7. Options for Surface Water Collection

3.7.1. Table 2 details several possible drainage components that have been considered as part of the Proposed Development considering the Solar Photovoltaic (PV) Development, Springwell Substation, Satellite Collector Compounds and BESS. Options considered are based upon the SuDS techniques described within the CIRIA SuDS manual (C753).

Drainage Components	Description
Pond	Permanently wet depression designed to temporarily store surface water runoff above the permanent pool and permit settlement of suspended solids and biological removal of pollutants. A separate pond with a shut-off valve would be required for discharge and storage of potentially contaminated water e.g. from battery firefighting
Detention Basin	Landscaped depressions that are normally dry except during and following rainfall events, normally for 24 hours. These can be vegetated and with mitigation measures pollutant runoff will be avoided/minimal.
Bioretention System	Bioretention systems can be used to capture surface runoff. They help to reduce peak flows and volume of downstream components. Bioretention systems are flexible in shape and features and can be planned as landscaping features.
Swales	A shallow vegetated channel designed to convey, treat and occasionally store surface water, and may also permit infiltration.
Filter Drain	A linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage.
Filter Strip	A vegetated area of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.

Green Roof	Green roofs are designed to intercept and retain precipitation, reducing the volume of runoff and attenuating peak flows. Provide good removal capability of atmospherically deposited urban pollutants.
Infiltration Systems	Infiltration components can be used to capture surface water runoff and allow it to infiltrate and filter through to the subsoil layer, before returning it to the water table below. Infiltration components can be incorporated into a range of SuDS components.
Permeable Paving	Permeable paving can be used for the proposed pedestrian footpaths allowing rainwater to infiltrate through the surface while providing an area suitable for pedestrian and vehicles if required. The water should be temporarily stored in storage systems (assuming no infiltration) before discharging to the drainage system. This will reduce the peak flows and the volume required for downstream components.

Table 2 Potential Drainage Components

3.7.2. As infiltration is assumed not to be possible at this stage (for the access tracks / substation), as a worst case scenario for the purposes of assessment, the following SuDS options are considered the most appropriate drainage components for the Proposed Development:

Permeable Paving

3.7.3. If acceptable for this development, this SuDS element could provide an additional source control measure on the Proposed Development. Assuming impermeable nature of the underlying soils, any permeable surfacing would likely need to be under drained and connected further into the sewers, though this specification would be subject to change upon receipt of any detailed site investigation results. Permeable paving may be implemented within the sections of parking / access routes.

Figure 2 Permeable paving with below ground attenuation (Extract from the SuDS Manual, CIRIA, 2015 [**Ref. 9**])

Bioretention Systems

3.7.4. Bioretention systems could be used locally alongside the access road / within the car parking areas to capture the runoff from hardstanding areas. They will help to reduce peak flows and volume of downstream components. Bioretention systems are flexible in shape and features and can be planned as landscaping features. Bioretention areas could also be used as an element for conveyance of the runoff.

3.7.5. Urban tree pits/cells can be used to capture, treat and attenuate runoff into the local drainage network. An example of a GreenBlue Urban raingarden system is shown in the Figure 3 below.

Figure 3 Hydroplanter Flex – flexible raingarden system (Source: GreenBlue Urban – [**Ref. 10**])

Tree Pits

3.7.6. Urban tree pits/ cells can be used to capture, treat and attenuate runoff before discharging into the local drainage network. An example of a GreenBlue Urban tree pit system is shown in Figure 4 below.

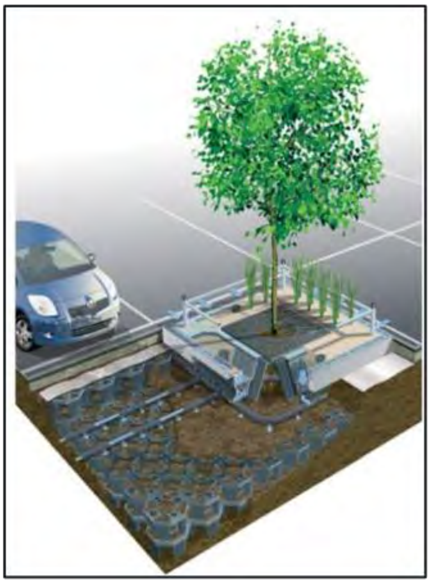


Figure 4 ArborCell Tree Pit (Source: GreenBlue Urban [**Ref. 10**])

Swales

3.7.7. Surface water runoff can be collected on site and re-used to irrigate trees and planting on the Proposed Development.

Detention Basins

3.7.8. Detention basins can provide a large volume of attenuated surface water following the capture of runoff from hardstanding areas. They will help to attenuate peak flows and reduce the discharge from these features whilst keeping surface water runoff above ground which assists with areas where outfall locations may be shallow ditches. Where relevant, the detention basins could also be used as local amenity areas.

3.8. Proposed Surface Water Discharge Strategy- Solar Photovoltaic (PV) modules

Panel Design

3.8.1. It is anticipated that any precipitation falling on each solar panel will run off the panels and flow towards / infiltrate in the rain shadow of the down-slope modules.

3.8.2. The specifications of the solar array supports are to be designed to be widely spaced and are driven vertically into the ground with no additional foundations. The modules are in rows with spaces of several metres in between the leading edge of one row and the trailing edge of the row behind.

3.8.3. Where practicable, panels mounted in multiple horizontal rows should be separated by a horizontal ‘rainwater’ gap. This gap allows rainwater to drain freely to the ground between the panels helping to replicate the Greenfield runoff conditions.

Vegetation and Soil Structure

3.8.4. Sustainable management of the post development situation in terms of vegetation planting and soil type can be used as a means of managing surface water runoff from the solar panels. As such, to ensure that there is no increase in surface water runoff managed sustainable vegetation (dripline planning) will be allowed to grow beneath the solar panels, which will avoid kinetic compaction and ensure that any potential instances of rivulet formation are minimised and surface water runoff flows over the ground in a natural way as noted in the paper Hydrologic Response of Solar Farms (Cook and McCuen 2013) [**Ref. 11**]. Vegetation planting and soil management should be site-wide to encompass all solar panel rows.

Perimeter Swales

3.8.5. To intercept extreme surface water runoff, which may already run offsite from the areas of the Proposed Development where Solar Photovoltaic (PV) modules are proposed, swales are proposed within low lying areas. With the negligible increase in surface water runoff associated with the Solar Photovoltaic (PV) development, the proposed swales will provide additional surface water storage capacity relative to the baseline scenario - they are considered ancillary and do not form part of the formal SuDS network.

Cabinets / containers

3.8.6. It is intended that surface water runoff from the equipment housing will be discharged to the ground after passing through the gravel subbase to closely mimic the existing situation. The design rainfall event for this assessment has been taken as the 6 hour, 1 in 100-year event with the intention of retaining any additional surface water runoff generated as a result of the Proposed Development in the gravel subbase. Due to the small volumes of runoff likely generated by the cabinets, surface water discharge will likely be via natural infiltration through a gravel subbase / evaporation.

Access tracks

3.8.7. Where required, access tracks are kept to a minimum. It is currently assumed that the internal access tracks will be either gravel or a hydraulically bound mixture. Taking a conservative approach, the tracks are considered to be constructed using a hydraulically bound mixture.

3.8.8. Initial estimates suggest that c. 90,000m2 of internal access tracks will be present on the Proposed Development (based on estimation that 1% of the area considered for PV development will consist of internal access roads).

3.8.9. As the access tracks are to be considered to consist of hydraulically bound materials, it is proposed that swales are incorporated into areas adjacent to the access tracks.

3.8.10. It is proposed that the use of swales running parallel to the access tracks will be included in the surface water drainage strategy as a way to manage any increase in runoff attributable to the tracks.

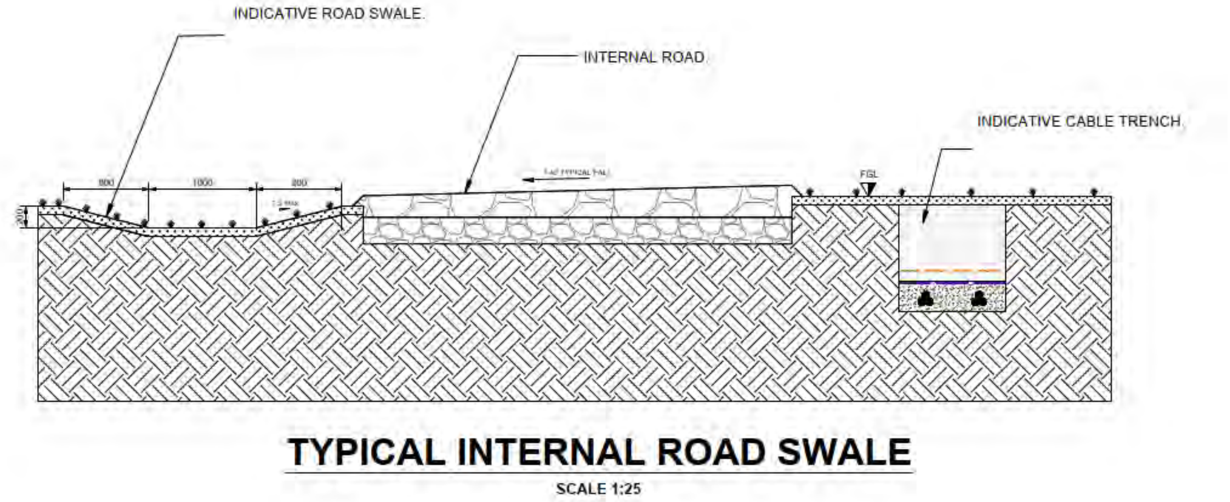


Figure 5 Typical access road section

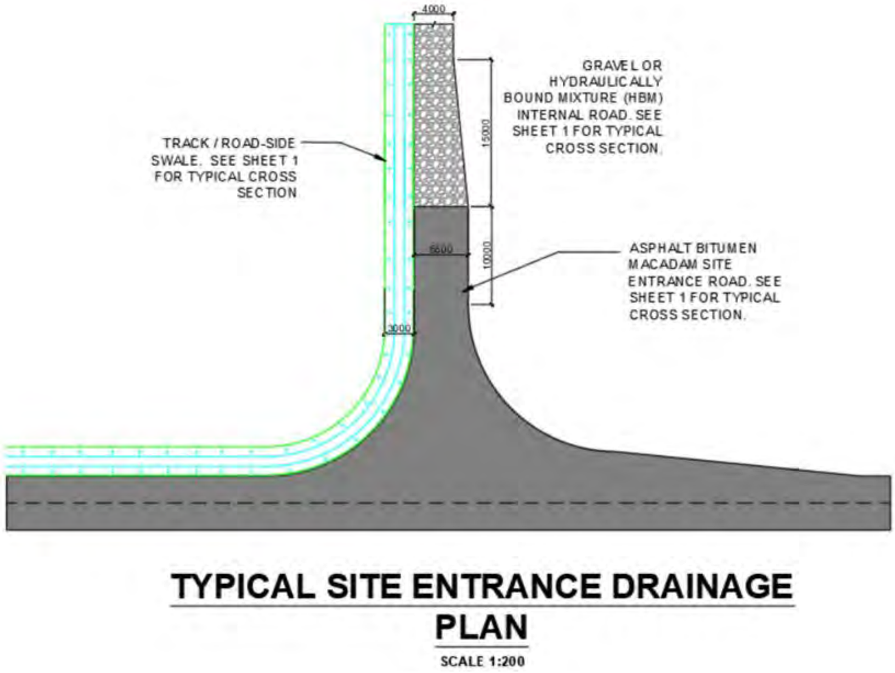


Figure 6 Typical access road plan

3.8.11. For general solar panel maintenance access off the main access, tracks / road could be gained by way of using 4x4 vehicle, quadbike or agricultural vehicles to minimise impacts on the ground.

3.9. Proposed Surface Water Discharge Strategy – Satellite Collector Compound

3.9.1. As part of the Proposed Development there are three Satellite Collector Compounds (1 in each parcel (Springwell West, Springwell Central and Springwell East).

3.9.2. As detailed in **ES Chapter 3 – Proposed Development Description [EN010149/APP/6.1]**, each Satellite Collector Compound has a footprint of 1,500m2. An initial consideration of a 50% impermeable area has been considered for the compounds, i.e. 750m2.

Storage volume requirements

3.9.3. Attenuation storage is required since post-development runoff flows are to be restricted to the pre-development greenfield runoff rates. With the presence of the Witham First IDB downstream of the Proposed Development, it is proposed to be discharged at 1.4l/s/ha. This rate is subject to confirmation from the IDB and LLFA. The following storage volumes will be required across the Proposed Development. Supporting information, including high level indicative drainage calculations undertaken using Causeway Flow software, is provided in **Appendix B**. Details are summarised in Table 3 below:

Name	Number	Fields	A. (m^2)	Total Impermeable A (m2)	Indicative Storage Volume required for 100 year plus 25%CC (m3)
Satellite Collector Compound	3	1 in each parcel (Fields Bcd102, Bk02, By22)	1500 per compound (4500 total)	750 per compound (2250 total)	36-51 per compound (108-153 total)

Table 3 Catchments Total impermeable Area

3.9.4. Indicative storage volume requirements have been estimated for the proposed Satellite Collector Compounds. The gross estimated storage volume (per collector compound) is 51m3 for up to the 1 in 100-year return period storm event including a 25% uplift allowance for climate change based on a 1.4l/s/ha discharge rate, though this is subject to change at detailed design. No allowance for urban creep has been assumed as a result of the development type.

Discharge Locations

3.9.5. It is assumed that the Satellite Collector Compounds will discharge into the local watercourse network / field drains. The discharge location is subject to relevant surveys and also final confirmation of the location of the compounds.

3.9.6. The storage features / volumes noted in this report are subject to change at later detailed design stages as more information is gained.

3.9.7. The feasibility of gravity discharge from the storage feature will be confirmed at design stage.

Exceedance

3.9.8. Drainage exceedance occurs when the rate of surface water runoff exceeds the capacity of the drainage system. For rainfall events above the 1 in 100-year return period, the capacity of the proposed drainage system will be exceeded, and excess water will cause surface water flooding.

3.9.9. Underground conveyance cannot economically or sustainably be built large enough for all types of extreme rainfall. As a result, there will be occasions when surface water runoff will exceed the capacity of the drainage system.

3.9.10. Flood flow paths from the Proposed Development will be directed onto the adjacent land within the Order Limits where the risk of flooding and the risk to health and safety is minimal and can be managed.

3.10. Proposed Surface Water Discharge Strategy – Springwell Substation and Main Collector Compound

3.10.1. As part of the Proposed Development, there will be the requirement to develop a Springwell Substation in the vicinity of the proposed National Grid Navenby Substation to the west of the A15.

3.10.2. As detailed in **ES Volume 1, Chapter 3: Proposed Development Description [EN010149/APP/6.1]**, the Springwell Substation has footprint of 62,500m2 and is assumed to be adjacent to the Main Collector Compound with a footprint of 21,600m2. Based on the total footprint of 84,100m2 an initial consideration of a 50% impermeable area has been considered for the compounds, i.e. 42,050m2.

Storage volume requirements

3.10.3. Attenuation storage is required since post-development runoff flows are to be restricted to the pre-development greenfield runoff rates. With the presence of the Witham First IDB downstream of the Proposed Development, it is proposed to be discharged at 1.4l/s/ha. The following storage volumes will be required across the Proposed Development. Supporting information, including high level indicative drainage calculations undertaken using Causeway Flow software, is provided in **Appendix C** of this report. Details are summarised in **Table 4** below:

Name	Number	Fields	A. (m^2)	Imp Area (%)	Total Impermeable A (m^2)	Indicative Storage Volume required for 100 year plus 25%CC (m^3)
Springwell Substation / Main Collector Compound	1	Located in Tb2	84,100	50	42,050	3,376-4,057

Table 4 – Catchments Total impermeable area

3.10.4. Indicative storage volume requirements have been estimated for the Springwell Substation and Main Collector Compound. The gross estimated storage volume is 4,057m3 for up to the 1 in 100-year return period storm event including a 25% uplift allowance for climate change based on a 11.7/s discharge rate (1.4l/s/ha*8.41ha) though this is subject to change at detailed design. No allowance for urban creep has been assumed as a result of the development type.

Discharge Locations

3.10.5. It is assumed that the Springwell Substation and Main Collector Compound will discharge into the local watercourse network / field drains in the vicinity of field Tb2. The discharge location is subject to relevant surveys and also final confirmation on substation location.

3.10.6. The storage features / volumes noted in this report are subject to change at later detailed design stages as more information is gained.

3.10.7. The feasibility of gravity discharge from the storage feature will be confirmed at detailed design stage.

Exceedance

3.10.8. Drainage exceedance occurs when the rate of surface water runoff exceeds the capacity of the drainage system. For rainfall events above the 1 in 100-year return period, the capacity of the proposed drainage system will be exceeded, and excess water will cause surface water flooding.

3.10.9. Underground conveyance cannot economically or sustainably be built large enough for all types of extreme rainfall, as a result, there will be occasions when surface water runoff will exceed the capacity of the drainage system.

3.10.10. Flood flow paths from the Proposed Development should where practicable be retained within the access roads / parking areas or directed towards the local SuDS features where the risk of infrastructure flooding and the risk to health and safety is minimal and can be managed.

3.11. Proposed Surface Water Discharge Strategy – BESS

3.11.1. As part of the Proposed Development there will be the requirement to develop a BESS in the vicinity of the proposed Springwell Substation and Main Collector Compound to the west of the A15.

3.11.2. As detailed in ES Chapter 3 – Proposed Development Description [EN010149/APP/6.1], the BESS compound has a footprint of up to 125,000m2. An initial consideration of an 85% impermeable area has been considered for the compounds, i.e. 106,250m2.

Storage volume requirements

3.11.3. Attenuation storage is required since post-development runoff flows are to be restricted to the pre-development greenfield runoff rates. With the presence of the Witham First IDB downstream of the Proposed Development, it is proposed to be discharged at 1.4l/s/ha. The following storage volumes will be required across the Proposed Development. Supporting information, including high level indicative drainage calculations undertaken using Causeway Flow software, is provided in Appendix D. Details are summarised in Table 5 below:

Name	Number	Fields	A. (m^2)	Imp Area (%)	Total Impermeable A (m^2)	Indicative Storage Volume required for 100 year plus 25%CC (m^3)
BESS	1	1 to be located in Tb2	125, 000	85	106,250	9,529 – 10,564

Table 5 – Catchments Total impermeable Area

3.11.4. Indicative storage volume requirements have been estimated for the proposed collection compounds. The gross estimated storage volume is 10,564m3 for up to the 1 in 100-year return period storm event including a 25% uplift allowance for climate change based on a 17.5l/s discharge rate (1.4l/s/ha*12.5ha) though this is subject to change at detailed design. No allowance for urban creep has been assumed as a result of the development type.

Discharge Locations

3.11.5. It is assumed that the BESS will discharge into the local watercourse network / field drains. The discharge location is subject to relevant surveys and also final confirmation on BESS location.

3.11.6. The storage features / volumes noted in this report are subject to change at later detailed design stages as more information is gained.

3.11.7. The feasibility of gravity discharge from the storage feature will be confirmed at detailed design stage.

Exceedance

3.11.8. Drainage exceedance occurs when the rate of surface water runoff exceeds the capacity of the drainage system. For rainfall events above the 1 in 100-year return period, the capacity of the proposed drainage system will be exceeded, and excess water will cause surface water flooding.

3.11.9. Underground conveyance cannot economically or sustainably be built large enough for all types of extreme rainfall, as a result, there will be occasions when surface water runoff will exceed the capacity of the drainage system.

3.11.10. Flood flow paths from the Proposed Development should where practicable be retained within the access roads / parking areas or directed towards the local SuDS features where the risk of infrastructure flooding and the risk to health and safety is minimal and can be managed.

Firefighting Water

3.11.11. An Emergency Response Plan will be agreed with Lincolnshire Fire and Rescue Service which may require the use of water for firefighting. This section describes the drainage approach if firefighting water is required. Final design will be agreed with the appropriate stakeholders.

3.11.12. Any immediate firefighting water runoff from a fire event would runoff the concrete base of the BESS units and be intercepted by the drainage system. There is potential that during an event where firefighting water is used, potential contaminants could enter the surface water drainage system.

3.11.13. If there is potential for contaminated runoff to enter the wider hydrological network, systems will be installed to isolate and contain any firefighting water runoff. This will likely be via use of impermeable membranes and a bung and penstock system which can be utilised to stop the surface water discharge offsite within the onsite drainage network. The potentially contaminated runoff can then be contained within an underground attenuation tank or bunded holding lagoons. The water will be tested following the fire and if contaminated, collected and tankered offsite to be suitably tested and disposed of.

3.11.14. Further details on the fire water proposals will be developed as part of the detailed design but also in accordance with the Emergency Response Plan.

3.12. Foul Drainage

3.12.1. During the operational phase there is capacity for small numbers (c. 12) permanent staff members to be located at the Springwell Substation/BESS. The facilities will comprise toilets and a kitchen with foul waters emanating from both facilities. Based on the rural nature of the location of the Springwell Substation and BESS, it is anticipated that there are no foul sewers within the immediate vicinity. Therefore connection to a foul sewer will not be feasible.

3.12.2. Two options therefore exist with respect to the foul water from the Springwell Substation/BESS. The Applicant's preference is to limit any requirements to tanker off foul water from the Proposed Development.

3.12.3. As such an initial approach to the foul water drainage would be via a form of package treatment works located within the vicinity of the Springwell Substation and Main Collector Compound/BESS. With respect to the nature of the Proposed Development, actual foul flows are likely to be small and as such a package treatment works may be a viable approach with ultimate discharge towards the local ditch/watercourse network (if required via a drainage field).

3.12.4. Should the above approach not be deemed suitable based on onsite conditions, foul water associated with the Springwell Substation and Main Collector Compound/BESS would be stored via cesspits on-site, within the immediate vicinity of the welfare facility areas. The cesspits will be managed, inspected and drained by a licensed courier who will then dispose of the waste offsite. The Environment Agency will be consulted to obtain a permit for the operation of the cesspits, as appropriate.

3.12.5. Any cesspit / septic tank should be at least 7m away from any 'habitable' part of a building and within 30m of an access point. Sizing of the sewage treatment systems should be in accordance with the British Water Flows and Loads Code of Practice.

3.12.6. Type and specification of package treatment works or cesspit would be outlined at detailed design.

3.13. Assumptions and Risks

Assumptions

3.13.1. This strategy has taken a worst case approach with the assumption that in that infiltration is not viable for the Satellite Collector Compounds, Springwell Substation and Main Collector Compound, or BESS development. Calculated runoff rates suggest a permeable soil stratigraphy and should through further survey it be determined that infiltration can assist in the surface water drainage strategy for the infrastructure, this will be incorporated into revisions of / detailed design of the drainage system.

3.13.2. Storage estimates are indicative and have been calculated using Causeway Flow software. The estimated volumes provided are subject to change at future design stages and have been provided as an initial guide.

3.13.3. It is assumed that the existing connection into the local field drains / watercourses is suitable to be utilised for the Proposed Development. A full survey of the local drainage ditch network / land drains is recommended in the areas of the Springwell Substation and BESS.

3.13.4. It is assumed that the urban tree pit systems and bioretention areas will be effective at removing any potential pollutants from the Proposed Development and that the trees will not be harmed.

3.13.5. It is assumed that the proposed drainage plans do not affect existing underground services. This will be investigated further during the detailed design stage.

Risks

3.13.6. There is little information available regarding the infiltration rate of the underlying ground at the Proposed Development. No infiltration testing was carried out at this stage, therefore further investigation will be required to obtain this value at a later stage of scheme development.

3.13.7. There is little information available regarding land drainage / field drainage to the west of the A15 i.e. the Springwell Substation and Main Collector Compound / BESS location. It is advised that surveys are undertaken to establish the ditch / watercourse network to the west of the A15. It is also advised that infiltration testing is undertaken in the specific locations of the Springwell Substation and Main Collector Compound / BESS.

3.13.8. There is a risk that contaminants may be present within the soil and sub surface. A sustainable drainage system will collect part of the runoff after it percolates through the ground, subsequently contaminants could be collected in the process and may require treatment.

3.13.9. Further investigation will be required to determine the requirements associated with any rainwater harvest and tree irrigation system. Consultation with the preferred supplier will be needed to ensure the drainage strategy will not be affected.

3.13.10. Further investigation will be required to determine the requirements associated with any foul and fire water drainage systems. Consultation with the preferred supplier will be needed to ensure the drainage strategy will not be affected and a suitably sized holding sump can be provided.

4. Conclusions and Recommendations

4.1. Conclusions

4.1.1. Best practice for drainage designs on new developments should prioritise Sustainable Drainage Systems (SuDS) solutions. The drainage strategy follows this approach, and it is therefore recommended that SuDS are included as part of the drainage design for the development.

4.1.2. SuDS should be used to intercept, convey and slow down (attenuate) surface water runoff before it enters the surface water network, in this case, assumed to be the local ditch / watercourse network (subject to infiltration testing and ditch network connectivity survey). A combination of potentially permeable surfaces and bioretention features could be employed for the drainage of the Springwell Substation, Main Collector Compound and BESS (provided any potential health and safety risks can be appropriately managed or minimised) along with main attenuation basins. Surface water will discharge from the attenuation basin at a pro rata rate of 1.4l/s/ha (based on development size) and downstream IDB location.

4.1.3. The use of SuDS will play a role in flood and pollution prevention by freeing up capacity in the local surface water network. This strategy will achieve the drainage requirements on:

- **Quantity**: By reducing volumes.
- **Quality**: By providing treatment of surface water.
- **Amenity**: By improving amenities for local communities contributing to improved landscaping.
- **Biodiversity**: By protecting and enhancing natural capital.

4.1.4. The SuDS components recommended in this strategy are flexible in shape and features and can be easily adapted to suit the detailed design of the Proposed Development.

4.1.5. The layout and components of the proposed drainage strategy is preliminary only. Components, features and locations will need to be confirmed during the design stage. Final site layout including drainage assets and proposed ground levels will need to be confirmed prior to the detailed design stage.

4.2. Recommendations

4.2.1. Site surveys should be carried out prior to the detailed design stage to confirm the ground conditions at proposed structures and storage locations. Site specific investigations (BRE Digest 365 Infiltration Testing) should also be undertaken to determine ground infiltration rates and assess the potential to use infiltration systems as a means of surface water disposal.

4.2.2. Soil testing should be carried out to assess whether the existing soil is free from contaminants and suitable to be reused for reprofiling.

4.2.3. All SuDS features to be designed in accordance with the CIRIA C753 SuDS Manual.

4.2.4. Health and safety aspects for these features need to adhere to CIRIA RP992 Health and Safety Principles for SuDS.

4.2.5. Discussions with LLFA / IDB should commence and continue during the outline and design stage to ensure suitable points of discharge for surface water flows can be agreed.

5. References

- **Ref 1:** British Geological Survey (BGS) Geoindex Onshore viewer; accessible at: http://mapapps2.bgs.ac.uk/geoindex/home.html
- **Ref 2:** DEFRA MAGIC Map; accessible at: [redacted]
- **Ref 3:** Water UK (2022) Design and Construction Guidance for foul and surface water sewers offered for adoption under the Code for adoption agreements for water and sewerage companies operating wholly or mainly in England ("the Code"), Approved Version 2.2
- **Ref 4:** DEFRA (2015) Sustainable Drainage Systems, Non-statutory technical standards for sustainable drainage systems, March 2015
- **Ref 5:** Environment Agency (2022) Climate Change Allowances , accessible at: https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall
- **Ref 6:** Soilscapes soil types viewer - National Soil Resources Institute. Cranfield University [redacted]
- **Ref 7:** HR Wallingford, Greenfield Runoff Rate Estimation, accessible at [redacted]
- **Ref 8:** BRE, Planning Guidance for the Development of Large Scale Ground Mounted Solar PV Systems, accessible at: [redacted]
- **Ref 9:** CIRIA (2015), The SuDS Manual (C753)
- **Ref 10:** Green Blue Urban, accessible at [redacted]
- **Ref 11:** Cook, L.M and McCuen, R. H (2013), Hydrologic Response of Solar Panels, Journal of Hyrdologic Engineering, American Sociey of Civil Engineers, May 2013

Outline Drainage Strategy
Appendix A

Greenfield Runoff Rates

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Kris Jackson
Site name:	Springwell
Site location:	Lincolnshire

Site Details

Latitude:	53.07115° N
Longitude:	0.45392° W
Reference:	2630007006
Date:	Jul 17 2023 16:11

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach: IH124

Site characteristics

Total site area (ha): 1

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	1	1
HOST class:	N/A	N/A
SPR/SPRHOST:	0.1	0.1

Hydrological characteristics

	Default	Edited
SAAR (mm):	586	586
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.14	0.14
1 in 1 year (l/s):	0.12	0.12
1 in 30 years (l/s):	0.33	0.33
1 in 100 year (l/s):	0.49	0.49
1 in 200 years (l/s):	0.57	0.57

Outline Drainage Strategy
Appendix B

Collector Compound Indicative Storage Volumes

Storage Estimate

Return Period (years)	100		OK
Climate Change (%)	25		Cancel
Impermeable Area (ha)	0.104	Update	
Peak Discharge (l/s)	1.400		
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Calc	
Required Storage (m³)	Calc		
from	55		
to	76		
With infiltration (m³)			
from			
to			

Outline Drainage Strategy
Appendix C

Springwell Substation Indicative Storage Volumes

Storage Estimate

Return Period (years)	100	OK
Climate Change (%)	25	Cancel
Impermeable Area (ha)	3.388	Update
Peak Discharge (l/s)	9.470	
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Calc
Required Storage (m^3)	Calc	
from	2716	
to	3268	
With infiltration (m^3)		
from		
to		

Outline Drainage Strategy Appendix D

BESS Indicative Storage Volumes

Storage Estimate

Return Period (years)	100	OK
Climate Change (%)	25	Cancel
Impermeable Area (ha)	10.625	Update
Peak Discharge (l/s)	17.500	
Infiltration Coefficient (m/hr) (leave blank if no infiltration)		Calc
Required Storage (m³)	Calc	
from	9529	
to	10564	
With infiltration (m³)		
from		
to		

Springwell
Solar Farm

springwellsolarfarm.co.uk

Application Document Ref: EN010149/APP/7.16
Planning Inspectorate Scheme Ref: EN010149