FLOOD RISK ASSESSMENT & SURFACE WATER DRAINAGE STRATEGY

Old Wood Energy Park

Land West of Wysall, Nottinghamshire

On behalf of Exagen Development Ltd

Date: 22/10/2025 | Pegasus Ref: P21-2533 – Author: Lucy Ginn

Document Management

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1. Introduction

Background

1.1. Pegasus Group has been appointed by Exagen Development Ltd to undertake a Flood Risk Assessment (FRA) and surface water drainage strategy for a proposed renewable energy Development (Old Wood Energy Park) consisting of ground mounted solar photovoltaic (PV) arrays with associated infrastructure, a Battery Energy Storage System (BESS) and substation (the Development). The Development is located on two parcels of land to the west of Wysall which will be connected via a buried cable that would be laid in the public highway (the Site).

1.2. Both land parcels are proposed to include solar PV arrays (along with associated infrastructure), with the Southern Parcel additionally accommodating the substation and BESS. The proposed substation and BESS are located close to the point of connection into the existing 132kV line that crosses the southern part of the Southern Parcel. This assessment considers the risk of flooding from all sources, including tidal, fluvial, surface water, historic, groundwater, sewer and artificial sources.

1.3. A planning application for the Development was submitted to, and validated by, Rushcliffe Borough Council (the Council) in February 2024 under application reference 24/00161/FUL. As part of the application, a Flood Risk Assessment and Surface Water Drainage Strategy (version 3, Pegasus, January 2024) was prepared. The Council refused the application in June 2024. Following this, an appeal was submitted against the decision, and the FRA & SWDS was subsequently updated (this document, version 5) to reflect:

- The latest Environment Agency (EA) flood data (published in March 2025)
- Amendments to the Site layout in response to the above (including micrositing of electrically sensitive equipment)
- Updated surface water drainage strategy within the BESS compound.

1.4. It is also noted the both the Lead Local Flood Authority (LLFA) and Environment Agency (EA) were consulted on the application validated in February 2024. The LLFA and EA were consulted on the planning application and provided formal consultation responses on the application on 26th February 2024 and 7th March 2024, respectively. Both consultees responded with no objection to the Development. Both consultation responses are included in **Appendix A.**

National and Local Policies

1.5. The National Planning Policy Framework (NPPF) (December 2024) and Environment Agency Guidance (August 2025) detail that a site-specific Flood Risk Assessment (FRA) will be required for proposals:

- in Flood Zone 2 or 3;
- within Flood Zone 3b;
- within Flood Zone 1 with a Site area of 1 hectare (ha) or more;

- within 'Flood Zones plus Climate Change', showing it is at increased risk of flooding from rivers or sea in future;
- with Flood Zone 1 and the flood map for planning shows it is at risk of flooding from surface water;
- in areas with critical drainage problems;
- within Flood Zone 1 where the Local Planning Authority (LPA)'s strategic flood risk assessment (SFRA) shows it will be at increased risk of flooding during its lifetime;
- that increases the vulnerability classification and may be subject to sources of flooding other than rivers or sea.

1.6. The Site is approximately 101ha in area, the majority of which is located in Flood Zone 1, however small areas in the Southern Parcel, associated with Kingston Brook, are located in Flood Zone 2 and 3. There are also localised areas identified as being at risk of surface water flooding. A full FRA is therefore required for the Development.

1.7. The NPPF (December 2024) places an emphasis on the use of Sustainable Drainage Systems (SuDS) within drainage schemes for new developments.

1.8. In February 2016, the Environment Agency (EA) introduced new guidance relating to the climate change allowances that must be considered within an FRA. Since 2016, the allowances for sea level rise, peak river flow and peak rainfall have each been updated.

1.9. Given the above, any new planning application that requires an FRA will also require a surface water drainage strategy to be submitted. The drainage strategy must demonstrate the use of SuDS within the design. The drainage strategy must also account for climate change over the lifetime of the Development, in accordance with the climate change allowances published by the EA.

1.10. In addition to the requirements from the NPPF and EA, as discussed above, this assessment has also reviewed the information and requirements included in the Greater Nottingham Strategic Flood Risk Assessment (SFRA) (2017).

1.11. The Council's "Solar Farm Development Planning Guidance" (2022) has also been reviewed. The guidance highlights the need to consider the impact of proposed solar developments on surface water runoff, with mitigation measures expected in any areas of identified flood risk. The guidance also highlights the need to incorporate Sustainable Drainage Systems (SuDS) as part of Site proposals. This FRA assesses the impact of the proposals on surface water runoff, highlights mitigation measures that will be implemented and provides a surface water drainage strategy to management surface water runoff from the Development

1.12. The following policies from the Rushcliffe Borough Council Local Plan Part 2: Land and Planning Policies (2019) apply to this Development:

- Policy 2: Climate Change
- Policy 16: Renewable Energy
- Policy 17: Managing Flood Risk

- Policy 18: Surface Water Management
- Policy 19: Development affecting Watercourses
- Policy 20: Managing Water Quality

2. Existing Site & Hydrology

Site Location & Existing Conditions

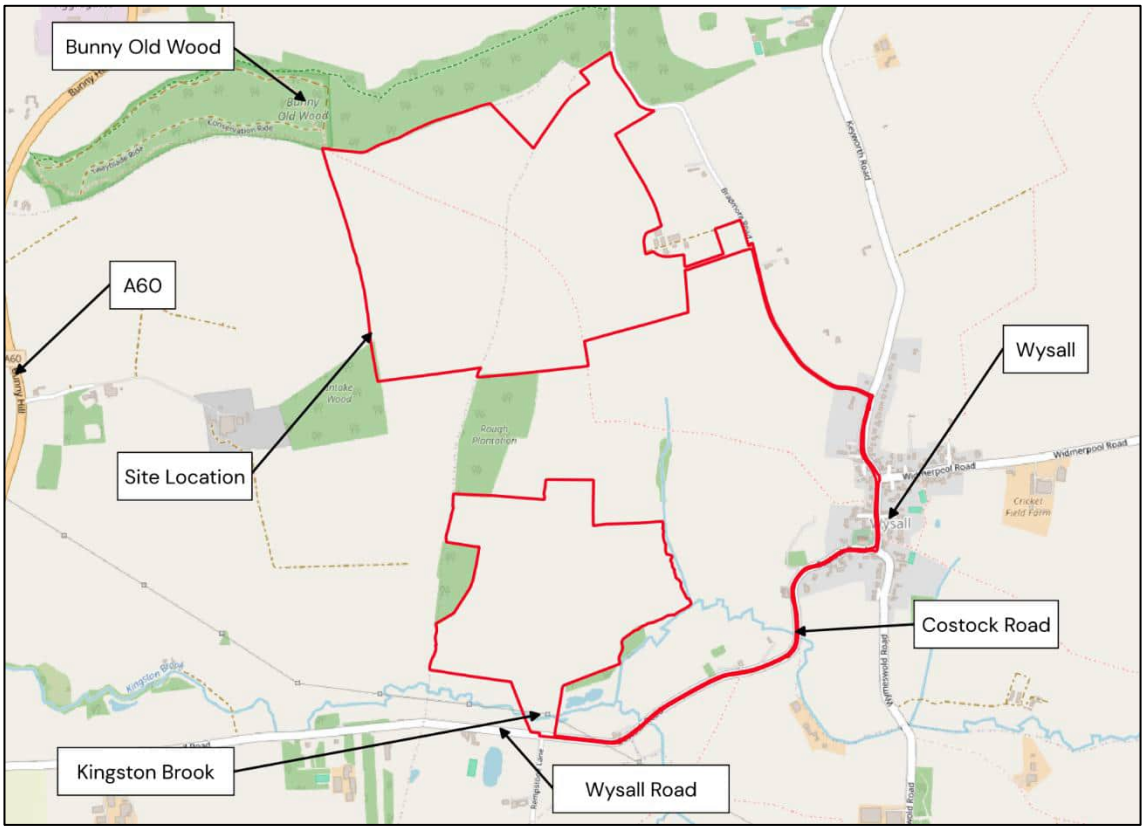
2.1. The Development is located over two land parcels to the west of Wysall. The Northern Parcel will host solar arrays and associated solar farm infrastructure, and the Southern Parcel will also host solar arrays and associated infrastructure as well as the BESS and substation.

2.2. The Site is bordered by Bunny Old Wood to the north, Wysall to the east, Costock Road to the south and agricultural land, the A60 and land previously granted consent for a solar development to the west. Kingston Brook runs through the Southern Parcel.

2.3. The Northern Parcel is centred at X: 459472 Y: 328041. The southern parcel is centred at X: 459568 Y: 327099. The nearest post code to the Site is NG12 5QR.

2.4. The Site location is shown in Figure 2.1.

Figure 2.1 – Site Location



Existing Drainage and Hydrology

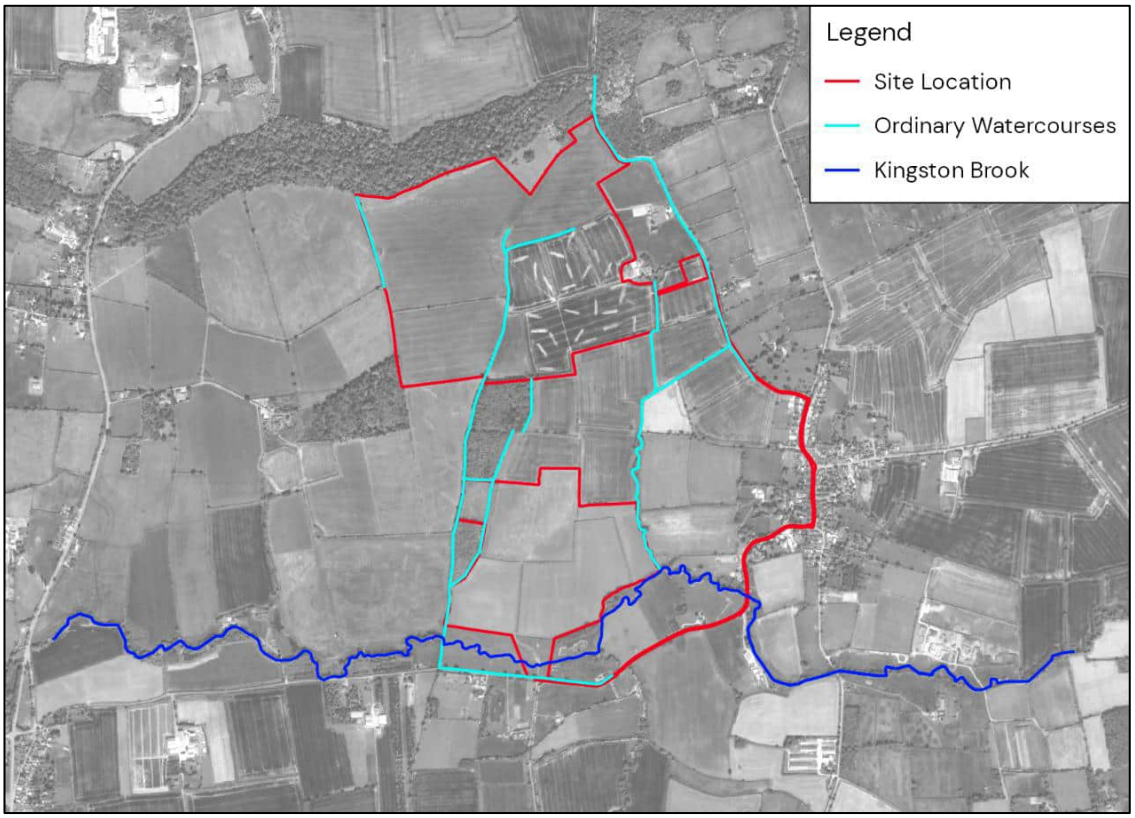
2.5. There are no Main Rivers located within the Site boundary. The nearest Main River to the Site is the River Soar approximately 7km to the southwest of the Site.

2.6. There are several Ordinary Watercourses flowing through the Site, including the Kingston Brook flowing through the southern end of the Southern Parcel.

2.7. There are also several field boundary ditches (Ordinary Watercourses) across the Site assumed to assist with the drainage of the existing agricultural fields.

2.8. Watercourses on Site and in the immediate vicinity are shown in Figure 2.2.

Figure 2.2 –Watercourses



2.9. The submitted Heritage Statement identifies the possible presence of existing land drains and trenches at the Site.

2.10. Geological data from the British Geological Survey (BGS) shows that the majority of the Site is underlain by 'Barnstone Member - Mudstone and limestone, interbedded' bedrock geology with small amounts of 'Barnby Member – Mudstone' along the eastern perimeter.

2.11. BGS also record superficial deposits at the Site comprised of 'Alluvium - Clay, Silt, Sand and Gravel', 'Head-Clay, Silt, Sand and Gravel' and 'Glaciofluvial Deposits-Sand and Gravel'.

2.12. SoilScapes mapping shows both 'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' with 'impeded drainage' and 'slightly acid loamy and clayey soils with impeded drainage' present at the Site.

2.13. The Northern Parcel generally falls in a southeasterly direction from a level of approximately 90mAOD in the northwest to approximately 75mAOD in the southeast.

2.14. The Southern Parcel generally falls to the south from a level of approximately 68mAOD in the north to a level of approximately 58mAOD in the south. The topographic survey of the Site is included in **Appendix B**.

3. Proposed Development

3.1. The Site is proposed for a renewable energy Development (Old Wood Energy Park) consisting of ground mounted solar photovoltaic (PV) arrays with associated infrastructure, a Battery Energy Storage System (BESS) and substation.

3.2. Further details of the Development can be found within P21-2533 Old Wood Energy Park – Planning Statement and P21-2533 Old Wood Energy Park – Design and Access Statement.

3.3. The proposed Site layout is in included in **Appendix C.** It is noted that this Site layout has been amended from that originally submitted to planning and refused. From a flood risk and drainage perspective, the changes include micrositing of electrically sensitive equipment following a review of the latest national flood risk data.

4. Development Vulnerability & Flood Zone Classification

National Planning Policy Framework (NPPF) (December 2024)

4.1. NPPF requires that, as part of the planning process:

- A 'Site specific' Flood Risk Assessment will be undertaken for any Site that has a flood risk potential.
- Flood risk potential is minimised by applying a 'sequential approach' to locating 'vulnerable' land uses.
- Sustainable drainage systems are used for surface water management where practical.
- Flood risk is managed through the use of flood resilient and resistant techniques.
- Residual risk is identified and safely managed.
- Safe access and escape routes are included where appropriate.

4.2. Table 1 of the 'Flood risk and coastal change' Planning Practice Guidance (PPG) defines each flood zone based on the probability of river and sea flooding in that area, as summarised below:

- Zone 1- Low probability (< 1 in 1000 years).
- Zone 2- Medium probability (1 in 1000 - 1 in 100 years for fluvial events and 1 in 1000 – 1 in 200 years for tidal events).
- Zone 3a- High probability (> 1 in 100 years for fluvial events and > 1 in 200 year for tidal events).
- Zone 3b- The functional floodplain (>1 in 30 years for fluvial events).

4.3. The flood risk and coastal change PPG sets out a matrix indicating the types of development that are acceptable in different Flood Zones (see Table 4.1). The proposals are for a solar and BESS Development which is classified as 'Essential Infrastructure'.

4.4. All proposed Development is generally located in Flood Zone 1, as shown in the proposed Site layout with flood risk information overlaid included in **Appendix C**. All types of development are appropriate in Flood Zone 1 (see Table 4.1).

4.5. The access track to the Southern Parcel is located across Flood Zone 2 and 3. Essential Infrastructure is appropriate in Flood Zone 2 and 3 subject to passing the Exception Test for development in Flood Zone 3 (see Table 4.1).

Table 4.1 – NPPF Guidance

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test Required	✓	✓	✓
Zone 3a	Exception Test Required	✗	Exception Test Required	Exception Test Required	✓
Zone 3b	Exception Test Required	✗	✗	✗	✓

Sequential Test

4.6. According to the "Flood risk and coastal change" Planning Practice Guidance (PPG), "the Sequential Test should be applied to 'Major' and 'Non-major development' proposed in areas at risk of flooding". The PPG states that the Sequential Test is intended to "steer new development to areas with the lowest risk of flooding, taking all sources of flood risk and climate change into account".

4.7. Following an update in September 2025, the PPG details that "where a Site-specific flood risk assessment demonstrates clearly that the proposed layout, design, and mitigation measures would ensure that occupiers and users would remain safe from current and future surface water flood risk for the lifetime of the development (therefore addressing the risks identified e.g. by Environment Agency flood risk mapping), without increasing flood risk elsewhere, then the sequential test need not be applied." Surface water flood risk and associated mitigation measures are discussed below in Section 5 and 6, with no requirement for a Sequential Test from a surface water point of view.

4.8. Flood risk from all sources is assessed below in Section 5. It is noted that proposed access to the Southern Parcel is located in Flood Zone 2 and 3 and as such, a Sequential Test is required.

4.9. A Sequential Test is included as a standalone report elsewhere in the planning application documents.

Exception Test

4.10. The proposed access to the Southern Parcel is located within Flood Zone 3. In accordance with Table 4.1, an Exception Test is required for Essential Infrastructure proposed in Flood Zone 3. An Exception Test is therefore required to the Development.

4.11. There are two parts to the Exception Test that the Development must demonstrate:

1. That Development that has to be in a flood risk area will provide wider sustainability benefits to the community that outweigh flood risk; and

2. That 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.

4.12. The wider sustainability benefits of the Development are considered elsewhere in the planning submission documents. In general, it is considered that the sustainability benefits of the Development are extensive and self-evident.

4.13. Part 2 of the Exception Test will be addressed within this report, with the conclusions of this report being that the Development will be safe over its lifetime and not increase flood risk.

5. Site Specific Flooding Issues and Existing Flood Records

National Planning Policy Framework (NPPF)

5.1. In accordance with the National Planning Policy Framework, this Flood Risk Assessment considers all sources of flooding including:

a) Tidal Flooding –from the sea;

b) Fluvial Flooding – from rivers and streams;

c) Surface Water Flooding – from overland surface water flow and exceedance;

d) Historic Flooding – known historic flooding issues;

e) Groundwater Flooding – from elevated groundwater levels or springs;

f) Flooding from Sewers – exceedance flows from existing sewer systems; and

g) Artificial Sources – reservoirs, canals etc.

Tidal Flooding

5.2. The Flood Map for Planning (see Figure 5.1) defines the probability of river and sea flooding and defines the majority of the Site as Flood Zone 1, at Low risk of flooding, not predicted to be impacted by a 1 in 1,000 year flood event.

5.3. Small areas of Flood Zone 2 and 3 are defined at the southern end of the Southern Parcel. There is generally no Development proposed within Flood Zone 2 or 3, as detailed in proposed Site Layout included in **Appendix C.** The proposed access and culverted crossing to the Southern Parcel is located across Flood Zone 2 and 3 where it is proposed to cross Kingston Brook. Both the proposed access and culverted crossing will be upgraded to facilitate the construction and operation of the Development.

5.4. The Flood Map for Planning also includes a 'Flood Zones plus climate change' dataset, also included in Figure 5.1. It is shown that the extent of Flood Zone 2 and 3 on Site shows a negligible increase with climate change over the next century.

5.5. The Site is located inland, with the nearest coastline Sited approximately 80km east of the Site. Flood risk predicted on Site by the Flood Map for Planning is therefore associated with fluvial flooding (see below) and not reflective of tidal flood risk.

5.6. Overall, tidal flood risk at the Site is considered to be **Very Low.**

Fluvial Flooding

5.7. The Flood Map for Planning (Figure 5.1) defines the majority of the Site to fall within Flood Zone 1, at Low risk of fluvial flooding, not predicted to be affected by a 1 in 1,000 year fluvial flood event.

5.8. Small areas of Flood Zone 2 and 3 are defined at the southern end of the Southern Parcel. There is generally no Development, and no electrical infrastructure, proposed within Flood Zone 2 or 3, as detailed in proposed Site Layout included in **Appendix C.** The proposed access to the Southern Parcel is located across Flood Zone 2 and 3 where it is proposed to cross Kingston Brook.

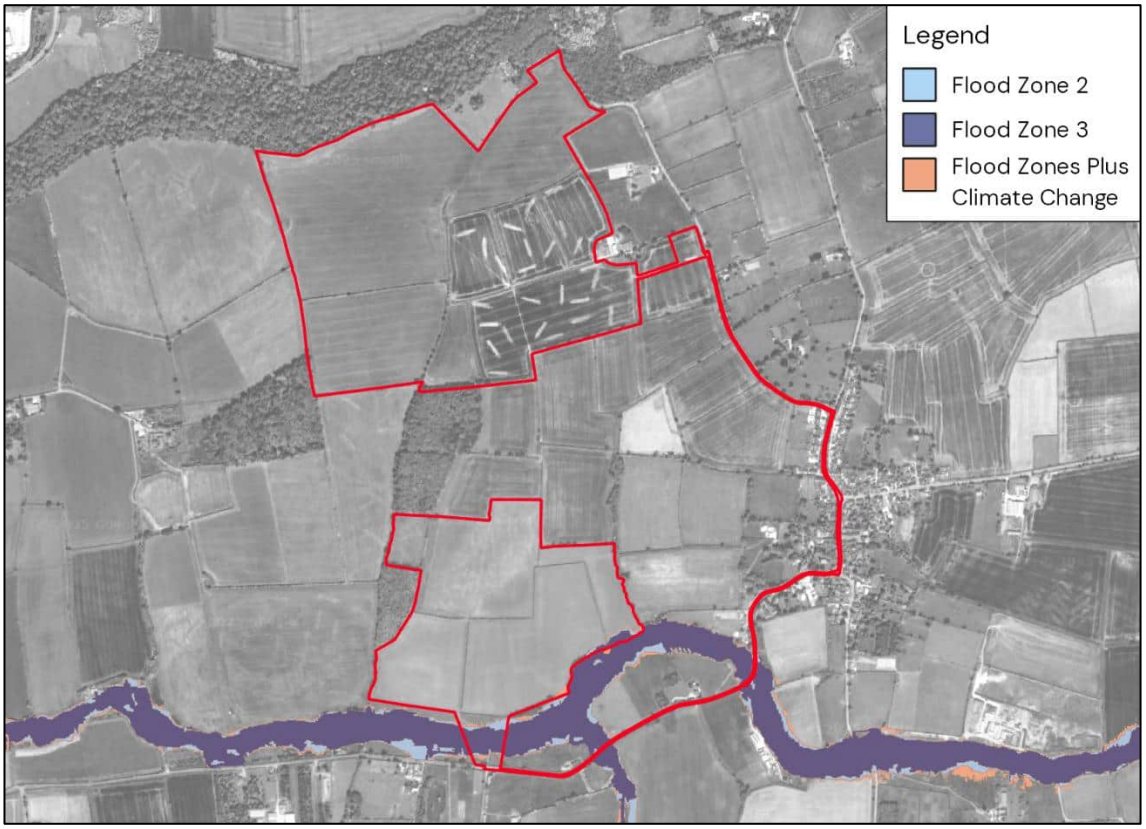
5.9. The Flood Map for Planning also includes a 'Flood Zones plus climate change' dataset, also included in Figure 5.1. It is shown that the extent of Flood Zone 2 and 3 on Site shows a negligible increase with climate change over the next century.

5.10. Fluvial flood risk mitigation measures are discussed in Section 6. At detailed design, full details of the access crossing over the Kingston Brook will be confirmed. The design will ensure flows within the Kingston Brook and associated flood risk are not impacted.

5.11. A Flood Emergency Management Plan will be provided for the Southern Parcel during detailed design to ensure Site users remain safe should a flood occur.

5.12. Overall, given the above, the fluvial flood risk at the Site is considered to be **Low**.

Figure 5.1 – Flood Map for Planning



Surface Water Flooding

5.13. The Risk of Flooding from Surface Water (RoFSW) dataset shows large areas of the Site are not predicted to be impacted by a 1 in 1,000 year rainfall event and have a Very Low likelihood of surface water flooding (see Figure 5.2). The dataset also highlights areas with High to Low

likelihood of flooding, impacted by a 1 in 30 and 1 in 1,000 year rainfall event, respectively, throughout the Site.

5.14. The RoFSW dataset also predicts the depths of surface water flooding across the Site. Within the Site, surface water flood depths generally remain shallow and are typically not predicted to exceed 300mm (see Figure 5.3).

5.15. The lowest edge of all proposed solar panels will be raised 800mm above ground levels as standard. Solar panels are therefore not predicted to be impacted by surface water flooding, nor negatively impact flood risk elsewhere.

5.16. It is noted that following release of the latest RoFSW data, that no solar panel raising above the standard 800mm is required. Previously, greater solar panel raising was proposed, based on the now superseded RoFSW depth data.

5.17. Purposefully through design, none of the greater vulnerability infrastructure on Site (inverters, storage containers, transformers and substation infrastructure) has been located in areas predicted to be at risk of flooding (see **Appendix C**). To achieve this, following release of the latest Risk of Flooding from Surface Water dataset, the previously submitted proposed Site layout has been amended slightly to include some micrositing of electrically sensitive equipment out of areas predicted to be at risk of surface water flooding.

5.18. Given the above, the Site is considered to be at **Low** risk of flooding from surface water.

Figure 5.2 – RoFSW Extents

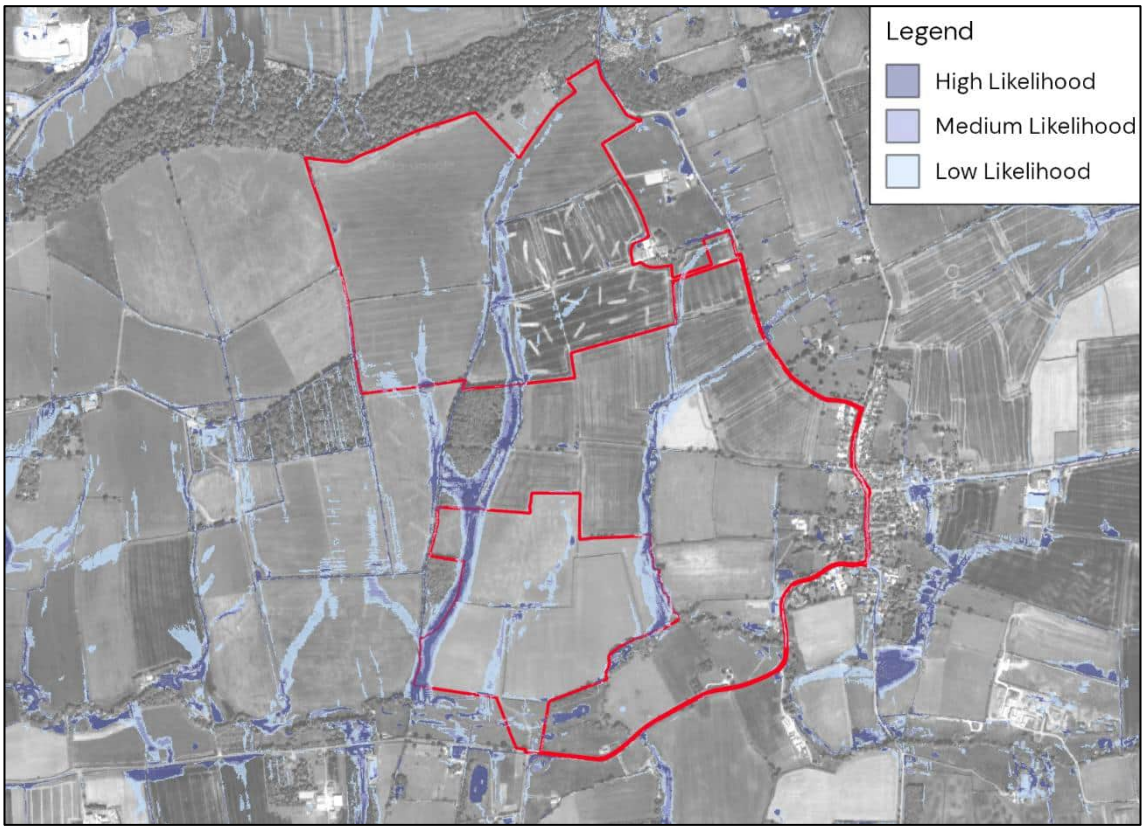
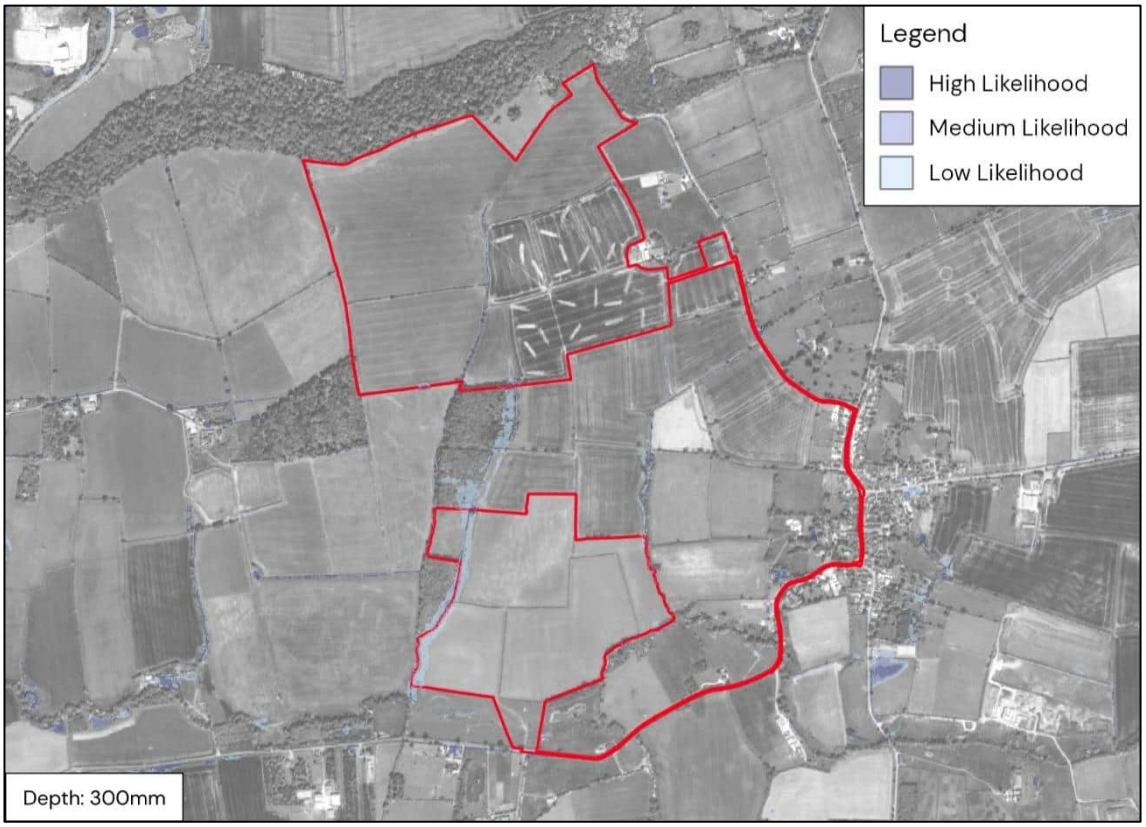


Figure 5.3 – RoFSW Depths (300mm)



Historic Flooding

5.19. The EA's Historic Flood Map does not record any historic flood events impacting the Site.

5.20. The Greater Nottingham SFRA (2017) has no mention of the Site area regarding historical floods.

5.21. Overall, the historic flood risk to the Site is considered to be **Very Low**.

Groundwater Flooding

5.22. BGS data show that most of the Site is underlain by mudstone and limestone bedrock geology. Mudstone is generally impermeable. The hydrogeology aquifer classification defines the Site entirely as 'rocks with essentially no groundwater'. There is therefore very little potential for groundwater emergence on the Site.

5.23. BGS record superficial deposits at the Site comprising of 'Alluvium - Clay, Silt, Sand and Gravel', 'Head-Clay, Silt, Sand and Gravel' and 'Glaciofluvial Deposits-Sand and Gravel'. Soilscapes mapping defines soils on Site to have impeded to slightly impeded drainage. Any clay in the superficial deposits and the poorly draining soils on Site will further prevent groundwater emergence on Site.

5.24. Topography on Site is also not conducive to groundwater flooding – any groundwater to emerge would follow the existing Site topography and flow towards the south of the Site, and towards the various watercourses on Site and in the immediate vicinity.

5.25. The Greater Nottingham SFRA (2017) states that "*areas with the greatest susceptibility to groundwater emergence [are] along the River Soar and River Trent corridors, followed by areas along the corridor of the River Smite*". These locations are far enough away from the Site to not be considered as a risk.

5.26. Overall, the risk of groundwater flooding at the Site is considered to be **Low**.

Flooding from Sewers

5.27. The Greater Nottingham SFRA (2017) does not include any records of sewer flooding occurring at the Site.

5.28. As the Site is entirely agricultural land, it is unlikely that there is an existing underground drainage network located within the Site boundary. Additionally, any flood water from sewers in the close vicinity of the Site would follow local topography and would not be expected to accumulate within the Site boundary.

5.29. The risk of flooding from sewers to the Site is therefore considered to be **Low.**

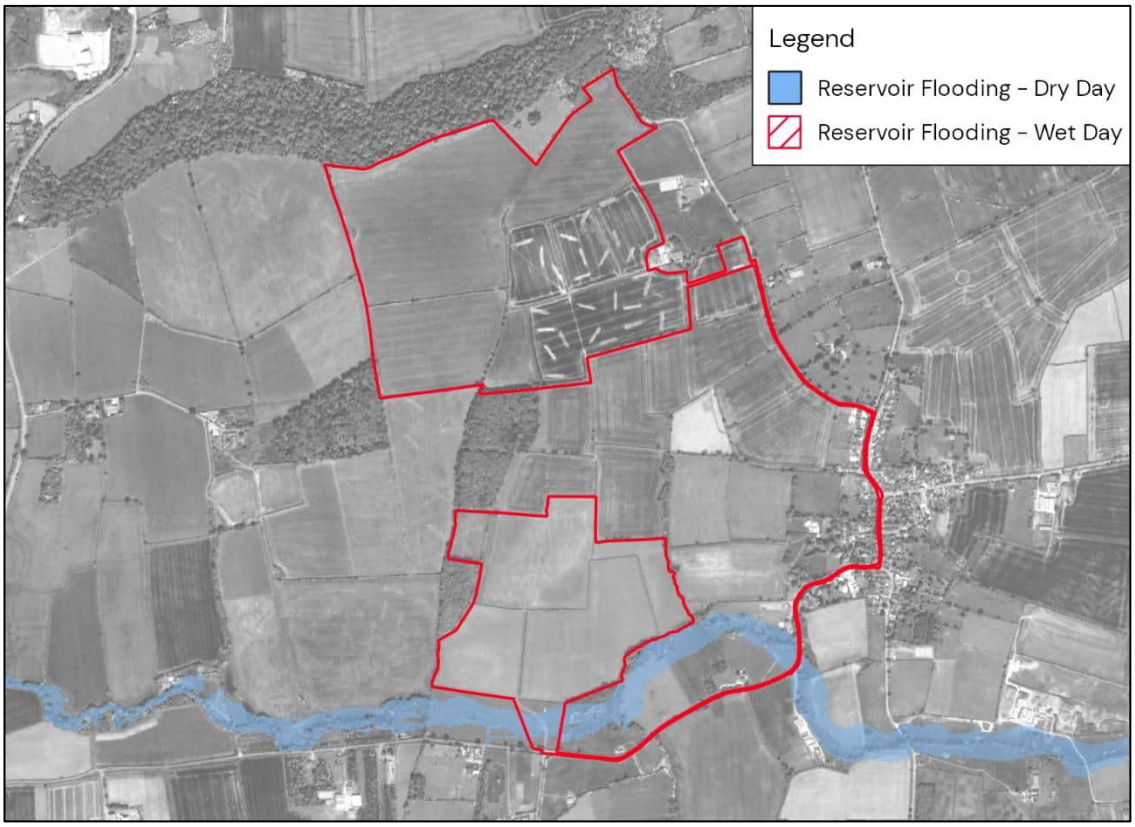
Flooding from Artificial Sources

5.30. The EA's Reservoir Flood Extents data shows that a small portion the Site at the southern end of the Southern Parcel is at risk of reservoir flooding should a catastrophic breach occur during a 'Dry Day' when watercourses are flowing under normal conditions (see Figure 5.4). There is generally no infrastructure proposed in this risk area, with the exception of the proposed access to the Southern Parcel. The Site is shown to have no risk during a 'Wet Day' when local rivers have already overflowed their banks.

5.31. The Reservoirs Act 1975 requires that all reservoirs are inspected regularly by competent persons to assess the likelihood of failure. The SFRA also details that provided the inspections are carried out regularly and to a high standard, the likelihood of reservoir failure is considered minimal. As such, the risk of reservoir flooding impacting the Site is considered to be Low.

5.32. There are no other artificial bodies of water near the Site that pose any risk. The Site is therefore considered to be at **Low** risk of flooding from artificial sources.

Figure 5.4 – Reservoir Flood Extents – Wet & Dry Day



Post Development Flood Risk Summary

5.33. The risk of flooding to the Site from all sources has been assessed above, with the conclusions summarised in Table 5.1:

Table 5.1 – Flood Risk Summary

Flood Source	Flood Risk	Mitigation/Comments
Tidal	Very Low	• Areas of Site predicted to be at risk of flooding by the Flood Map for Planning are not reflective of tidal flood risk. • The Site's inland location ensures that it is well beyond the extent of any tidal influences.
Fluvial	Low	• The Development is generally entirely located in Flood Zone 1. • The proposed Southern Parcel access located across Flood Zone 2 and 3 will be designed to ensure

		existing flow patterns and flood risk are not impacted. • A Flood Emergency Management Plan for the Southern Parcel will be prepared during detailed design.
Surface Water	Low	• Large areas of the Site have a Very Low likelihood of flooding, not predicted to be impacted by 1 in 1,000 year rainfall event. • Intentionally through design, none of the greater vulnerability infrastructure is proposed in areas predicted to be at risk of surface water flooding. • The lowest edge of all solar panels will be raised above the maximum predicted surface water flood depths on Site. •The proposed surface water drainage scheme will manage surface water arising on Site.
Historic	Very Low	• The SFRA and EA data do not include records of any historic flood events impacting the Site.
Groundwater	Low	• Mudstone bedrock on Site is likely to be impermeable. The hydrogeology consists of rocks with essentially no groundwater. Additionally, clay deposits and soils with impeded drainage are expected to limit any groundwater emergence on Site. • Topography on Site is not conducive to groundwater flooding. • Information included in the SFRA shows the Site to be at low risk of groundwater flooding.
Sewers	Low	• There are no records of sewer flooding occurring at Site included in the SFRA. • The Site is currently agricultural land with no existing sewer network expected within the Site boundary.
Artificial	Very Low	• A small section at the southern end of the Southern Parcel is predicted to be at risk of reservoir flooding. There is generally no Development proposed here, with the exception of the Southern Parcel access

		and brook crossing, both of which will be upgraded for the Development. • The likelihood of reservoir failure is considered minimal. • There are no artificial bodies of water surrounding the Site.

Access & Egress

5.34. Access to the Northern Parcel will be via a new access to the south of the farm access. Access to the Southern Parcel will be via an upgrade to the existing field access opposite the Rempstone Lane / Costock Road junction to the south.

5.35. The access and brook crossing to the Southern Parcel is located in Flood Zone 2/3, at risk of fluvial flooding (see **Appendix C**). Approximately 100m of the Southern Parcel access track is located in Flood Zone 2/3.

5.36. The access point to the Northern Parcel is located in Flood Zone 1, at Very Low risk of fluvial flooding. The access is also predicted to be at Low risk of flooding from surface water by the RoFSW dataset.

5.37. Neither access point is at significant flood risk from any other source.

5.38. Although the Site is beyond the coverage of Environment Agency Flood Warnings, it is recommended that those potentially working on Site avoid access to the Southern Parcel if significant rain is expected, unless there is an emergency. The provision of safe refuge at the Southern Parcel will be considered at detailed design to ensure that if the proposed access is flooded whilst anyone is on Site, they will have safe refuge to remain on Site until the flood waters subside along the access. A Flood Emergency Management Plan for the Southern Parcel will also be provided during detailed design.

5.39. Access and egress for the Northern Parcel will not be impaired during an extreme flooding event. In addition to the above, the Site will be managed remotely and only visited occasionally for maintenance. Site access and egress should therefore not be needed during an extreme flood event.

5.40. Flood risk to the Southern Parcel access has been assessed using the Site topographic survey information (**Appendix B**) and the extent of Flood Zone 2 along the access route, as defined by the Flood Map for Planning (see Figure 5.1). Based on this assessment, a 1 in 1,000 year flood level of 57.95mAOD has been estimated along the Southern Parcel access route (see **Appendix D**).

5.41. The access and brook crossing to the Southern Parcel is subject to detailed design. At this stage, to ensure no loss of floodplain storage, it is recommended that the access is constructed at current ground levels. The soffit of the brook crossing is recommended to be at a minimum level of 57.95mAOD (the estimated 1 in 1,000 year flood level along the access route).

5.42. If the new access is constructed at existing ground levels, with an estimated flood level of 57.95mAOD, a maximum 1 in 1,000 year flood depth of 0.67m is predicted along the access (see **Appendix D**).

5.43. The Development's Fire Consultant (Jim Tough – Abbot Risk Consulting) has advised of a maximum flood depth that an emergency fire vehicle can pass of 0.75m to 1m. Based on the presented assessment, emergency fire access for the Southern Parcel would therefore not be restricted during a 1 in 1,000 year flood event if the access is constructed as existing ground levels (see **Appendix D**).

5.44. It is recommended that the access to the Southern Parcel is constructed with flood resilient materials that would not easily wash away. This may include, for example, crushed stone.

5.45. To provide betterment over the existing situation, it is recommended that the existing culvert along the Kingston Brook where the Southern Parcel brook crossing is proposed, is removed. This would improve ecological connectivity, increase capacity of the Kingston Brook and reduce the risk of blockage.

6. Mitigation Measures and Surface Water Drainage

6.1. This section summarises the proposed mitigation measures required on Site to ensure that:

a) The Development is not at significant risk of fluvial flooding.

b) The Development is not at significant risk of surface water flooding.

c) Maintenance access to Ordinary Watercourses is not impacted by the Development.

d) The potential impacts of the Development on surface water runoff are minimised.

6.2. This section also considers if, with proposed mitigation measures in place, any further measures (such as a surface water drainage strategy) are required to ensure that the Development is safe from flooding and does not increase flood risk elsewhere.

Solar Farm

Solar Panels

6.3. The majority of the proposed solar farm will comprise of solar panels. The solar panels are proposed to be a 'fixed system', with vertical supports driven directly into the ground and no need for concrete foundations. There will be a gap of between 2.5 and 6.5m between the rows of solar panels. Generally, the lowest edge of solar panels will be 0.8m above the ground, extending to 3.1m above the ground at their highest point.

6.4. The RoFSW dataset generally predicts surface water flood depths on Site to remain shallow, not predicted to exceed 300mm across the Site. The proposed solar panel raising will therefore ensure the panels are situated above the predicted surface water flood depths, allowing surface water to flow freely below. It can be noted that RoFSW 2025 update (on which this report version is based upon), shows a reduction in surface water depths compared to those shown prior to the update, with no additional solar panels raising required beyond the proposed 0.8m to ensure the solar panels are situated above the predicted surface water flood depths.

6.5. No solar panels are proposed within the areas in Flood Zone 2 or 3.

6.6. Overall, the proposed solar panels will be safe from fluvial flooding and will be raised sufficiently so as not to be at risk from surface water flooding.

6.7. No further mitigation measures, beyond those mentioned above and currently included in the Site design, are considered necessary.

Greater Vulnerability Infrastructure

6.8. In addition to solar panels, central inverters, battery storage containers, battery storage inverters, auxiliary transformers, substation infrastructure and solar connection infrastructure are proposed on Site. These items are referred to as the greater vulnerability infrastructure and cover a small percentage of the Site area (see **Appendix C**).

6.9. In addition to being small, these units are generally well distributed across the Site (see Site Layout in **Appendix C**).

6.10. It is proposed to Site the central inverters dispersed across the Site on concrete plinths or screw piles off the ground with permeable areas beneath. Runoff from the container's roof will therefore be able to discharge into the surrounding ground, as per existing. It is expected that the same approach is taken for auxiliary transformers. To be confirmed at detail design stage.

6.11. The two buildings associated with the solar connection infrastructure have the potential to increase surface water runoff from the Site. As such, these areas have been included in the surface water drainage strategy presented in Section 7. The surface water drainage strategy is also proposed to manage the proposed BESS at the southern end of the Site (see below in Section 6 and Section 7).

6.12. None of the greater vulnerability infrastructure is located within Flood Zone 2 or 3 or within an area of surface water flood risk identified by the RoFSW dataset.

6.13. Based on the above, the proposed central inverters will not be at significant risk of flooding, nor will they significantly impact the existing surface water drainage patterns as the infrastructure is small in area, sited on concrete plinths or screw piles with the permeable areas beneath and are well distributed across the Site whilst also avoiding the areas at greatest flood risk. It is also noted that the majority of ground cover on Site will consist of species rich grassland which will help improve infiltration potential on Site and help manage any minor surface water runoff from the proposed central inverters. The more significant infrastructure will be managed with the proposed surface water drainage strategy.

6.14. No further mitigation measures are considered necessary.

<u>Access Tracks</u>

6.15. Proposed access tracks will be constructed with permeable materials, expected to be type 1 or 2 crushed stone. Surface water runoff will therefore be able to discharge into the crushed stone before soaking into the surrounding ground, as per existing. It is also noted that traffic volumes will be very low during the operational phase of the Development. This will ensure significant compaction is avoided and infiltration is not restricted.

6.16. Where access tracks are proposed to cross Ordinary Watercourses on Site, they will be designed to ensure flows are not impacted. There are currently 3 proposed instances of access roads crossing Ordinary Watercourses on Site, including 1 over Kingston Brook. The exact design of these access crossings will be confirmed during detailed design.

6.17. As discussed above in Section 5, access to the Southern Parcel in through Flood Zone 2 and 3. The exact track requirements for this section will be confirmed during detailed design. A Flood Emergency Management Plan for the Southern Parcel should also be provided during detailed design.

6.18. No further mitigation measures are considered necessary.

Proposed Land Use Change

6.19. The proposals will result in the cessation of agricultural activities at the Site which will in turn, result in a variety of beneficial effects which will serve to reduce soil compaction and runoff rates from the Site, as listed below:

- The Site will not be left without vegetation cover during the winter as experienced with arable farming;
- The Site will not be intensively trodden or over grazed; and
- The Site will not be regularly traversed by heavy machinery

6.20. It is also recommended that following installation of the panels, the Site is chisel-ploughed or similar cultivated and seed with native meadow grass and wildflowers. Chisel-ploughing will reduce soil compaction on the Site and promote seed growth; it has been proven to significantly increase infiltration rates thereby reducing runoff rates from the Site.

6.21. If grazing is undertaken on Site following Development, the grazing density will be kept low to limit compaction and ensure a varied grassland and sward establishes.

6.22. Additionally, larger meadow type grasses and wildflower vegetation provide high levels of natural attenuation which will serve to reduce the risk of erosion and limit surface water flows across the Site. With the implementation of chisel-ploughing, changing the Site's primary function to solar power generation will have several potential longer-term benefits regarding surface water runoff rates.

6.23. A Landscape Strategy has also been developed for the Site and is included elsewhere in the planning submission. The strategy includes woodland areas, new hedgerows, new trees and varied grassland and wildflower meadow. These features will also help to manage surface water runoff from the Site.

Ordinary Watercourses Easements

6.24. To ensure maintenance access is not impacted by the Development a 3m easement from the top of bank from all Ordinary Watercourses has been kept clear of all Development, with the exception of where watercourse crossings are proposed. These easements have been based on LiDAR data and an estimated width of 5m for most Ordinary Watercourses and 6m for the Kingston Brook. Development works within the easement (i.e. watercourse crossings), will be subject to Ordinary Watercourse Consent.

6.25. The Site is not located in an Internal Drainage Board Area nor are there any Main Rivers on Site. As a result, a maintenance easement of more than 3m is not considered necessary.

Surface Water Drainage Strategy

6.26. As discussed above, the central inverters dispersed across the Site will generally not significantly impact surface water runoff rates and patterns at the Site.

6.27. In addition, the cessation of intensive agricultural activities at the Site will have beneficial effects which will help reduce soil compaction and surface water runoff rates from the Site. The Landscape Strategy also proposes features that will help manage surface water runoff,

as discussed above. Overall, the proposed solar farm Development at the Site therefore has the potential to provide betterment in terms of surface water runoff rates and downstream flood risk.

6.28. The solar connection infrastructure buildings will be managed with the proposed surface water drainage strategy detailed in Section 7. It is not considered necessary to provide drainage features for the other solar infrastructure.

BESS and Substation Compound

6.29. Compared to the proposed solar farm Site, the proposed BESS and substation has the potential to increase surface water runoff from the Site.

Battery Storage Containers and Inverters

6.30. The BESS is located in Flood Zone 1 (see **Appendix C**). The RoFSW dataset also does not predict the BESS area to be at risk of surface water flooding.

6.31. As a large proportion of the proposed BESS Site will comprise rows of battery storage containers and battery inverters which will increase the impermeable area of the Site and have the potential to increase surface water runoff, a surface water drainage strategy will be required to manage surface water runoff from the proposed battery storage container and inverters (see Section 7).

Access Tracks

6.32. Taking a conservative approach, the proposed surface water drainage strategy defined the full BESS compound, including access tracks here, to be impermeable. As a result, proposed SuDS on Site will be designed to manage surface water runoff from the proposed access tracks.

6.33. No further mitigation measures are considered necessary.

Substation

6.34. A substation is proposed at the southern end of the Southern Parcel. There is potential that this infrastructure increase surface water runoff from the Site. A conservative approach has therefore been taken and the entire substation area will be assumed impermeable and managed with suitable SuDS features (see Section 7) to ensure surface water runoff from the Site does not increase.

Surface Water Drainage Strategy

6.35. As discussed above, left unmanaged, the proposed BESS has the potential to increase surface water runoff from the Site and as such, to ensure flood risk downstream does not increase, a surface water drainage strategy will be required for the BESS and Substation. The surface water drainage strategy is discussed in detail in Section 7.

7. Proposed Surface Water Drainage Strategy

7.1. As discussed above, the BESS and substation infrastructure will increase the impermeable area on Site and have the potential to increase the surface water runoff from the Site. A surface water drainage strategy is therefore required for the proposals to ensure flood risk elsewhere does not increase.

Surface Water Management

7.2. The SuDS hierarchy demands that surface water run off should be disposed of as high up the following list as practically possible:

- Into the ground (infiltration) and re-use, or then;
- To a surface water body, or then;
- To a surface water sewer, highway drain or another drainage system, or then;
- To a combined sewer.

7.3. In order to determine the most suitable method of surface water disposal from the Site the options listed above have been considered as follows:

Infiltration

7.4. BGS data show that most of the Site is underlain by mudstone and limestone bedrock geology. Mudstone is expected to be impermeable. Additionally, BGS record superficial deposits at the Site including 'Alluvium - Clay, Silt, Sand and Gravel' and 'Head-Clay, Silt, Sand and Gravel'. Soilscapes mapping shows the BESS infrastructure to fall under 'loamy and clayey soils with impeded drainage.' These ground conditions are not considered suitable for infiltration-based SuDS. Therefore, infiltration-based SuDS have been ruled out as the source of surface water disposal.

Surface Water Body

7.5. The next option in the SuDS hierarchy is to discharge surface water runoff into an existing surface water body.

7.6. It is proposed to discharge surface water runoff from the BESS and substation infrastructure into the Kingston Brook.

SuDS selection process

7.7. Various methods of SuDS (Sustainable Drainage Systems) should be considered for use as different methods have constraints attached to them and may not be suitable for this development.

7.8. An assessment of the suitability of different SuDS techniques is summarised in Table 7.1 below. Guidance from 'The SuDS manual' C753 has been used to form the basis of this assessment.

Table 7.1 – Assessment of SuDS Suitability

SuDS Technique	Potentially suitable for this development	Justification
Rainwater Harvesting	No	Not considered suitable for BESS developments.
Green Roofs	No	Not considered suitable for BESS developments.
Infiltration Systems (Soakaways, etc.)	No	The ground conditions on Site are not considered suitable for infiltration-based SuDS.
Filter Drains	Yes	Could be used to help convey surface water runoff on Site.
Swales	Yes	Could be used to help convey surface water runoff on Site. Note that no swales have been included within the proposed Surface Water Drainage strategy.
Bioretention Systems	No	Not considered suitable due to land take.
Trees	Yes	Could be considered but would not significantly reduce the storage requirements.
Underground storage	Yes	Proposed to contain potentially contaminated fire suppression water.
Detention basins & ponds	Yes	Proposed as the main source of surface water storage from the BESS and substation infrastructure on Site.
Wetlands	No	Not considered suitable due to land take.
Permeable Paving	Yes	Could be used for the proposed access tracks.

BESS and Substation Compound

7.9. The BESS and substation compound is 1.323ha in area and will comprise type 1 or type 2 crushed stone. Taking a conservative approach, it has been assumed for the purpose of this surface water drainage strategy that the full BESS and substation area (1.323ha) will be impermeable. This area includes the BESS and substation infrastructure, as well as the associated access tracks.

7.10. Surface water runoff will be collected from the BESS and substation compound with a system of perforated collector pipes and surface water drains running through the BESS and substation area.

7.11. Surface water flows will be conveyed to the proposed attenuation basin via a storm water drain. The basin will discharge surface water runoff into the Kingston Brook at a restricted QBAR greenfield runoff rate and has been designed to manage flows for all storm events up to and including the 1 in 100 year event plus 25% allowance for climate change. This is the Soar Management Catchment central climate change allowance for the 2070s epoch, noting a design life for the Development of approximately 40 years.

7.12. The proposed attenuation basin is located in Flood Zone 1.

7.13. The QBAR greenfield runoff rate has been calculated using the IH124 method via Micro drainage. Rates have been calculated for 50 hectares and then factored down to an area of 1.323 hectares. As such, a hydro-brake is proposed near the outfall to restrict the flow to the calculated greenfield runoff rate of 4.9 l/s.

7.14. The proposed drainage strategy drawings can be found in **Appendix E.** Causeway Flow network calculations are also included in **Appendix E.**

Solar Connection Infrastructure Buildings

7.15. As discussed in Section 6, the two buildings associated with the solar connection infrastructure have the potential to increase surface water runoff from the Site. As such, these areas have been included in the surface water drainage strategy presented here.

7.16. It is proposed to locate a filter drain 22.5m long, 1.0m wide and 0.7m deep around the proposed buildings. These gravel trenches will help store surface water runoff from the small buildings, aiding infiltration into the ground below. Any surface water exceeding the capacity of the gravel trench will slowly overtop and disperse into the surrounding ground.

7.17. The proposed drainage strategy drawings can be found in **Appendix E.**

Fire Water Supply and Containment

7.18. In case of a fire event at the BESS on Site, the National Fire Chiefs Council (NFCC) BESS guidance **(see Appendix F)** requires as a minimum supply of 1,900 litres per minute of water for at least 2 hours to be readily available at the Site. This is equivalent to a volume of 228m^3. The Site layout included in **Appendix C** shows two proposed water storage tanks and pumps located alongside the proposed BESS. These tanks are designed to supply fire suppression water on Site.

7.19. There are also two fire water containment pipes proposed on Site that are design to ensure that in the event of a fire, potentially contaminated fire suppression water is contained within the drainage system and not able to pollute the local environment. These pipes have been designed to store a total of 228m^3 of fire suppression water, in accordance with NFCC guidance discussed above.

7.20. There is a penstock located downstream of the two fire water containment pipes that will be shut off in the event of a fire. This will ensure potentially contaminated fire suppression water does not reach the proposed attenuation basin and subsequently enter the Kingston Brook. Instead, water will be trapped within proposed drainage system. Contaminated water would then be manually pumped out and taken away from the Site.

7.21. It is also noted that the BESS platform with have an impermeable liner to ensure potentially contaminated fire water cannot infiltrate.

Water Quality

7.22. The SuDS Manual (CIRIA C753) states that the design of surface water drainage should consider minimising contaminants in surface water runoff discharged from the Site. The level of treatment required depends on the proposed land use, according to the pollution hazard indices.

7.23. Table 7.2 shows the pollution indices for the proposed BESS.

7.24. It is noted that the issue of potentially contaminated fire suppression water has been considered in the Site design, as detailed above. In the event of a fire, the penstock on Site will be closed to contain all potentially contaminated fire suppression water and not allow it to pollute the local environment.

Table 7.2 – Pollution Hazard Indices

Pollutant	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2	0.05
Low Traffic Roads (general access roads)	Low	0.5	0.4	0.4
Total		**0.8**	**0.6**	**0.45**

7.25. Table 7.3 shows the pollution mitigation indices for the proposed BESS gravel compound and attenuation basin. It is shown that each individual pollution mitigation indices exceeds the Development pollution indices. Therefore, the mitigation measures are deemed adequate for the Site.

Table 7.3 – Indicative SuDS Mitigation Indices

Type of SuDS component	Total suspended solids (TSS)	Metals	Hydrocarbons
Gravel BESS Compound (Permeable Pavement)	0.7	0.6	0.7
Attenuation Basin (0.5 mitigation)	0.25	0.25	0.3
Total	**0.95**	**0.85**	**1**

8. Summary

8.1. The Site is approximately 101ha in area and is currently almost entirely greenfield and predominantly used for arable farming with some smaller areas of modified grassland. The redline also includes a section of highway in which the cable will be laid. The Site is proposed for a solar farm and BESS Development.

8.2. The Site is generally located in Flood Zone 1, with small areas of Flood Zone 2 and 3 at the southern end of the Southern Parcel, associated with the Kingston Brook. Flood Zone 2 and 3 are generally left undeveloped with the exception of the proposed access and brook crossing to the Southern Parcel. Areas of surface water flood risk are also predicted on Site. Mitigation measures are proposed to help protect the Development from flooding over its lifetime.

8.3. The Site is not considered to be at significant risk of flooding from any source. Access and egress to the Northern Parcel is not predicted to be impeded during an extreme flood event. Flooding may restrict access and egress at the Southern Parcel during extreme events, although as the Site will be operated remotely, it is unlikely that access during an extreme flood event will be required. Furthermore, a Flood Emergency Management plan should be complete during detailed design.

8.4. Surface water runoff from the solar connection infrastructure buildings, BESS and substation will be managed with the proposed surface water drainage strategy to ensure surface water runoff rates and associated flood risk does not increase as a result of the Development.

8.5. With mitigation measures and the proposed surface water drainage strategy in place, the Development will not increase flood risk on Site or elsewhere.

8.6. The Development is considered to accord with the requirements of the National Planning Policy Framework (NPPF) with residual risk to the Site fully mitigated, and as such considered low risk.

Appendix A – EA and LLFA Comments

Mr Gareth Elliott
Rushcliffe Borough Council
Development Control
Rushcliffe Borough Council (Rushcliffe Arena) Rugby Road
West Bridgford
Nottingham
NG2 7YG

Our ref: LT/2024/128434/01-L01
Your ref: 24/00161/FUL

Date: 07 March 2024

Dear Mr Elliott,

CONSTRUCTION, OPERATION AND SUBSEQUENT DECOMMISSIONING OF A RENEWABLE ENERGY PARK COMPRISING GROUND MOUNTED SOLAR PV WITH CO-LOCATED BATTERY ENERGY STORAGE SYSTEM (BESS) AT THE POINT OF CONNECTION, TOGETHER WITH ASSOCIATED INFRASTRUCTURE, ACCESS, LANDSCAPING AND CABLING.

LAND WEST OF BRADMORE ROAD AND NORTH OF WYSALL ROAD, LAND WEST OF WYSALL, WYSALL

We have no objection to the proposals.

Advice to the applicant
The proposals include 3 instances of access roads crossing ordinary watercourses, including the Kingston Brook. The permanent structures and the associated temporary works may require consent under Section 23 of the Land Drainage Act 1991. It is recommended that the applicant engages early with Nottinghamshire County Council as the Lead Local Flood Authority with details of their proposals.

Yours sincerely,

Mr Joshua Milsom
Planning Advisor

Direct e-mail josh.milsom@environment-agency.gov.uk

This matter is being dealt with by:
Callum Smith
[redacted]

Nottinghamshire County Council

Planning ref:
24/00161/FUL
Consultation received:
22/02/24

Ms Helen Knott
Service Manager – Planning
Rushcliffe Borough Council
Rushcliffe Arena
Rugby Road
West Bridgford
NG2 7YG

26 February 2024

Dear Ms Knott

PROPOSAL: Construction, operation and subsequent decommissioning of a renewable energy park comprising ground mounted Solar PV with co-located battery energy storage system (BESS) at the point of connection, together with associated infrastructure, access, landscaping and cabling.

LOCATION: Wysall Road, Wysall

Thank you for inviting Nottinghamshire County Council as the Lead Local Flood Authority (LLFA) to comment on the above application, we have reviewed the application which you consulted us with on the 22 Feb 2024.

Based on the submitted information we have **no objection** and no further comments to make on the proposals.

Yours sincerely

[redacted]

Callum Smith

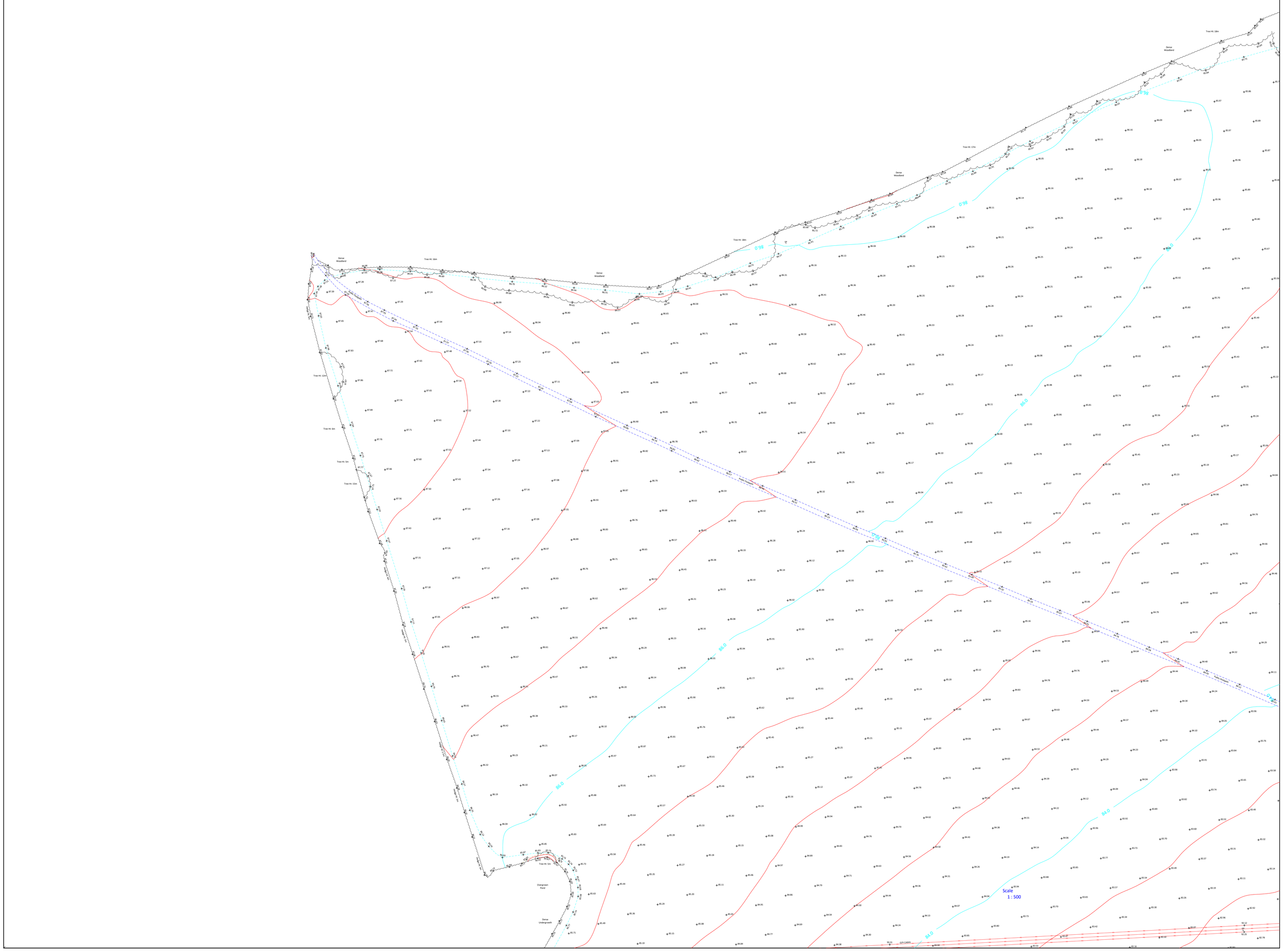
Principal Flood Risk Management Officer
Nottinghamshire County Council

Please ensure any consultations are sent to [redacted]

Corporate Letterhead Apr 20

The Council is committed to protecting your privacy and ensuring all personal information is kept confidential and safe. For more details see our general and service specific privacy notices at: https://www.nottinghamshire.gov.uk/global-content/privacy

Appendix B – Topographic Survey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Public Footpath
Overgrown Pond
Dense Undergrowth
O/H Cables
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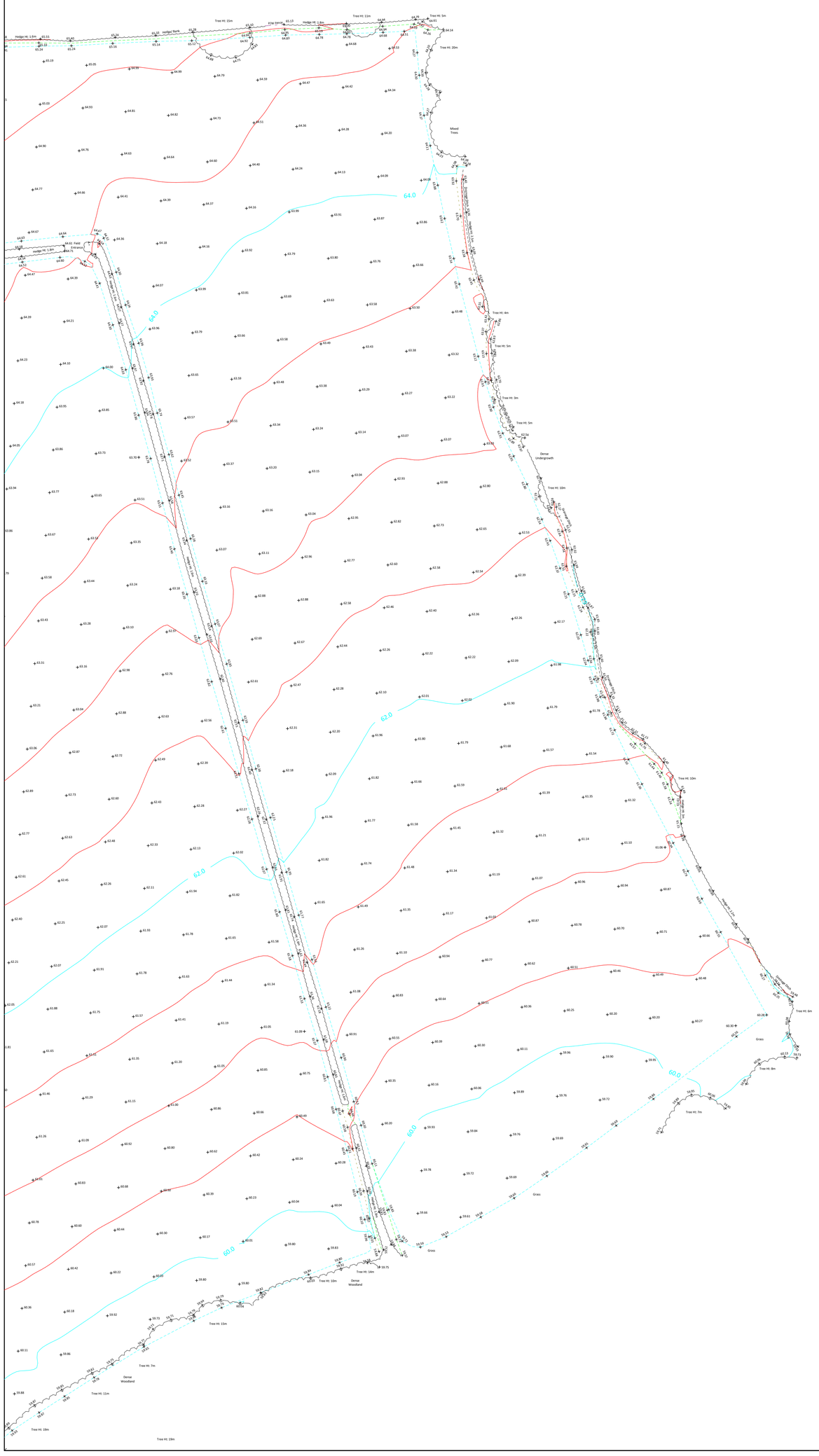
85.0
84.0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60.0
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Hedge Ht: 1.8m
Hedge Ht: 2.8m
Tree Ht: 15m
Tree Ht: 13m
Tree Ht: 5m
Tree Ht: 20m
Mixed Trees
Tree Ht: 4m
Tree Ht: 3m
Dense Undergrowth
Tree Ht: 10m
Tree Ht: 6m
Grass
Tree Ht: 8m
Tree Ht: 2m
Tree Ht: 14m
Dense Woodland
Tree Ht: 7m
Tree Ht: 11m
Tree Ht: 19m

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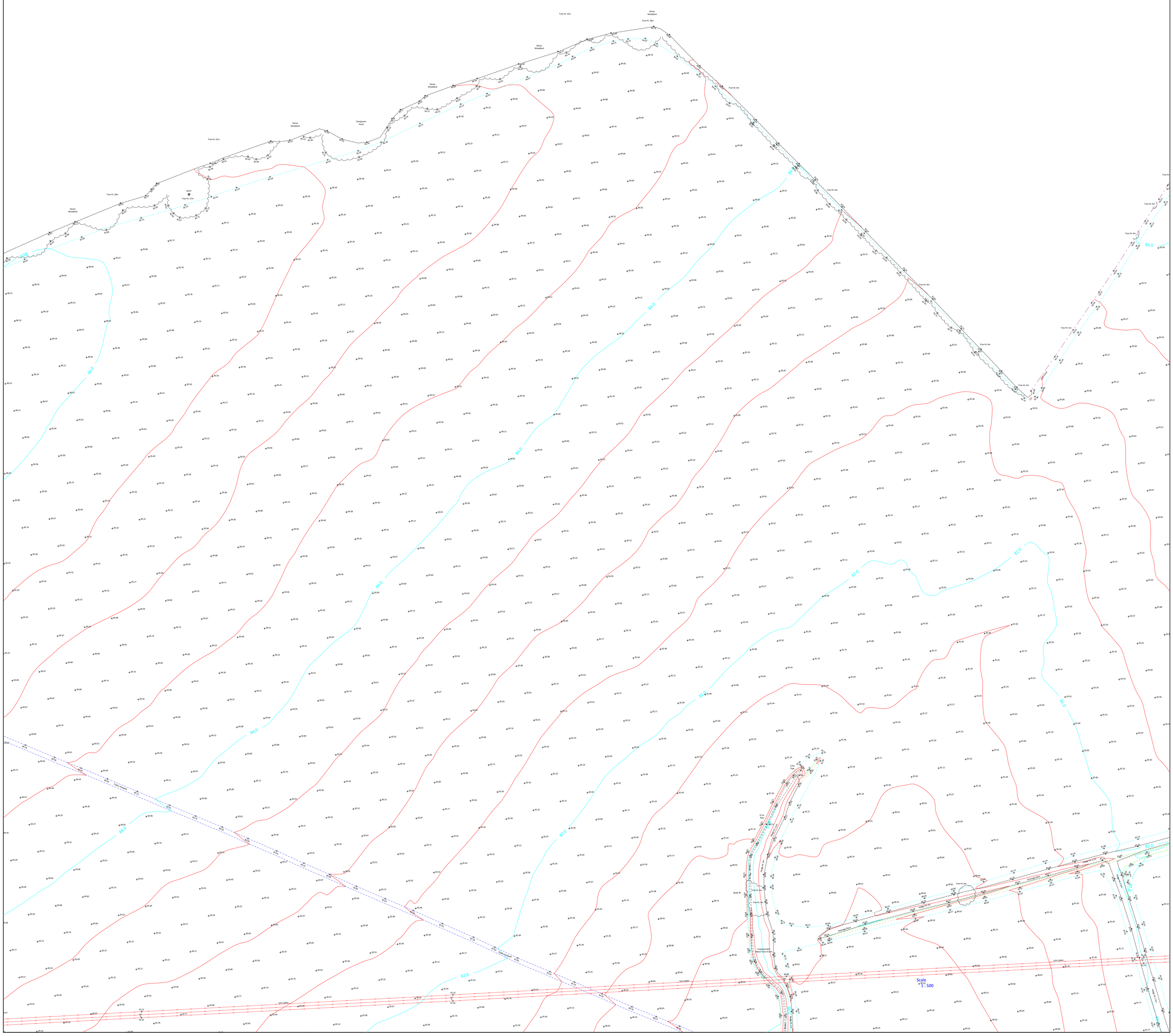
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Tree Ht: 6m
Tree Ht: 4m
Overgrown Pond
Public Footpath
O/H Cables
Undergrowth Mixed Trees Ht:
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Hedge 1.5m
Drainge Ditch
0.5m Pipe
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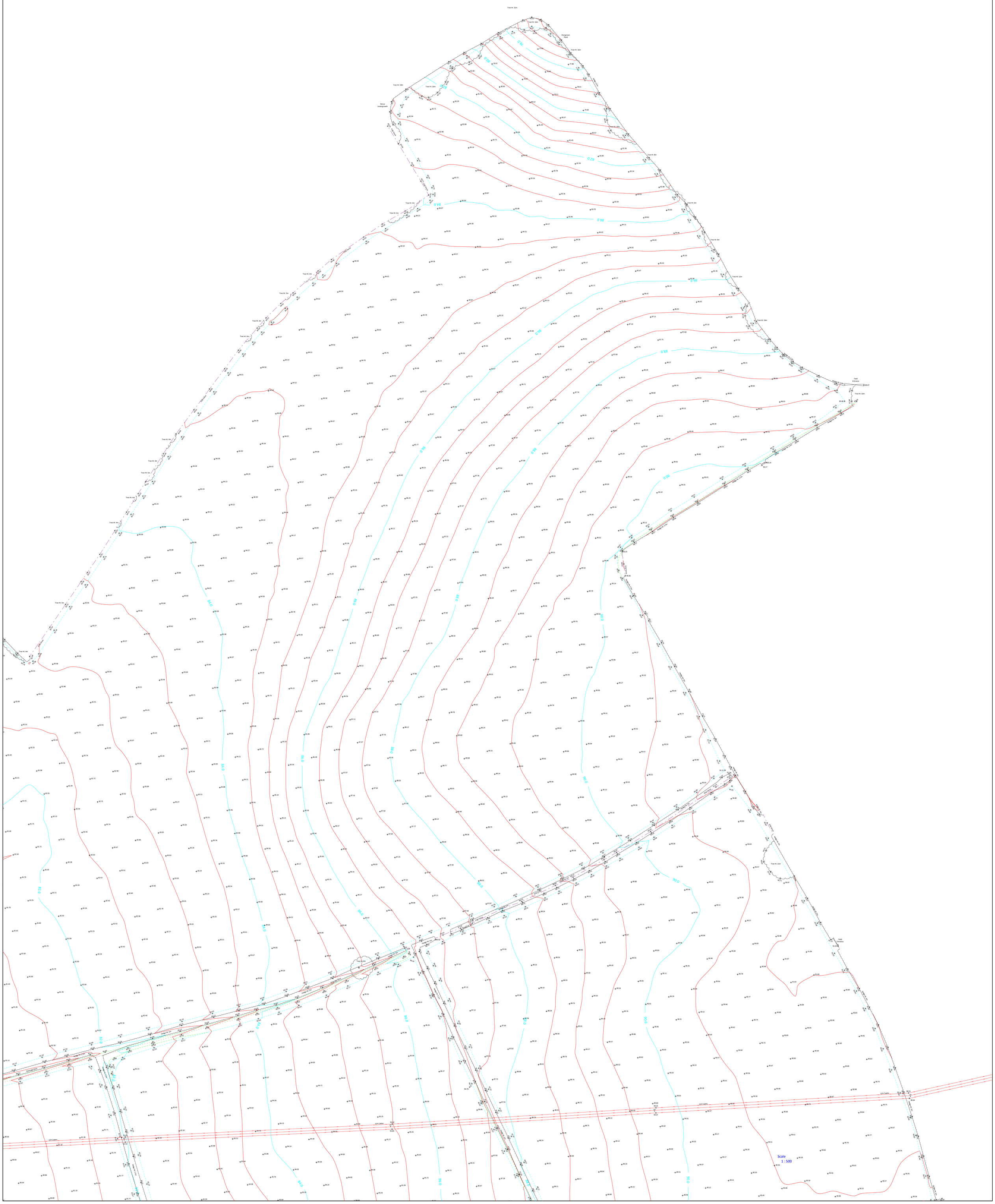
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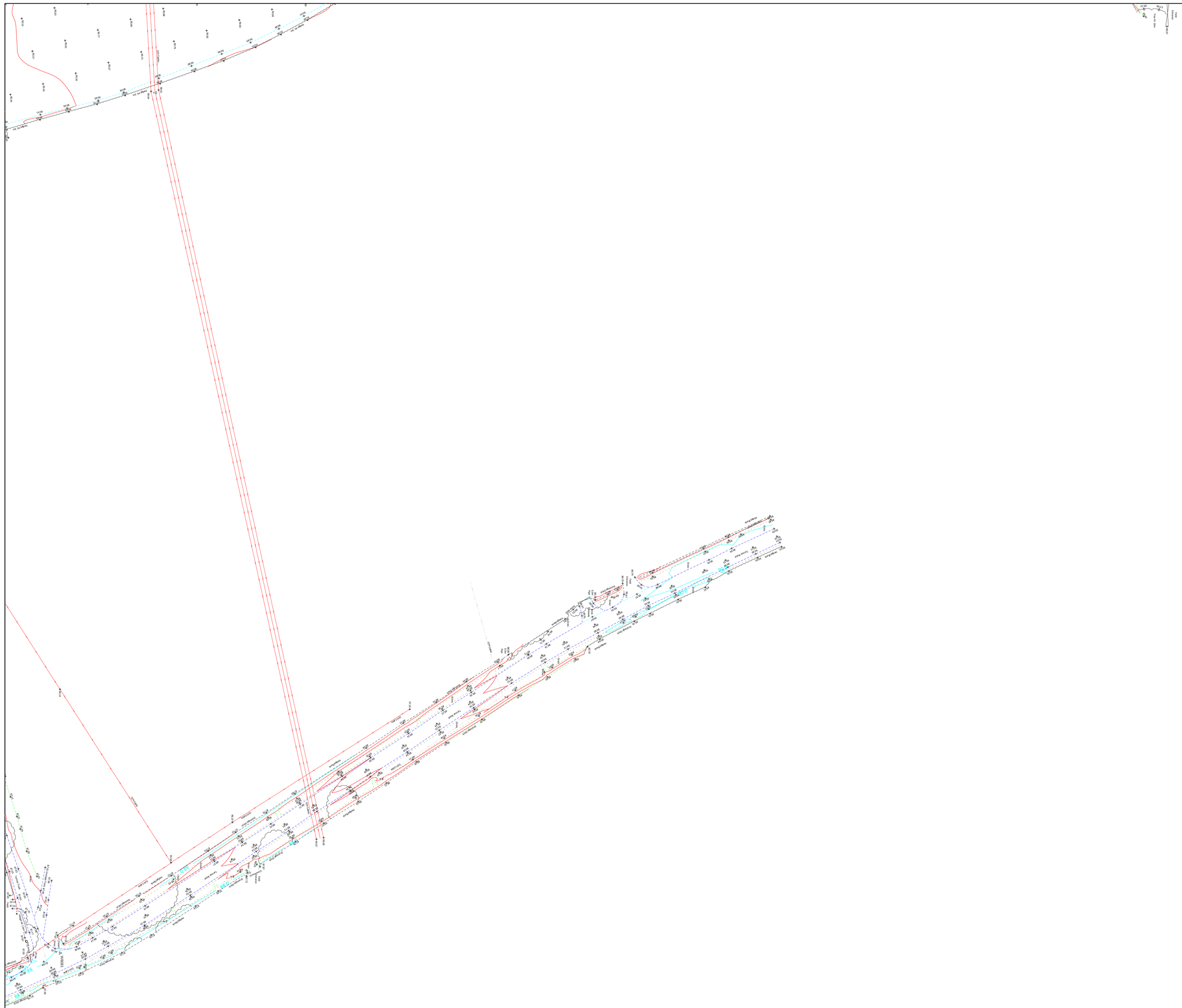

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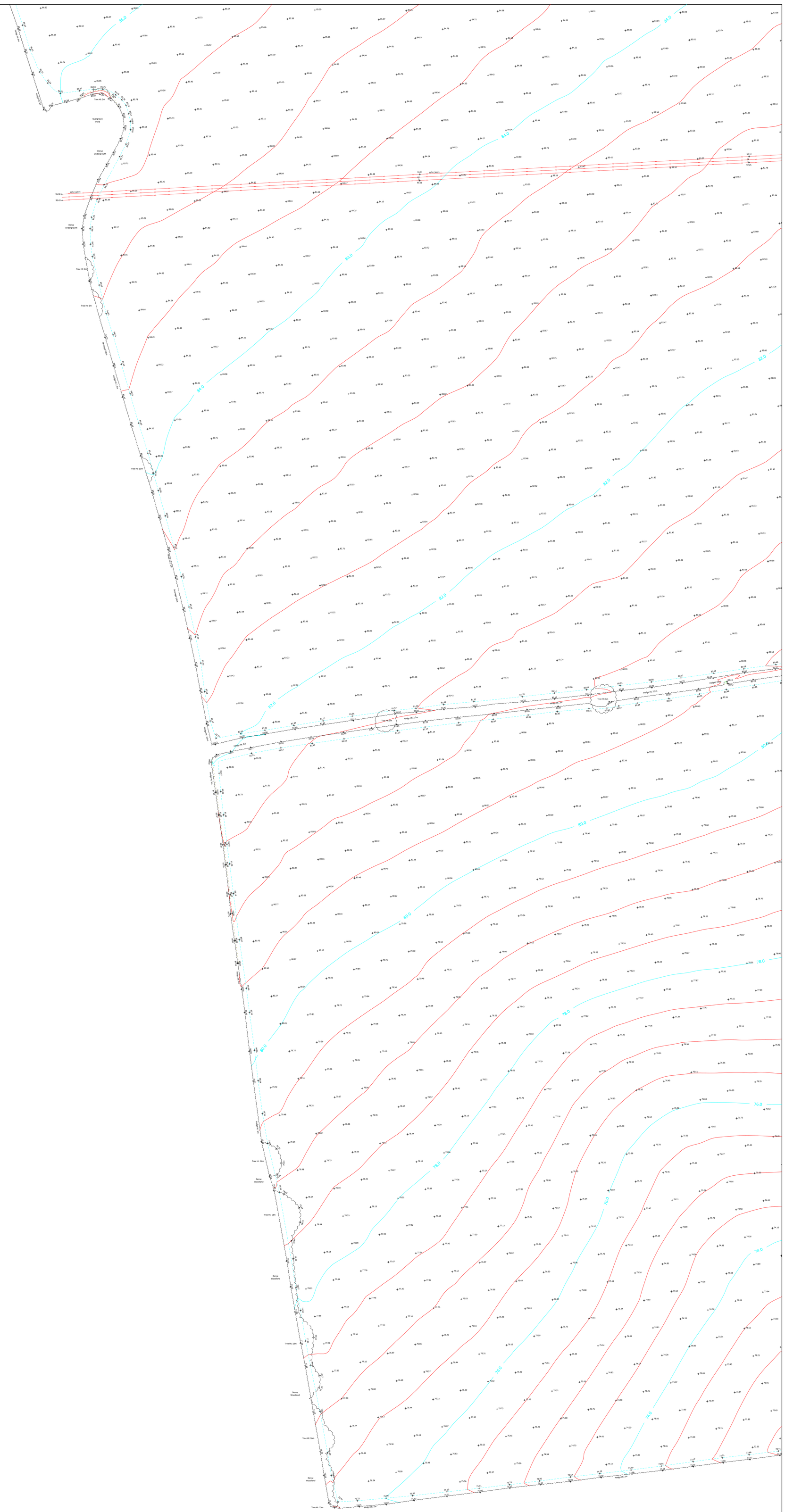
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Overgrown Pond
Dense Undergrowth
O/H Cables
Tree Ht: 5m
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Tree Ht: 13m
Tree Ht: 14m
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Dense Woodland
Hedge Ht: 2m
Hedge Ht: 3m

Scale
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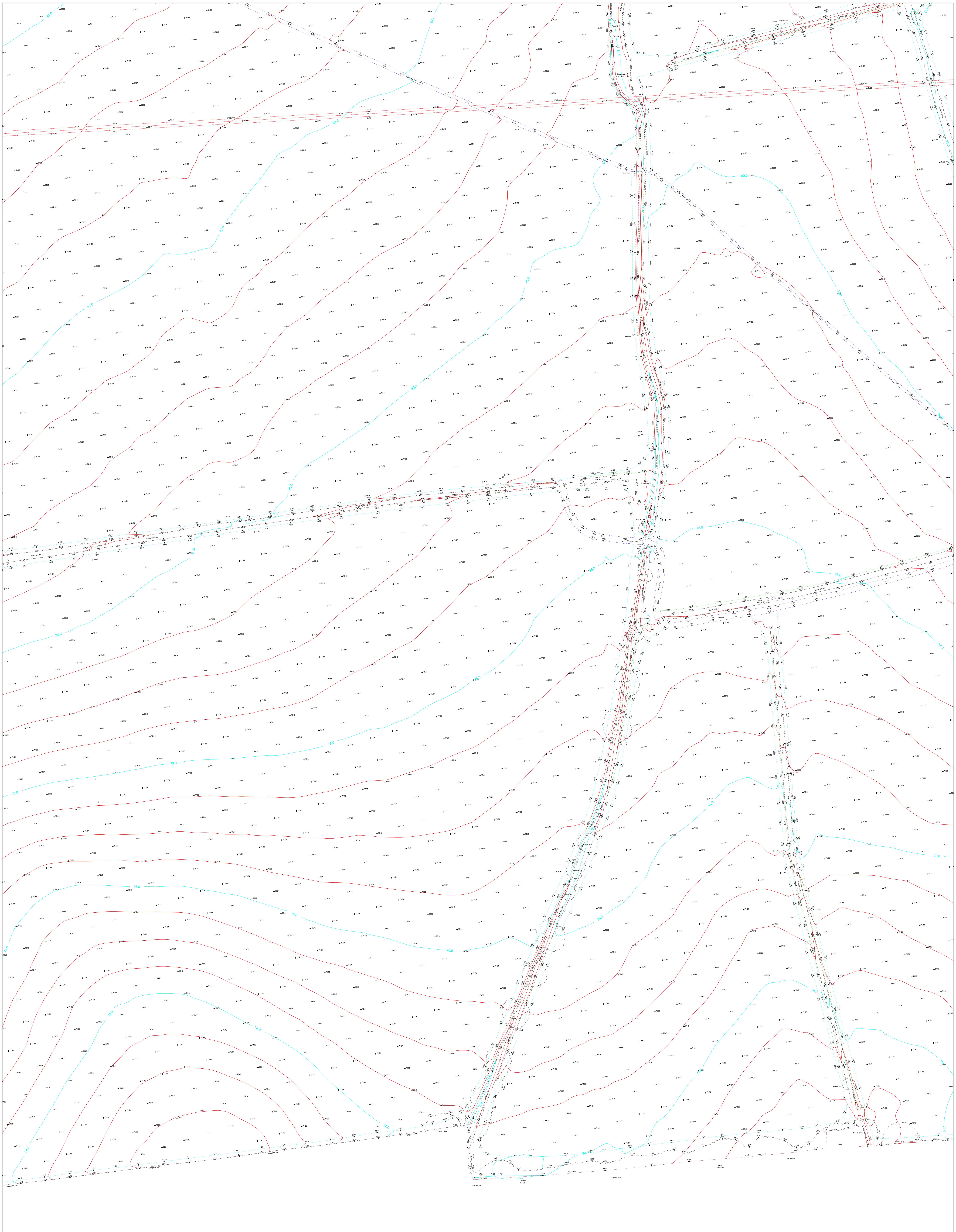
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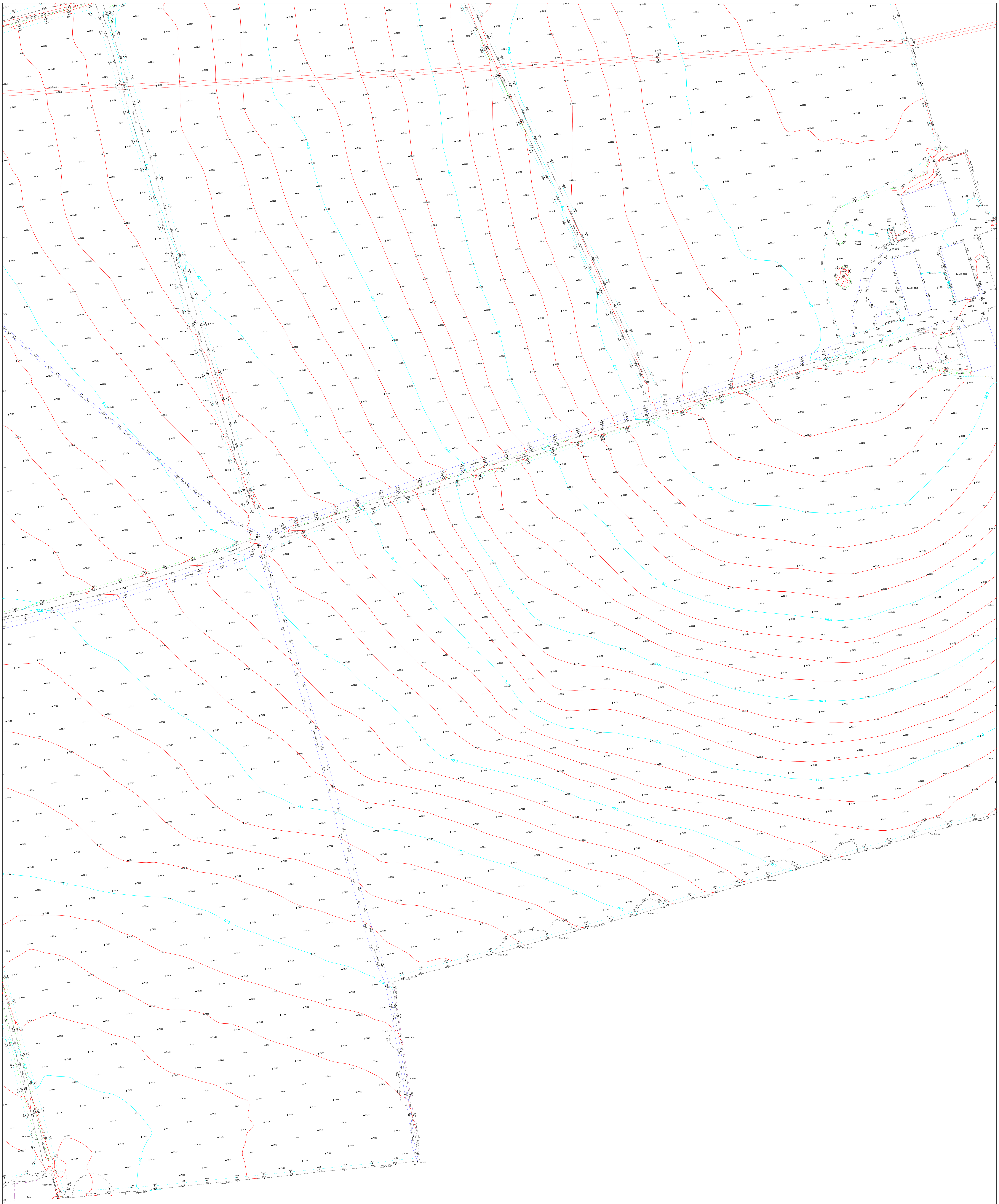
74.0
O/H Cables
Public Footpath
Footbridge
Undergrowth Mixed Trees Ht:4m
Drainage Ditch
Hedge Ht: 2m
Hedge/ Ditch
Hedge Ht: 2.2m
Hedge Ht: 2.5m
Hedge Ht: 1.8m
ST1
ST2
0.1m Pipe
0.25m Pipe
Grass
Brick Wall
Dense Undergrowth
Unmade Track
Stone Track
Water Trough
Undergrowth
Tree Ht: 7m
Tree Ht: 10m
Tree Ht: 13m
Tree Ht: 18m
P/W Fence
Bin
Dense Woodland
Pond

Scale
1 : 500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O/H Cables
Hedge Ht: 2.2m
Hedge Ht: 2.5m
Hedge Ht: 2m
Hedge Ht: 3m
Hedge Ht: 1.8m
Stone Track
Public Footpath
Slurry Pond
Tree Ht: 6m
Block Wall
Concrete
Concrete Wall
Barn Ht: 97.43
Barn Ht: 95.10
Barn Ht: 94.76
Unmade Ground
Unmade Track
Grass Mound
Metal Railings
Mast Ht: 15.16m
C/L Fence
Grass
WB05
WB06
WB07
P/W Fence
Tree Ht: 10m
Tree Ht: 11m
Tree Ht: 13m
Tree Ht: 14m
Tree Ht: 16m
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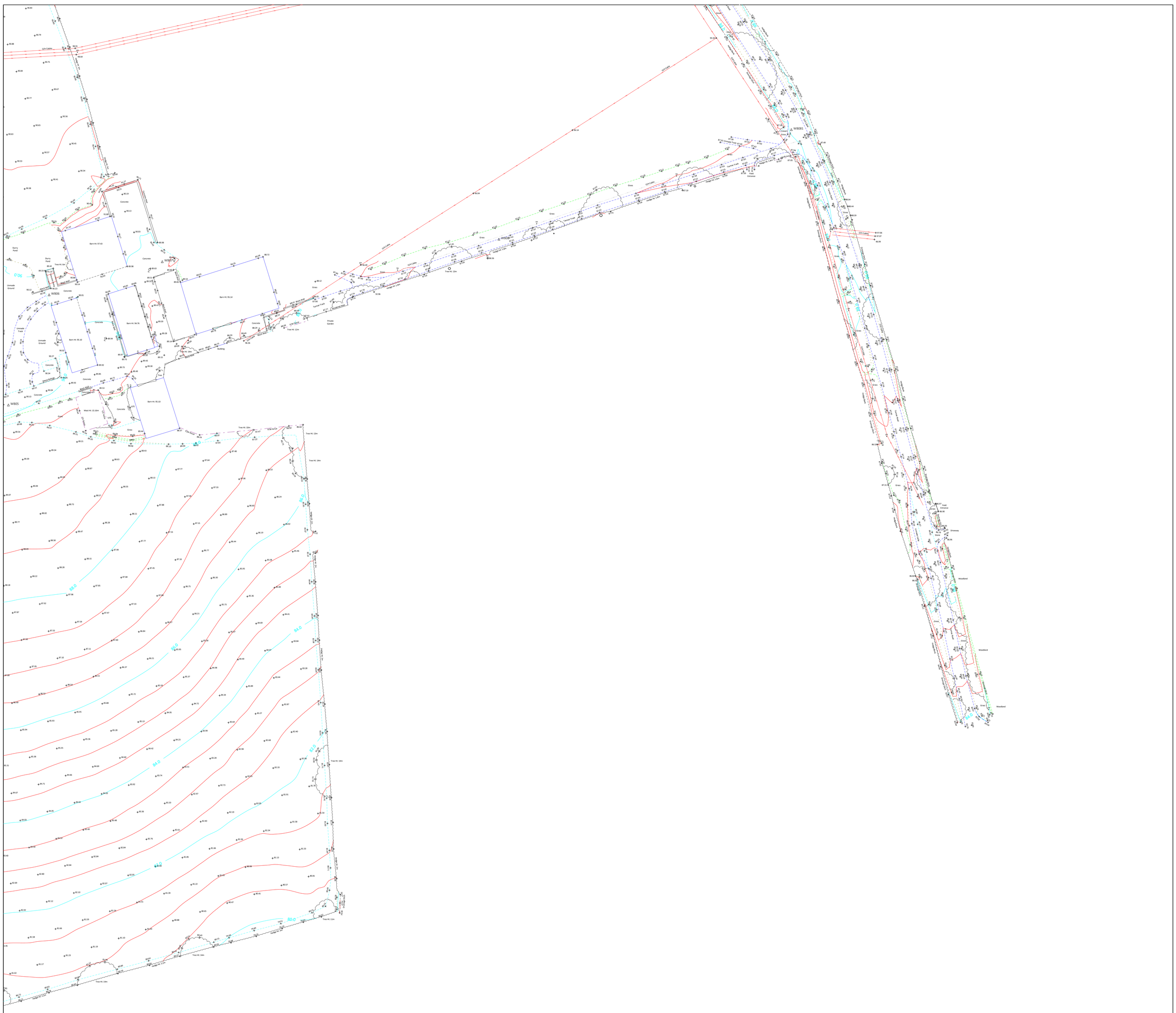
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WB08
WB081
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Concrete
Grass
Tree Ht: 14m
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Tree Ht: 12m
Building
Private Garden
Woodland
Field Entrance
Driveway
Stone
Slurry Pond
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Unmade Track
Tarmac Track
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Bridge Ht: 2.5m
Bridge Ht: 2.7m
Bridge Ht: 3.2m
O/H Cables
U/G Cable
Black Wall
Stone Wall
Brick Wall
Hedge
Fence
Ditch
Gate
Post
Stile
Tree
Bush
Rail
Pond
Sign
Bollard
Manhole
Footpath
Footway
Cycle Track
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Road
Kerb
Edge of Road
Drainage Ditch
Drainage Pipe
Drainage Channel
Drainage Manhole
Drainage Inlet
Drainage Outlet
Drainage Grid
Drainage Cover
Drainage Chamber
Drainage Junction
Drainage Bend
Drainage Tee
Drainage Cross
Drainage Valve
Drainage Meter
Drainage Tank
Drainage Pump
Drainage Filter
Drainage Screen
Drainage Weir
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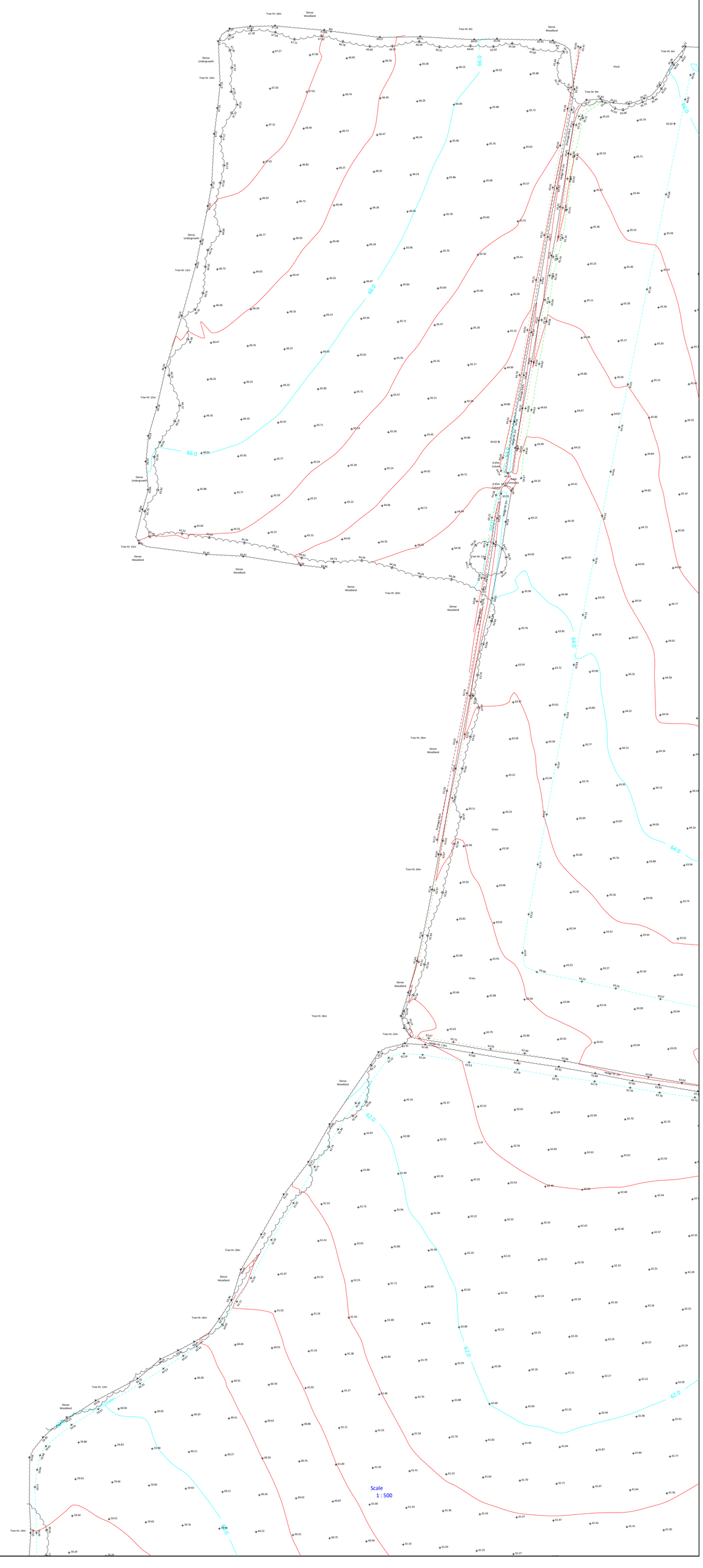
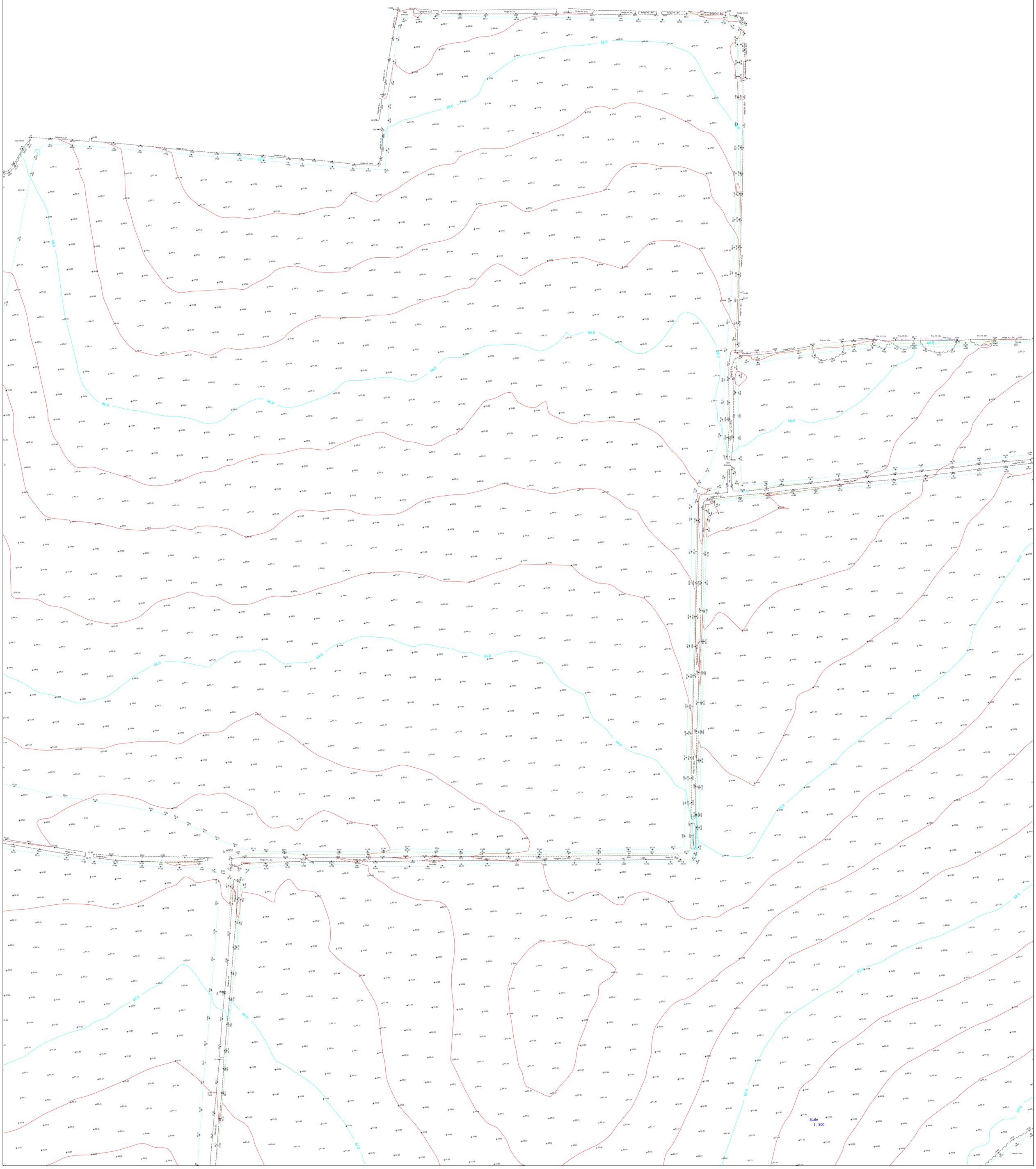
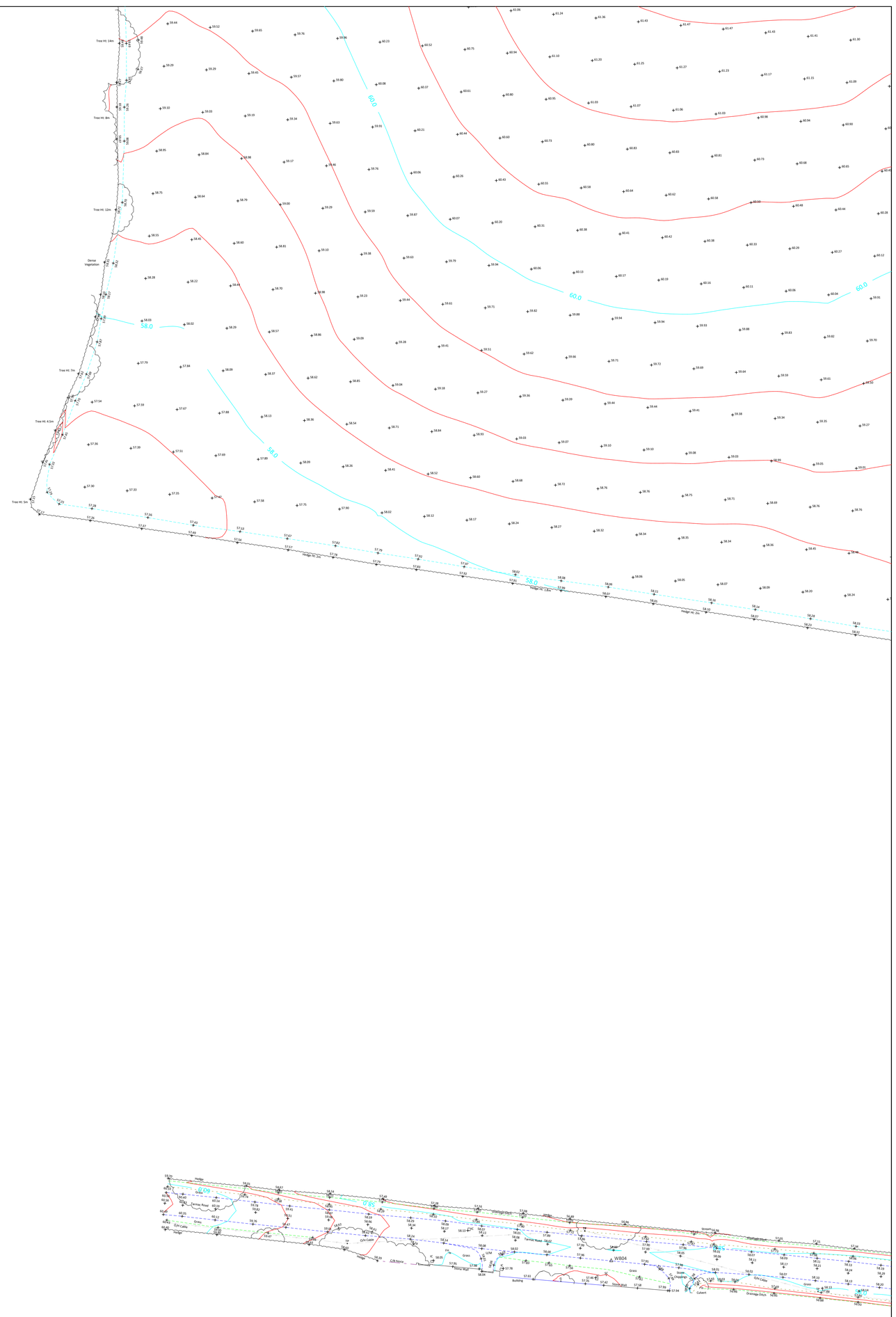
Drainage Bridge
Drainage Tunnel
Drainage Shaft
Drainage Pit
Drainage Well
Drainage Sump
Drainage Basin
Drainage Pond
Drainage Lake
Drainage River
Drainage Stream
Drainage Canal
Drainage Ditch
Drainage Pipe
Drainage Channel
Drainage Manhole
Drainage Inlet
Drainage Outlet
Drainage Grid
Drainage Cover
Drainage Chamber
Drainage Junction
Drainage Bend
Drainage Tee
Drainage Cross
Drainage Valve
Drainage Meter
Drainage Tank
Drainage Pump
Drainage Filter
Drainage Screen
Drainage Weir
Drainage Flume
Drainage Culvert
Drainage Bridge
Drainage Tunnel
Drainage Shaft
Drainage Pit
Drainage Well
Drainage Sump
Drainage Basin
Drainage Pond
Drainage Lake
Drainage River
Drainage Stream
Drainage Canal
Drainage Ditch
Drainage Pipe
Drainage Channel
Drainage Manhole
Drainage Inlet
Drainage Outlet
Drainage Grid
Drainage Cover
Drainage Chamber
Drainage Junction
Drainage Bend
Drainage Tee
Drainage Cross
Drainage Valve
Drainage Meter
Drainage Tank
Drainage Pump
Drainage Filter
Drainage Screen
Drainage Weir
Drainage Flume
Drainage Culvert
Drainage Bridge
Drainage Tunnel
Drainage Shaft
Drainage Pit
Drainage Well
Drainage Sump
Drainage Basin
Drainage Pond
Drainage Lake
Drainage River
Drainage Stream
Drainage Canal
90.0
89.0
88.0
87.0
86.0
85.0
84.0
83.0
82.0
81.0
80.0

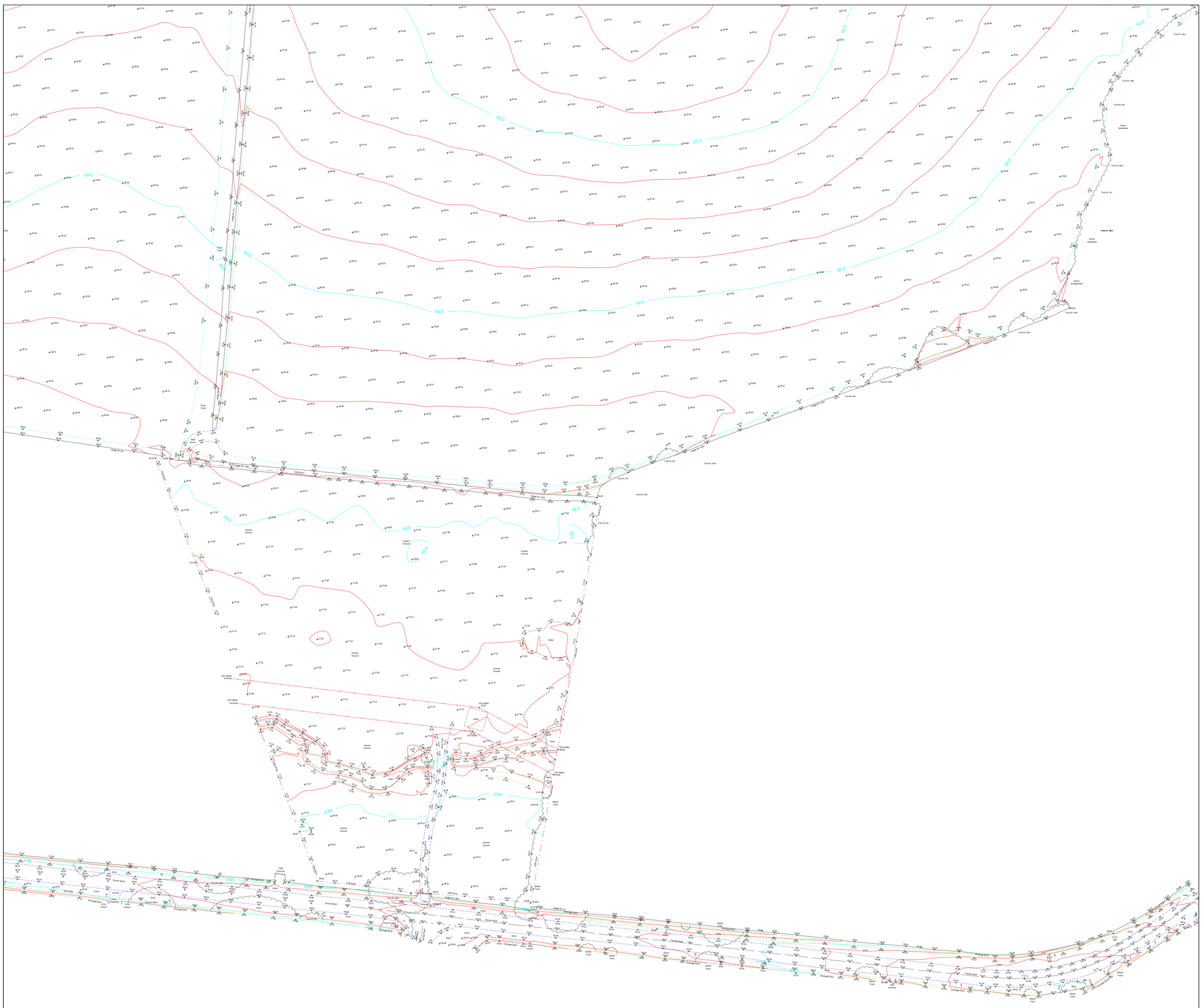
Scale
1 : 500


Scale
1 : 500
66.0
65.0
64.0
63.0
62.0
Dense Woodland
Dense Undergrowth
Grass
Pond
Tree Ht: 10m
Tree Ht: 9m
Tree Ht: 6m
Tree Ht: 14m
Tree Ht: 12m
Tree Ht: 15m
Tree Ht: 20m
Tree Ht: 26m
Tree Ht: 24m
Tree Ht: 16m
Hedge Ht: 1.8m
Hedge Ht: 2m


Scale
1 : 500

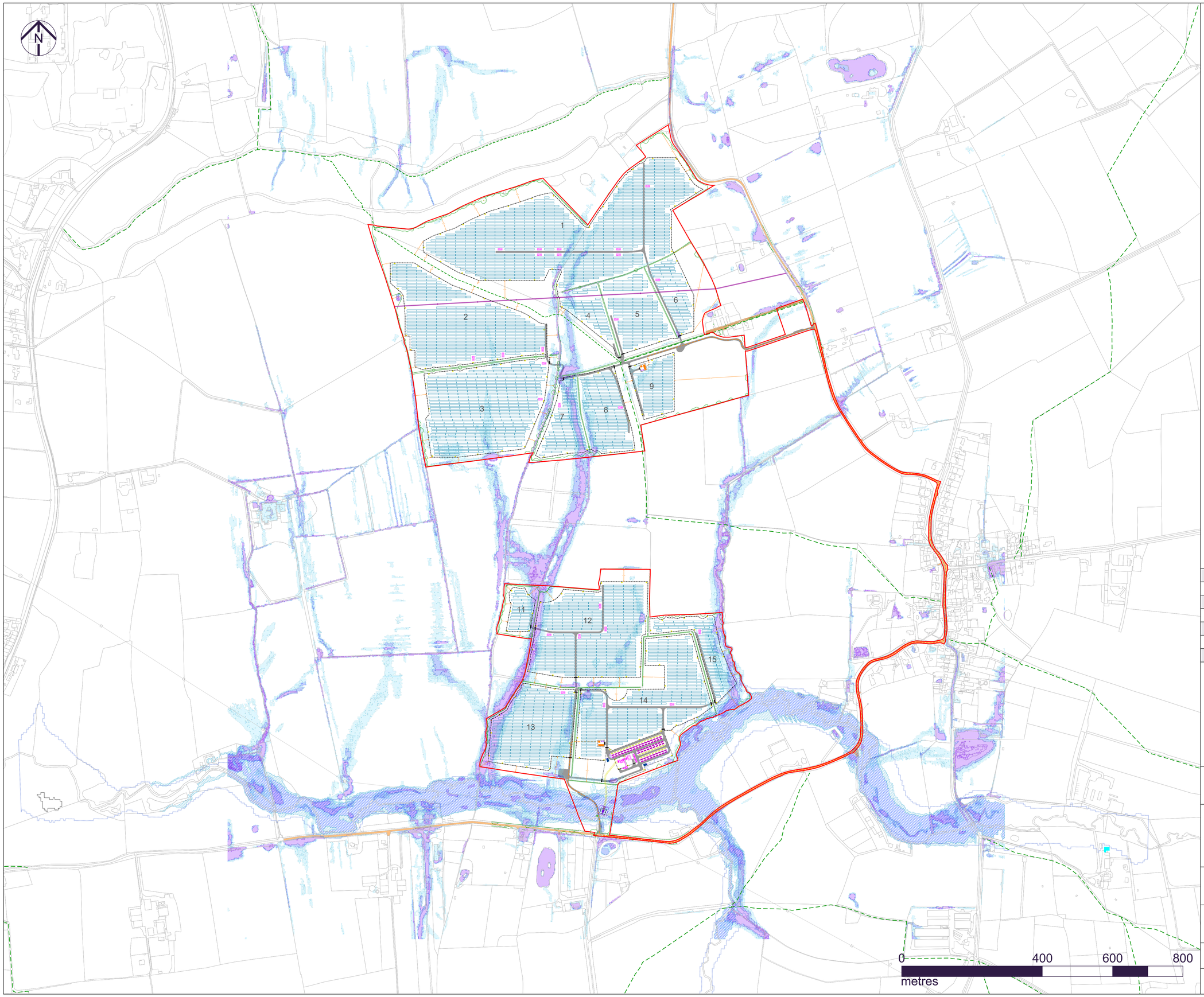

Tree Ht: 14m
Tree Ht: 8m
Tree Ht: 12m
Dense Vegetation
Tree Ht: 7m
Tree Ht: 4.5m
Tree Ht: 5m
Hedge Ht: 2m
Hedge Ht: 1.8m
Hedge Ht: 2m
60.0
58.0
Hedge
Grass
Farmer Road
O/H Cable
Stone Wall
Building
Stream
Culvert
Drainage Ditch
WB04

Scale
1 : 500


62.0
60.0
58.0
Tarmac Road
Drainage Ditch
Culvert
Uneven Ground
Mixed Trees
Dense Woodland
Dense Undergrowth
River
Water
Pylon
O/H Cables
Field Entrance
Grass Track
Stream

Scale
1 : 500

Appendix C – Site Layout



Notes:
View in conjunction with all relevant documents.
All dimensions to be checked on site before proceeding with work.
To be used only for the status specified.
The information contained therein must not be copied or reproduced in any form without written permission.
All dimensions, levels, and coordinates are in metres unless defined.
All areas are approximate and indicative only.
All omissions and discrepancies to be reported in writing to Exagen Development Ltd.
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Key

- Site Boundary
- Existing 33kV overhead electricity line
- Existing public road
- Existing access track
- Existing Public Right of Way
- Existing watercourse
- Existing vegetation
- Proposed solar panel table (2P24)
- Proposed solar panel table (2P12)
- Proposed deer fencing
- Proposed palisade fencing
- Proposed fence gate
- Proposed access tracks
- Proposed central inverter
- Proposed battery storage container
- Proposed battery storage inverter
- Proposed auxiliary transformer
- Proposed CCTV / lighting post
- Proposed substation infrastructure
- Proposed POC infrastructure
- Proposed POC cable connection
- Proposed solar cable connection
- Proposed solar connection infrastructure
- Proposed water storage tank and pump
- EA Flood Zone 2 extent (previous)
- EA Flood Zone 2 extent (2025)
- EA Flood Zone 3 extent (2025)
- EA 1 in 30 RoFSW (High Risk)
- EA 1 in 100 RoFSW (Medium Risk)
- EA 1 in 1000 RoFSW (Low Risk)

Rev	Date	Description
07	05.09.25	Track amendments for PROW
06	13.08.25	New flood data changes
05	13.08.24	PV changes
04	05.01.24	PV and planting changes
03	01.08.23	2 BESS access, minor aligns
02	12.07.23	Reduced solar, new planting

exagen

2nd Floor Coachworks
9-10 Charlotte Mews
London W1T 4EF
info@exagen.co.uk
www.exagen.co.uk

Client
Exagen Development Limited

Drawing title
Site Layout Plan
(with EA Flood Risk 2025)

Project
Old Wood Energy Park

Status
Planning Application

Date	Scale at A1	Status code
18/05/2023	1:5000	S4

Drawing number	Revision
WLL02A-EXG-04-00-D-K003	P07

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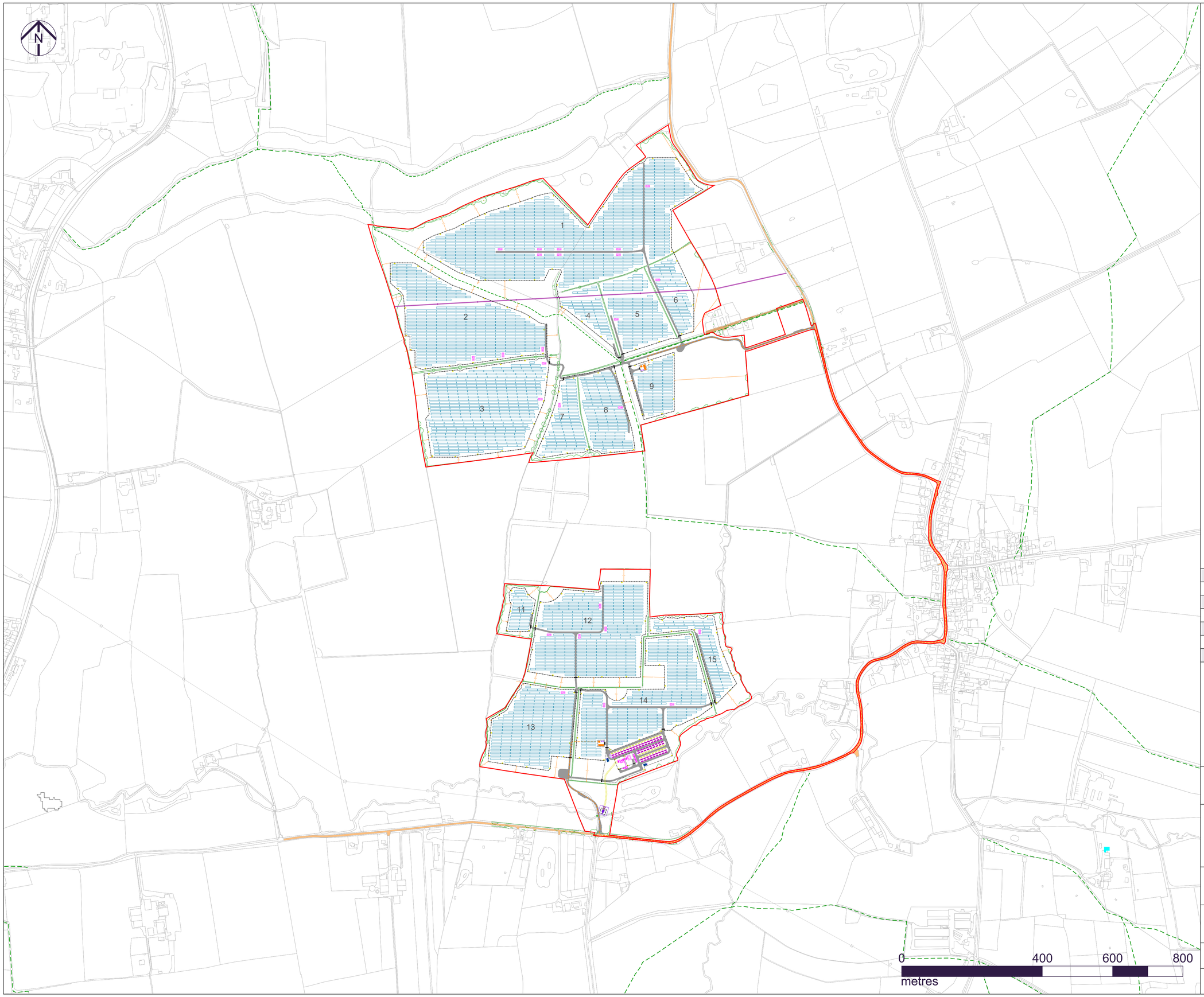

Notes:
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Key

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- Proposed battery storage inverter
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- Proposed POC infrastructure
- Proposed POC cable connection
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- Proposed solar connection infrastructure
- Proposed water storage tank and pump

Rev	Date	Description
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04	05.01.24	PV and planting changes
03	01.08.23	2 BESS access, minor aligns
02	12.07.23	Reduced solar, new planting

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2nd Floor Coachworks
9-10 Charlotte Mews
London W1T 4EF
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www.exagen.co.uk

Client
Exagen Development Limited

Drawing title
Site Layout Plan

Project
Old Wood Energy Park

Status
Planning Application

Date	Scale at A1	Status code
18/05/2023	1:5000	S4

Drawing number	Revision
WLL02A-EXG-04-00-D-K001	P07

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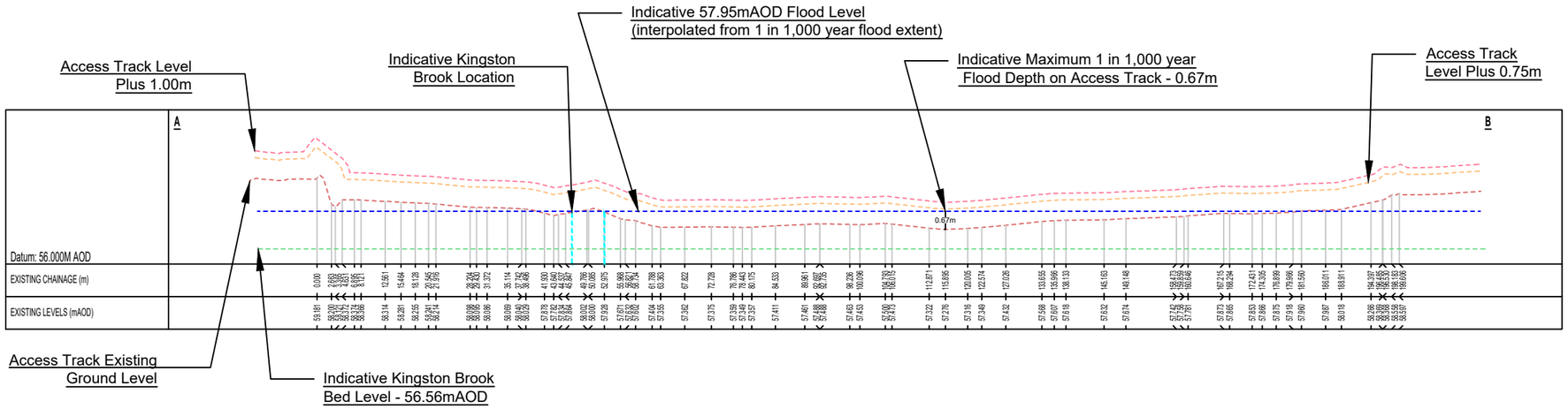
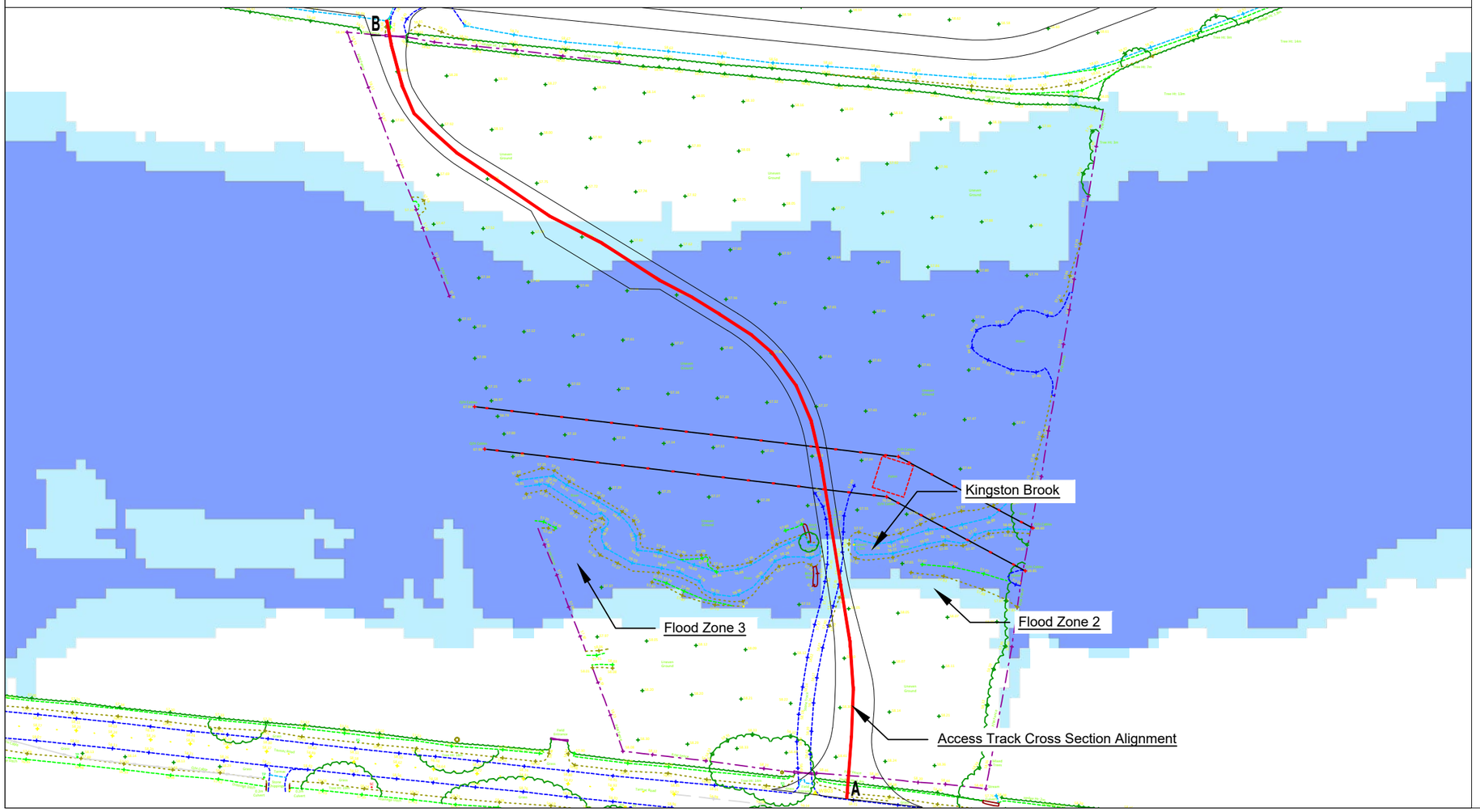
Appendix D – Southern Access Cross Section



Cross section scale: 5x vertical exaggeration



N

1:1000
0 25m

REV	DATE	DESCRIPTION	REVISED	CHECKED	APPROVED
P1	14/10/2025	First Issue	LG	CT	CT

Old Wood Energy Park
Southern Access Cross Section

Land West of Wysall
Nottinghamshire

CLIENT:
Exagen Developments Ltd

DATE: 14/10/2025

SCALE: 1:1000@A3

DRAWN BY: LG
CHECKED BY: CT
APPROVED BY: CT

DRAWING NUMBER: P25-1631 - PEG - XX - XX - DR - C - 0500 - P1

PG OFFICE / TEAM: BRS/IN

PEGASUS REF No: P25-1631

DRAWING STATUS: SO

PEGASUS GROUP

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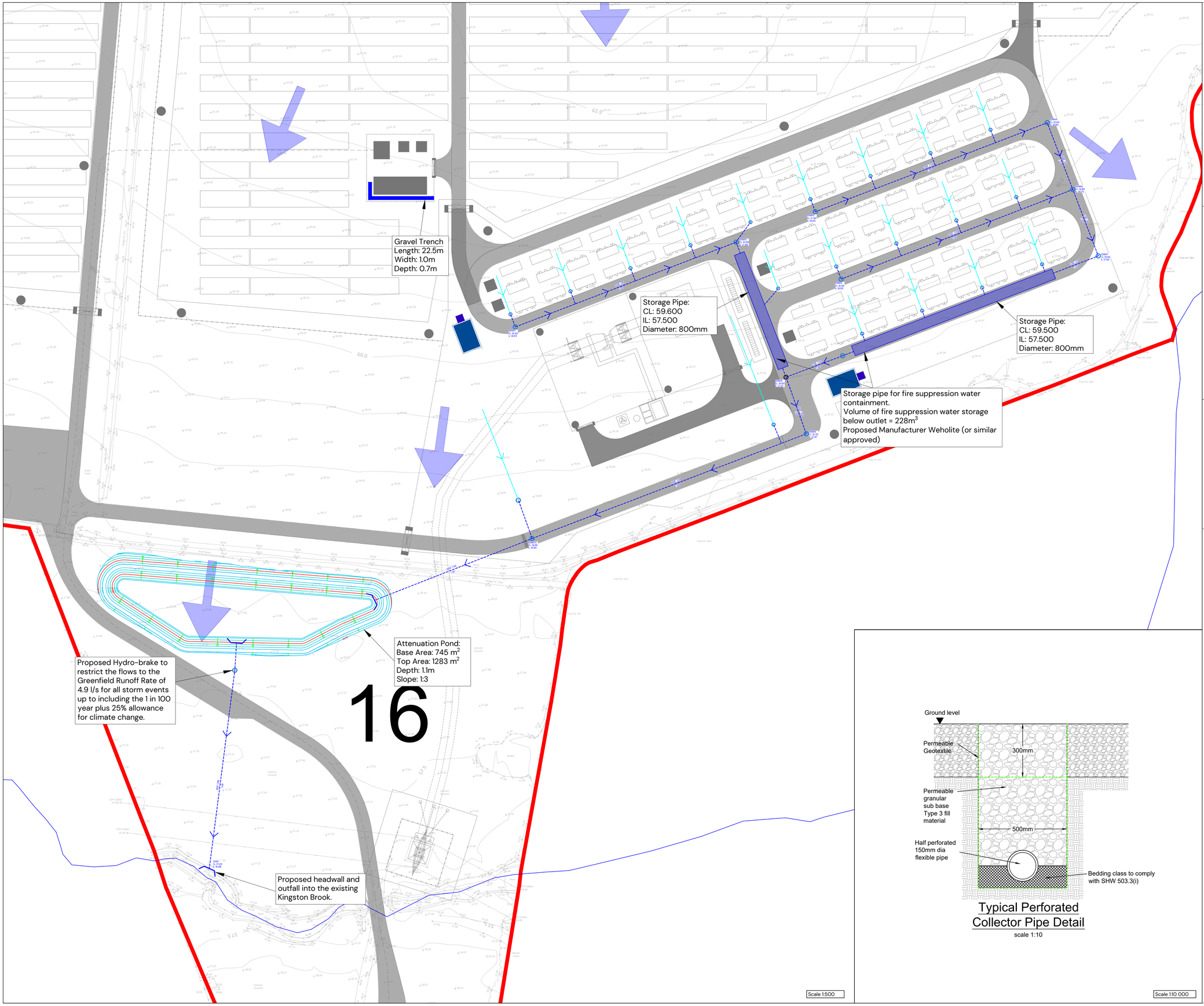
Appendix E – Causeway Flow and Greenfield Runoff Calculations and Surface Water Drainage Strategy Drawing



Typical Perforated Collector Pipe Detail

scale 1:10

Scale 1:10 000

N

Notes:

1. A site specific Topographical Survey was undertaken by Landmark Surveys (Wales), date: March 2023; ref: 6569.
2. Site Layout was produced by Exagen Old Wood Ltd, date: September 2025; Drawing Number: WLL02A-EXG-04-00-D-K001; Revision: P07.
3. The BESS compound will use an impermeable liner to prevent the formation of a pathway between firewater and the ground.
4. 25% climate change allowance has been incorporated in line with the latest guidelines for development with a lifetime of between 2061 and 2100.

Impermeable Area: 1.323 ha
Scale 1: 10 000

Key:

- Perforated collector pipes
- Storm water drain
- Overland flow exceedance
- Storm Water Manhole
- Storm Water inspection Chamber
- Penstock (to be closed in the event of a fire)

REV	DATE	DESCRIPTION	REVISED	CHECKED	APPROVED
P6	23.09.2025.	Updated site layout	NM	NM	CT
P5	05.09.2025.	Updated site layout and drainage strategy details	NM	NM	CT
P4	17.01.2024.	Updated site layout	LG	LG	LAJ
P3	30.11.2023.	Updated to address Client comments	MR	LG	LAJ
P2	28.11.2023.	Updated to address fire safety water storage	MR	LG	LAJ
P1	23.11.2023.	First Issue	MR	LG	LAJ

Drainage Strategy Drawing Sheet 1

Old Wood Energy Park
Nottinghamshire

CLIENT:
Exagen Development Limited

DATE: 23.11.2023.
SCALE: As noted
DRAWN BY: MR
CHECKED BY: LG
APPROVED BY: LAJ

DRAWING NUMBER: P21-2533 - PEG - XX - XX - DR - C - 0100 - P6
PG OFFICE / TEAM: BRS/IN

PEGASUS REF No: P21-2533
DRAWING STATUS: SO

PEGASUS GROUP

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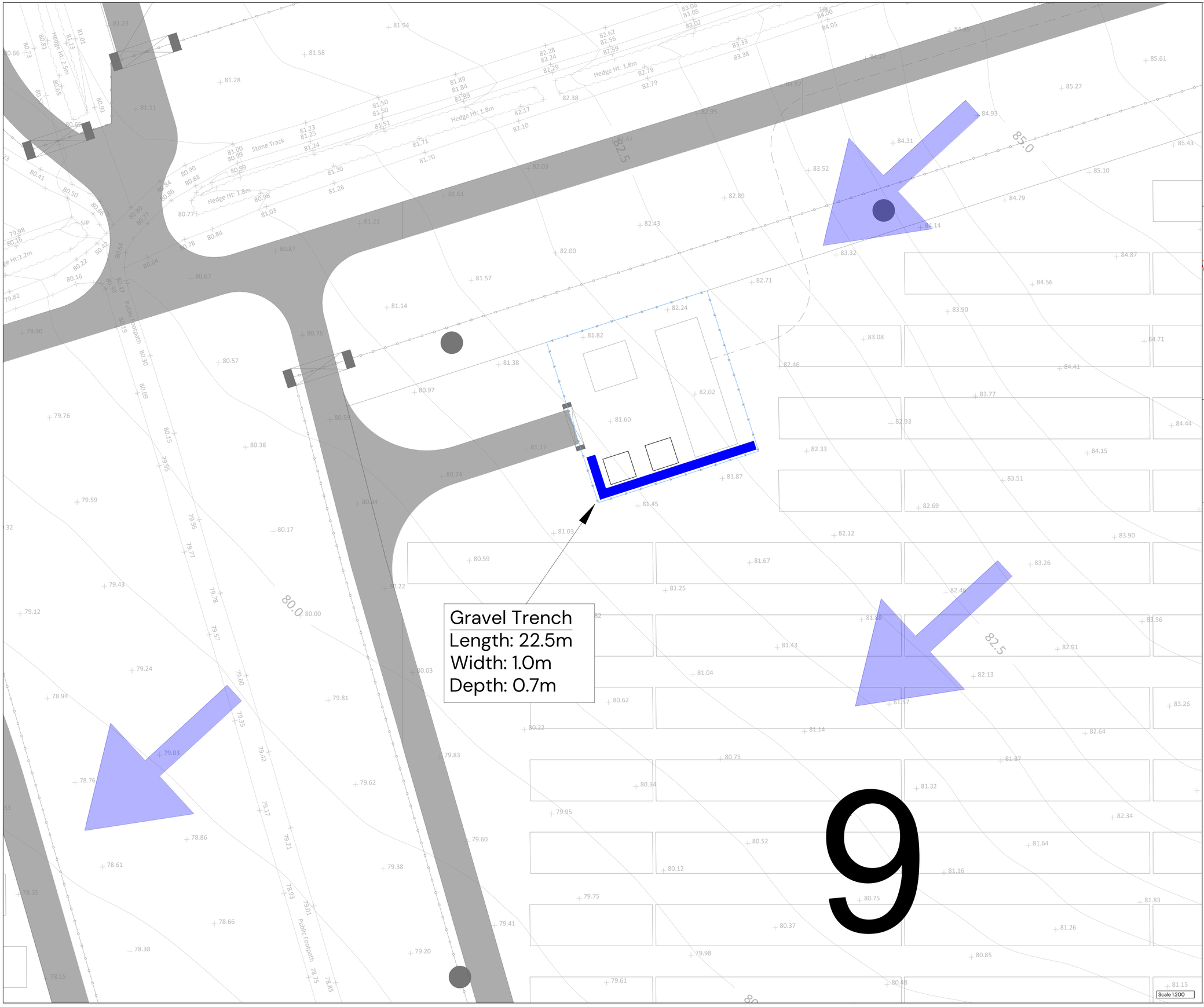
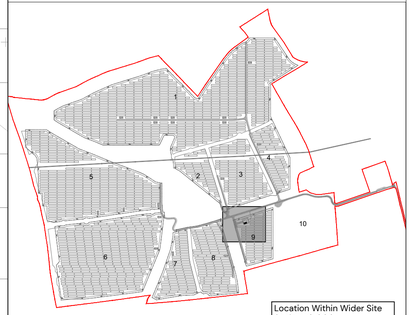


N

Notes:

1. A site specific Topographical Survey was undertaken by Landmark Surveys (Wales), date: March 2023; ref: 6569.
2. Site Layout was produced by Exagen Old Wood Ltd, date: September 2025; Drawing Number: WLL02A-EXG-04-00-D-K001; Revision: P07.



Location Within Wider Site
Scale 1: 10 000

Key:

Overland flow exceedance

REV	DATE	DESCRIPTION	REVISED	CHECKED	APPROVED
P4	23.09.2025.	Updated site layout	NM	NM	CT
P3	05.09.2025.	Updated site layout and drainage strategy details	NM	NM	CT
P2	17.01.2024.	Updated site layout	LG	LG	LAJ
P1	30.1.2023.	First Issue	MR	LG	LAJ

Drainage Strategy Drawing Sheet 2

Old Wood Energy Park
Nottinghamshire

CLIENT:
Exagen Development Limited

DATE: 30.11.2023.
SCALE: As noted
DRAWN BY: MR
CHECKED BY: LG
APPROVED BY: LAJ

DRAWING NUMBER: P21-2533 - PEG - XX - XX - DR - C - 0101 - P4
PG OFFICE / TEAM: BRS/IN

PEGASUS REF No: P21-2533
DRAWING STATUS: SO

PEGASUS GROUP

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IH 124 Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	50.000	Urban	0.000
SAAR (mm)	603	Region Number	Region 4

Results	**l/s**
QBAR Rural	184.5
QBAR Urban	184.5
Q100 years	474.1
Q1 year	153.1
Q2 years	165.3
Q5 years	226.9
Q10 years	274.9
Q20 years	327.9
Q25 years	346.5
Q30 years	361.5
Q50 years	406.2
Q100 years	474.1
Q200 years	557.1
Q250 years	584.8
Q1000 years	767.4

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Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	1.000	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SWMH1	0.056	5.00	60.300	1200	459521.441	326764.671	1.425
SWMH2	0.164	5.00	60.900	1200	459583.686	326788.556	3.211
TANK 1	0.073	5.00	59.600	1200	459596.167	326754.778	2.100
SWMH3	0.043	5.00	61.050	1200	459606.008	326797.122	1.425
SWMH4	0.153	5.00	60.400	1200	459671.360	326822.200	1.550
SWMH5	0.036	5.00	60.350	1200	459613.286	326778.157	1.425
SWMH6	0.129	5.00	59.800	1200	459678.553	326803.386	1.725
SWMH7	0.000		59.400	1200	459685.758	326784.680	1.575
TANK 2	0.161	5.00	59.500	1200	459613.702	326756.543	2.000
SWMH8	0.000		59.500	1200	459597.745	326750.507	2.169
SWMH9	0.014	5.00	59.100	1200	459603.435	326734.544	1.813
SWMH10	0.494	5.00	58.600	1200	459528.039	326706.008	1.650
BASIN	0.000		57.600	1200	459470.088	326660.369	1.100
OUTFALL	0.000		57.200	1200	459432.866	326610.756	0.812

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
3.000	SWMH1	SWMH2	66.670	0.600	58.875	57.764	1.111	60.0	225	5.66	50.0
3.001	SWMH2	TANK 1	36.010	0.600	57.689	57.500	0.189	190.5	300	6.19	50.0
3.002	TANK 1	SWMH8	4.553	0.600	57.500	57.481	0.019	238.0	300	6.26	50.0
1.000	SWMH3	SWMH4	69.998	0.600	59.625	58.925	0.700	100.0	225	5.89	50.0
1.001	SWMH4	SWMH6	20.142	0.600	58.850	58.150	0.700	28.8	300	6.01	50.0
2.000	SWMH5	SWMH6	69.973	0.600	58.925	58.225	0.700	100.0	225	5.89	50.0
1.002	SWMH6	SWMH7	20.046	0.600	58.075	57.825	0.250	80.2	375	6.17	50.0
1.003	SWMH7	TANK 2	77.355	0.600	57.825	57.500	0.325	238.0	375	7.27	50.0
1.004	TANK 2	SWMH8	17.060	0.600	57.500	57.406	0.094	181.5	375	7.49	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
3.000	1.691	67.2	10.1	1.200	2.911	0.056	0.0	58	1.222
3.001	1.135	80.3	39.8	2.911	1.800	0.220	0.0	149	1.133
3.002	1.015	71.7	52.9	1.800	1.719	0.293	0.0	192	1.107
1.000	1.307	52.0	7.8	1.200	1.250	0.043	0.0	58	0.944
1.001	2.942	207.9	35.4	1.250	1.350	0.196	0.0	83	2.216
2.000	1.307	52.0	6.5	1.200	1.350	0.036	0.0	53	0.895
1.002	2.025	223.6	65.2	1.350	1.200	0.361	0.0	138	1.764
1.003	1.170	129.2	65.2	1.200	1.625	0.361	0.0	189	1.173
1.004	1.341	148.2	94.3	1.625	1.719	0.522	0.0	218	1.419

Flow+ v12.0 Copyright © 1988-2025 Causeway Technologies Ltd

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.005	SWMH8	SWMH9	16.947	0.600	57.331	57.287	0.044	385.0	450	7.76	50.0
1.006	SWMH9	SWMH10	80.616	0.600	57.287	56.950	0.337	239.2	450	8.79	50.0
1.007	SWMH10	BASIN	73.765	0.600	56.950	56.500	0.450	163.9	450	9.56	50.0
1.008	BASIN	OUTFALL	62.024	0.600	56.500	56.388	0.112	556.0	600	10.57	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.005	1.030	163.8	147.3	1.719	1.363	0.815	0.0	335	1.159
1.006	1.310	208.3	149.8	1.363	1.200	0.829	0.0	283	1.420
1.007	1.585	252.1	239.1	1.200	0.650	1.323	0.0	352	1.791
1.008	1.025	289.9	239.1	0.500	0.212	1.323	0.0	417	1.139

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
3.000	66.670	60.0	225	Circular	60.300	58.875	1.200	60.900	57.764	2.911
3.001	36.010	190.5	300	Circular	60.900	57.689	2.911	59.600	57.500	1.800
3.002	4.553	238.0	300	Circular	59.600	57.500	1.800	59.500	57.481	1.719
1.000	69.998	100.0	225	Circular	61.050	59.625	1.200	60.400	58.925	1.250
1.001	20.142	28.8	300	Circular	60.400	58.850	1.250	59.800	58.150	1.350
2.000	69.973	100.0	225	Circular	60.350	58.925	1.200	59.800	58.225	1.350
1.002	20.046	80.2	375	Circular	59.800	58.075	1.350	59.400	57.825	1.200
1.003	77.355	238.0	375	Circular	59.400	57.825	1.200	59.500	57.500	1.625
1.004	17.060	181.5	375	Circular	59.500	57.500	1.625	59.500	57.406	1.719
1.005	16.947	385.0	450	Circular	59.500	57.331	1.719	59.100	57.287	1.363
1.006	80.616	239.2	450	Circular	59.100	57.287	1.363	58.600	56.950	1.200
1.007	73.765	163.9	450	Circular	58.600	56.950	1.200	57.600	56.500	0.650
1.008	62.024	556.0	600	Circular	57.600	56.500	0.500	57.200	56.388	0.212

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
3.000	SWMH1	1200	Manhole	Adoptable	SWMH2	1200	Manhole	Adoptable
3.001	SWMH2	1200	Manhole	Adoptable	TANK 1	1200	Manhole	Adoptable
3.002	TANK 1	1200	Manhole	Adoptable	SWMH8	1200	Manhole	Adoptable
1.000	SWMH3	1200	Manhole	Adoptable	SWMH4	1200	Manhole	Adoptable
1.001	SWMH4	1200	Manhole	Adoptable	SWMH6	1200	Manhole	Adoptable
2.000	SWMH5	1200	Manhole	Adoptable	SWMH6	1200	Manhole	Adoptable
1.002	SWMH6	1200	Manhole	Adoptable	SWMH7	1200	Manhole	Adoptable
1.003	SWMH7	1200	Manhole	Adoptable	TANK 2	1200	Manhole	Adoptable
1.004	TANK 2	1200	Manhole	Adoptable	SWMH8	1200	Manhole	Adoptable
1.005	SWMH8	1200	Manhole	Adoptable	SWMH9	1200	Manhole	Adoptable
1.006	SWMH9	1200	Manhole	Adoptable	SWMH10	1200	Manhole	Adoptable
1.007	SWMH10	1200	Manhole	Adoptable	BASIN	1200	Manhole	Adoptable
1.008	BASIN	1200	Manhole	Adoptable	OUTFALL	1200	Manhole	Adoptable

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Starting Level (m)	
Rainfall Events	Singular	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	1.000	Drain Down Time (mins)	1440	Check Discharge Volume	x
Winter CV	1.000	Additional Storage (m³/ha)	0.0		

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Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
30	25	0	0
100	25	0	0

Node BASIN Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	56.500	Product Number	CTL-SHE-0108-4900-0800-4900
Design Depth (m)	0.800	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	4.9	Min Node Diameter (mm)	1200

Node TANK 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	57.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	8

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	103.5	0.0	0.800	103.5	0.0	0.801	0.0	0.0

Node TANK 2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	57.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	9

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	181.5	0.0	0.800	181.5	0.0	0.801	0.0	0.0

Node BASIN Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	56.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	745.0	0.0	1.100	1283.0	0.0

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Results for 30 year +25% CC Critical Storm Duration. Lowest mass balance: 99.41%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SWMH1	10	58.979	0.104	29.9	0.1172	0.0000	OK
15 minute summer	SWMH2	11	58.280	0.591	117.0	0.6683	0.0000	SURCHARGED
15 minute summer	TANK 1	14	57.969	0.469	165.3	49.0245	0.0000	SURCHARGED
15 minute summer	SWMH3	11	59.729	0.104	22.9	0.1175	0.0000	OK
15 minute summer	SWMH4	11	59.019	0.169	103.1	0.1911	0.0000	OK
15 minute summer	SWMH5	10	59.018	0.093	19.2	0.1049	0.0000	OK
15 minute summer	SWMH6	12	58.682	0.607	188.1	0.6862	0.0000	SURCHARGED
15 minute summer	SWMH7	12	58.496	0.671	176.4	0.7590	0.0000	SURCHARGED
15 minute summer	TANK 2	15	58.006	0.506	300.7	92.4250	0.0000	SURCHARGED
15 minute summer	SWMH8	13	57.938	0.607	213.2	0.6865	0.0000	SURCHARGED
15 minute summer	SWMH9	12	57.889	0.602	214.8	0.6807	0.0000	SURCHARGED
15 minute summer	SWMH10	9	57.869	0.919	268.2	1.0390	0.0000	SURCHARGED
720 minute winter	BASIN	720	57.295	0.795	54.2	747.9857	0.0000	SURCHARGED
15 minute summer	OUTFALL	1	56.388	0.000	4.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SWMH1	3.000	SWMH2	29.5	0.935	0.439	1.9205	
15 minute summer	SWMH2	3.001	TANK 1	108.4	1.685	1.350	2.5358	
15 minute summer	TANK 1	3.002	SWMH8	79.6	1.131	1.110	0.3206	
15 minute summer	SWMH3	1.000	SWMH4	22.2	1.258	0.428	1.2379	
15 minute summer	SWMH4	1.001	SWMH6	100.5	2.211	0.483	1.1208	
15 minute summer	SWMH5	2.000	SWMH6	18.8	0.953	0.361	1.9313	
15 minute summer	SWMH6	1.002	SWMH7	176.4	1.600	0.789	2.2110	
15 minute summer	SWMH7	1.003	TANK 2	172.0	1.797	1.331	8.5320	
15 minute summer	TANK 2	1.004	SWMH8	133.6	1.211	0.902	1.8817	
15 minute summer	SWMH8	1.005	SWMH9	214.0	1.351	1.306	2.6851	
15 minute summer	SWMH9	1.006	SWMH10	218.9	1.538	1.051	12.7731	
15 minute summer	SWMH10	1.007	BASIN	275.9	2.583	1.094	7.4953	
720 minute winter	BASIN	Hydro-Brake®	OUTFALL	4.9				544.6

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Results for 100 year +25% CC Critical Storm Duration. Lowest mass balance: 99.41%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	SWMH1	11	59.004	0.129	38.2	0.1459	0.0000	OK
15 minute summer	SWMH2	11	58.659	0.970	149.0	1.0966	0.0000	SURCHARGED
15 minute summer	TANK 1	14	58.148	0.648	226.5	67.8116	0.0000	SURCHARGED
15 minute summer	SWMH3	10	59.744	0.119	29.3	0.1345	0.0000	OK
15 minute summer	SWMH4	12	59.449	0.599	133.2	0.6777	0.0000	SURCHARGED
15 minute summer	SWMH5	12	59.369	0.444	24.5	0.5016	0.0000	SURCHARGED
15 minute summer	SWMH6	12	59.199	1.124	219.3	1.2711	0.0000	SURCHARGED
15 minute summer	SWMH7	12	58.919	1.094	206.4	1.2374	0.0000	SURCHARGED
15 minute summer	TANK 2	15	58.197	0.697	393.6	127.3340	0.0000	SURCHARGED
15 minute summer	SWMH8	14	58.109	0.778	234.9	0.8804	0.0000	SURCHARGED
15 minute summer	SWMH9	13	58.055	0.768	236.6	0.8691	0.0000	SURCHARGED
15 minute summer	SWMH10	9	57.990	1.040	336.6	1.1765	0.0000	SURCHARGED
960 minute winter	BASIN	945	57.502	1.002	54.6	993.3010	0.0000	FLOOD RISK
15 minute summer	OUTFALL	1	56.388	0.000	4.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SWMH1	3.000	SWMH2	37.3	1.073	0.554	2.1104	
15 minute summer	SWMH2	3.001	TANK 1	137.6	1.954	1.714	2.5358	
15 minute summer	TANK 1	3.002	SWMH8	86.6	1.230	1.208	0.3206	
15 minute summer	SWMH3	1.000	SWMH4	28.9	1.229	0.556	2.1250	
15 minute summer	SWMH4	1.001	SWMH6	115.0	2.144	0.553	1.4184	
15 minute summer	SWMH5	2.000	SWMH6	23.2	0.942	0.446	2.7829	
15 minute summer	SWMH6	1.002	SWMH7	206.4	1.872	0.923	2.2110	
15 minute summer	SWMH7	1.003	TANK 2	197.7	1.793	1.530	8.5320	
15 minute summer	TANK 2	1.004	SWMH8	149.4	1.355	1.008	1.8817	
15 minute summer	SWMH8	1.005	SWMH9	236.3	1.492	1.443	2.6851	
15 minute summer	SWMH9	1.006	SWMH10	238.8	1.556	1.146	12.7731	
15 minute summer	SWMH10	1.007	BASIN	305.8	2.765	1.213	8.7386	
960 minute winter	BASIN	Hydro-Brake®	OUTFALL	5.4				664.5

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Appendix F – National Fire Chiefs Council BESS Guidance

Grid Scale Battery Energy Storage System planning – Guidance for FRS

Grid scale Battery Energy Storage Systems (BESS) are a fundamental part of the UK's move toward a sustainable energy system. The installation of BESS systems both in the UK and around the globe is increasing at an exponential rate. A number of high profile incidents have taken place and learning from these incidents continues to emerge.

In the UK, approval for the majority of BESS installations takes place through the Local Authority planning process. Fire and Rescue Services (FRSs) may be engaged throughout the planning process, but this is not a statutory requirement. However, the National Fire Chiefs Council would encourage early engagement with the local FRS, continuing throughout the planning process.

The NFCC's expectation is that a comprehensive risk management process must be undertaken by operators to identify hazards and risks specific to the facility and develop, implement, maintain and review risk controls. From this process a robust Emergency Response Plan should be developed.

Given the rapidly developing nature of the technology, and ever evolving understanding of risks and mitigation measures, there is a need for guidance to support FRSs in providing consistent and evidence-based contributions to the planning process.

The guidance does not seek to provide a full specification or opinion on the entirety of a BESS system design. Instead, the aim is to limit the content to such matters that directly relate to facilitating a safe and effective response, by the fire and rescue service, to a fire or vapour cloud release involving a BESS installation. This includes factors such as facilities for the fire and rescue service, and design factors that contribute to reducing the escalation in the severity of an incident.

This guidance relates specifically to grid scale (typically 1 MW or larger) BESS in open air environments, using lithium-ion batteries.

The guidance is based upon a range of supporting materials including academic research, national and international standards, case studies, and industry guidance. The content of this document is the result of analysis of that supporting material with subsequent professional judgement applied. Every BESS installation will be different and fire and rescue services should not limit themselves to the content of this guidance. Particular reference has been made to the following:

- State of Victoria (County Fire Authority) (2022), *Design Guidelines and Model Requirements: Renewable Energy Facilities*
- FM Global (2017) *Property Loss Prevention Data Sheets: Electrical Energy Storage Systems Data Sheet 5-33*
- NFPA (2023) *Standard for the Installation of Stationary Energy Storage Systems*

Further advice and guidance can be obtained through the NFCC Alternative Fuels and Energy Systems lead officer.

This document contains guidance on:

1. Information requirements
2. System design, construction, testing and decommissioning
3. Detection and monitoring
4. Suppression systems
5. Site access
6. Water supplies
7. Emergency plans
8. Environmental impacts
9. Recovery

Principles

This guidance has been developed with the safety of the public and emergency responders in mind. It is based on trying to help reduce the risk as far as reasonably practicable, whilst recognising that ultimate responsibility for the safe design and running of these facilities rests with the operator.

The guidelines are a starting point and cannot cover every eventuality or type of design.

In developing these guidelines the hazards and risks from lithium-ion batteries, identified in National Operational Guidance, has been considered.

The following principles should be considered by Fire Services, when liaising with owners and operators, and form the basis of this guidance[1]:

1. Effective identification and management of hazards and risks specific to the siting, infrastructure, layout, and operations at the facility.
2. Impact on surrounding communities, buildings, and infrastructure.
3. Siting of renewable energy infrastructure so as to eliminate or reduce hazards to emergency responders.
4. Safe access for emergency responders in and around the facility, including to energy storage infrastructure and firefighting infrastructure.

[1] State of Victoria (County Fire Authority) (2022), *Design Guidelines and Model Requirements: Renewable Energy Facilities*, p.4

5. Provision of adequate water supply and firefighting infrastructure to allow safe and effective emergency response.
6. Vegetation sited and managed so as to avoid increased bushfire and grassfire risk.
7. Prevention of fire ignition on-site.
8. Prevention of fire spread between site infrastructure (solar panel banks, wind turbines, battery containers/enclosures).
9. Prevention of external fire impacting and igniting site infrastructure.
10. Provision of accurate and current information for emergency responders during emergencies.
11. Effective emergency planning and management, specific to the site, infrastructure and operations.
12. Owner to have a comprehensive Emergency Response Plan, showing full understanding of hazards, risks, and consequences.

Information Requirements

Grid scale BESS should form part of FRS planning in accordance with arrangements required under section 7(2)(d) of the Fire and Rescue Services Act (2004). Site Specific Risk Information (SSRI) should be made available to crews in the form of an effective Emergency Response Plan.

Details of any site access arrangements, such as key codes, should be provided to the FRS.

System design, construction, testing and decommissioning

Information is required as early as possible from the applicant /developer/designer/manufacturer etc., to allow an initial appraisal of the BESS to be made. This information should be provided to the FRS (via the Local Authority Planners in the first instance), with appropriate evidence provided to support any claims made on performance, and with appropriate standards cited for installation.

Such information should also be made available to FRSs for inclusion in Site Specific Risk Information (SSRI) records.

System design and construction

Information required:

1. The battery chemistries being proposed (e.g. Lithium-ion Phosphate (LFP), Lithium Nickel Manganese Cobalt Oxide (NMC)). Because:
    a. Battery chemistries will directly affect the heat released when a cell goes into thermal runaway[2]
    b. Battery chemistries will influence vapour cloud formation.

[2] https://www.nasa.gov/sites/default/files/atoms/files/nabw20_fire_gas_char_studies_liion_cells_batt_djuarez-robles.pdf

    c. An understanding of the battery chemistry is useful when requesting scientific advice during an incident.
2. The battery form factor (e.g. cylindrical, pouch, prismatic)
3. Type of BESS e.g. container or cabinet
4. Number of BESS containers/cabinets
5. Size/capacity of each BESS unit (typically in MWh)
6. How the BESS units will be laid out relative to one another.
7. A diagram / plan of the site.
8. Evidence that site geography has been taken into account (e.g. prevailing wind conditions).
9. Access to, and within, the site for FRS assets
10. Details of any fire-resisting design features
11. Details of any:
    a. Fire suppression systems
    b. On site water supplies (e.g. hydrants, EWS etc)
    c. Smoke or fire detection systems (including how these are communicated)
    d. Gas and/or specific electrolyte vapour detection systems
    e. Temperature management systems
    f. Ventilation systems
    g. Exhaust systems
    h. Deflagration venting systems
12. Identification of any surrounding communities, sites, and infrastructure that may be impacted as a result of an incident.

Testing

Details of any evidence based testing of the system design should be requested, for example, results of UL 9540A testing.

Design

Design features should be made clear. These may include:

- Rack layout and setup
- Thermal barriers and insulation
- Container layout and access arrangements

Detection and monitoring

An effective and appropriate method of early detection of a fault within the batteries should be in place, with immediate disconnection of the affected battery/batteries. This may be achieved automatically through the provision of an effective Battery Management System (BMS) and/or a specific electrolyte vapour detection system.

Should thermal runaway conditions be detected then there should be the facility in place for the early alerting of emergency services.

Detection systems should also be in place for alerting to other fires that do not involve thermal runaway (for example, fires involving electrical wiring).

Continuous combustible gas monitoring within units should be provided. Gas detectors should alarm at the presence of flammable gas (yes/no), shut down the ESS, and cause the switchover to full exhaust of the ventilation system[3]. Sensor location should be appropriate for the type of gas detected e.g. hydrogen, carbon monoxide, volatile organic compounds.

External audible and visual warning devices (such as cabinet level strobing lights), as well as addressable identification at control and indicating equipment, should be to linked to:

1. Battery Management System (when a thermal runaway event is identified)
2. Detection and suppression system activation

This will enable first responders to understand what the warning is in relation to. This will aid in their decision-making.

Suppression systems

Suitable fixed suppression systems should be installed in units in order to help prevent or limit propagation between modules.

Where it is suggested that suppression systems are not required in the design, this choice should be supported by an evidence based justification and Emergency Response Plan that is designed with this approach in mind (for example, risk assessed controlled burn strategies, and external sprinkler systems).

Whilst gaseous suppression systems have been proposed previously, current research indicates the installation of water based suppression systems for fires involving cell modules is more effective.

The installation of gaseous suppression systems for electrical fires that do not involve cell modules may be appropriate but should be built into a wider suppression strategy.

FM Global cite the following reasons for not recommending gaseous protection systems[4]:

1. **Efficacy relative to the hazard**. As of 2019, there is no evidence that gaseous protection is effective in extinguishing or controlling a fire involving energy storage systems. Gaseous protection systems may inert or interrupt the chemical reaction of the fire, but only for the duration of the hold time. The hold time is generally ten minutes, not long enough to fully extinguish an ESS fire or to prevent thermal runaway from propagating to adjacent modules or racks.

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[3] FM Global (2017) *Property Loss Prevention Data Sheets: Electrical Energy Storage Systems*, para. 2.5.5.2
[4] FM Global (2017) *Property Loss Prevention Data Sheets: Electrical Energy Storage Systems*, para. 3.3

2. **Cooling**. FM Global research has shown that cooling the surroundings is a critical factor to protecting the structure or surrounding occupancy because there is currently no way to extinguish an ESS fire with sprinklers. Gaseous protection systems do not provide cooling of the ESS or the surrounding occupancy.
3. **Limited Discharge**. FM Global research has shown that ESS fires can reignite hours after the initial event is believed to be extinguished. As gaseous protection systems can only be discharged once, the subsequent reignition would occur in an unprotected occupancy

The choice of a suppression system should be informed by liaison with a competent system designer who can relate the system choice to the risk identified and the duration of its required activation. Such a choice must be evidence based.[5]

Any calculations for sufficient water supply for an appropriate suppression system will need to be completed by a competent person considering the appropriate risk and duration of any fire.

Water run-off and potential impact on the environment, along with mitigation measures, should be considered and detailed in the Emergency Response Plan.

Lack of sufficient water supplies at a particular site location should not be considered as the basis for a suppression system choice. Such an approach could result in potentially ineffective and/or dangerous system designs.

Deflagration Prevention and Venting

BESS containers should be fitted with deflagration venting and explosion protection appropriate to the hazard. Designs should be developed by competent persons, with design suitability able to be evidenced.[6] Exhaust systems designed to prevent deflagration should keep the environment below 25% of Lower Explosive Limit (LEL).

Flames and materials discharged as a result of any venting should be directed outside to a safe location and should not contribute to any further fire propagation beyond the unit involved or present further risk to persons. The likely path of any vented gasses or materials should be identified in Emergency Response Plans to reduce risk to responders.

Explosion/deflagration strategies should be built into the emergency plan such that responders are aware of their presence and the impact of their actions on these strategies.[7]

Where emergency ventilation is used to mitigate an explosion hazard, the disconnect for the ventilation system should be clearly marked to notify personnel or first responders to not disconnect the power supply to the ventilation system during an evolving incident.[8]

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[5] NFPA (2023) *Standard for the Installation of Stationary Energy Storage Systems*, para C.3
[6] BS EN 16009:2011 *Flameless Explosion Venting Devices*; BS EN 14373:2021 *Explosion Suppression Systems*; BS EN 14797:2007 *Explosion Venting Devices*.
[7] UL FRSI (2020) *Four Firefighters Injured in Lithium-ion Battery Energy Storage System Explosion – Arizona*, pp. 47-49
[8] NFPA (2023) *Standard for the Installation of Stationary Energy Storage Systems*, para G.1.4.3.3

Access

Site access

Suitable facilities for safely accessing and egressing the site should be provided. Designs should be developed in close liaison with the local FRS as specific requirements may apply due to variations in vehicles and equipment.

This should include:

- At least 2 separate access points to the site to account for opposite wind conditions/direction.
- Roads/hard standing capable of accommodating fire service vehicles in all weather conditions. As such there should be no extremes of grade.
- A perimeter road or roads with passing places suitable for fire service vehicles.
- Road networks on sites must enable unobstructed access to all areas of the facility.
- Turning circles, passing places etc size to be advised by FRS depending on fleet.

Access between BESS units and unit spacing

In the event of a fire involving a BESS unit, one of the primary tactics employed will be to prevent further unit to unit fire spread. Suitable access for firefighters to operate unimpeded between units will therefore be required. This should allow for the laying and movement of hose lines and, as such, access should be free of restrictions and obstacles. The presence of High Voltage DC Electrical Systems is a risk and their location should be identified. Exclusion zones should be identified.

A standard minimum spacing between units of 6 metres is suggested[9] unless suitable design features can be introduced to reduce that spacing. If reducing distances a clear, evidence based, case for the reduction should be shown.

Any reduction in this separation distance should be design based by a competent fire engineer. There should be consideration for the fire separation internally and the total realistic load of fire. Proposed distances should be based on radiant heat flux (output) as an ignition source.

The NFCC does not support the stacking of containers/units on top of one another on the basis of the level of risk in relation to fire loading, potential fire spread, and restrictions on access.

Distance from BESS units to occupied buildings & site boundaries

Individual site designs will mean that distances between BESS units and occupied buildings/site boundaries will vary. Proposed distances should take into account risk and mitigation factors. However, an initial minimum distance of 25 metres is proposed prior to any mitigation such as blast walls. Reduction of distances may be possible in areas of lower risk (e.g. rural settings). Where possible buildings should be located upwind.

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[9] FM Global (2017) *Property Loss Prevention Data Sheets: Electrical Energy Storage Systems*, para. 2.3.2.2

Site Conditions

Sites should be maintained in order that, in the event of fire, the risk of propagation between units is reduced. This will include ensuring that combustibles are not stored adjacent to units and access is clear and maintained. Areas within 10 metres of BESS units should be cleared of combustible vegetation and any other vegetation on site should be kept in a condition such that they do not increase the risk of fire on site. Areas with wildfire risk or vegetation that would result in significant size fires should be factored into this assessment and additional cleared distances maintained as required.

Water Supplies

Water supplies will depend on the size of the installation. In the majority of cases, initial firefighting intervention will focus on defensive firefighting measures to prevent fire spread to adjacent containers. As a result, proposals for water supplies on site should be developed following liaison with the local fire and rescue service taking into account the likely flow rates required to achieve tactical priorities. This should also take account of the ability of/anticipated time for the fire and rescue service to bring larger volumes of water to site (for example through the provision of High Volume Pumps).

IP ratings of units should be known so that risks associated with boundary cooling can be understood.

As a minimum, it is recommended that hydrant supplies for boundary cooling purposes should be located close to BESS containers (but considering safe access in the event of a fire) and should be capable of delivering no less than 1,900 litres per minute for at least 2 hours. Fire and rescue services may wish to increase this requirement dependant on location and their ability to bring supplementary supplies to site in a timely fashion.

Water supply for any automatic suppression system will be covered by the relevant standard/design depending on which system chosen as appropriate for the risk. For manual water, amounts should come from performance based requirement rather than a reference to a code, unless it can be proven that the code specifically covers BESS. Regarding water storage tanks, volumes will again need to be informed on a performance-based need. Isolation points should be identified.

Any static water storage tanks designed to be used for firefighting must be located at least 10 metres away from any BESS container/cabinet. They must be clearly marked with appropriate signage. They must be easily accessible to FRS vehicles and their siting should be considered as part of a risk assessed approach that considers potential fire development/impacts. Outlets and connections should be agreed with the local FRS. Any outlets and hard suction points should be protected from mechanical damage (e.g. through use of bollards).

Consideration should be given, within the site design, to the management of water run-off (e.g. drainage systems, interceptors, bunded lagoons etc).

Signage

Signage should be installed in a suitable and visible location on the outside of BESS units identifying the presence of a BESS system. Signage should also include details of:

- Relevant hazards posed
- The type of technology associated with the BESS
- Any suppression system fitted
- 24/7 Emergency Contact Information

Signs on the exterior of a building or enclosure should be sized such that at least one sign is legible at night at a distance of 30 metres or from the site boundary, whichever is closer[10].

Adherence to the Dangerous Substances (Notification and Marking of Sites) Regulations 1990 (NAMOS) should be considered where the total quantity of dangerous substances exceeded 25 tonnes.

Emergency Plans

Site operators should develop emergency plans and share these with the Fire and Rescue Service. These include:

A Risk Management Plan should be developed by the operator, which provides advice in relation to potential emergency response implications including:

- The hazards and risks at and to the facility and their proposed management.
- Any safety issues for firefighters responding to emergencies at the facility.
- Safe access to and within the facility for emergency vehicles and responders, including to key site infrastructure and fire protection systems.
- The adequacy of proposed fire detection and suppression systems (eg., water supply) on-site.
- Natural and built infrastructure and on-site processes that may impact or delay effective emergency response.

An Emergency Response Plan should be developed to facilitate effective and safe emergency response and should include:

- How the fire service will be alerted
- A facility description, including infrastructure details, operations, number of personnel, and operating hours.
- A site plan depicting key infrastructure: site access points and internal roads; firefighting facilities (water tanks, pumps, booster systems, fire hydrants, fire hose reels etc); drainage; and neighbouring properties.

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[10] NFPA (2023) *Standard for the Installation of Stationary Energy Storage Systems*, para G.1.4.2.1.1

- Details of emergency resources, including fire detection and suppression systems and equipment; gas detection; emergency eye-wash and shower facilities; spill containment systems and equipment; emergency warning systems; communication systems; personal protective equipment; first aid.
- Up-to-date contact details for facility personnel, and any relevant off-site personnel that could provide technical support during an emergency.
- A list of dangerous goods stored on site.
- Site evacuation procedures.
- Emergency procedures for all credible hazards and risks, including building, infrastructure and vehicle fire, grassfire and bushfire

Environmental impacts

Suitable environmental protection measures should be provided. This should include systems for containing and managing water runoff. System capability/capacity should be based on anticipated water application rates, including the impact of water based fixed suppression systems.

Sites located in flood zones should have details of flood protection or mitigation measures.

Recovery

The operator should develop a post-incident recovery plan that addresses the potential for reignition of ESS and de-energizing the system, as well as removal and disposal of damaged equipment.[11]

[11] FM Global (2017) *Property Loss Prevention Data Sheets: Electrical Energy Storage Systems*, para. 2.8.2.3

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