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PEGASUS GROUP

# Old Wood Energy Park

## Land west of Wysall, Nottinghamshire

## Flood Risk Assessment and Drainage Strategy

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# 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. This assessment considers the risk of flooding from all sources, including tidal, fluvial, surface water, historic, groundwater, sewer and artificial sources.

National and Local Policies

1.3. The National Planning Policy Framework (NPPF) states that a site-specific Flood Risk Assessment (FRA) will be required for proposals:

a) that are greater than 1 hectare (ha) in area within Flood Zone 1;

b) that are located in Flood Zone 2 or 3 (including minor development and change of use);

c) in an area within Flood Zone 1 which has critical drainage problems;

d) in an area within Flood Zone 1 identified in a Strategic Flood Risk Assessment as being at increased flood risk in the future;

e) in an area in Flood Zone 1 that may be subject to other sources of flooding, where its development would introduce a more vulnerable use.

1.4. The site is approximately 101ha in area. The vast majority of the site is located in Flood Zone 1, at low risk of flooding from rivers and the sea. There are small areas of the site located within Flood Zone 2 and 3. A full FRA is therefore required for the proposals.

1.5. As of April 2015, the legislation for dealing with FRAs changed, with additional emphasis placed on the use of Sustainable Drainage Systems (SuDS) within drainage schemes for new developments.

1.6. 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.

1.7. 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 and should be in line with the requirements as set out within the National Planning Policy Framework Technical Guidance (NPPFTG). 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.

1.8. 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).

1.9. The Rushcliffe Borough Council "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 proposed development.

# 2. Existing Site & Hydrology

Site Location & Existing Conditions

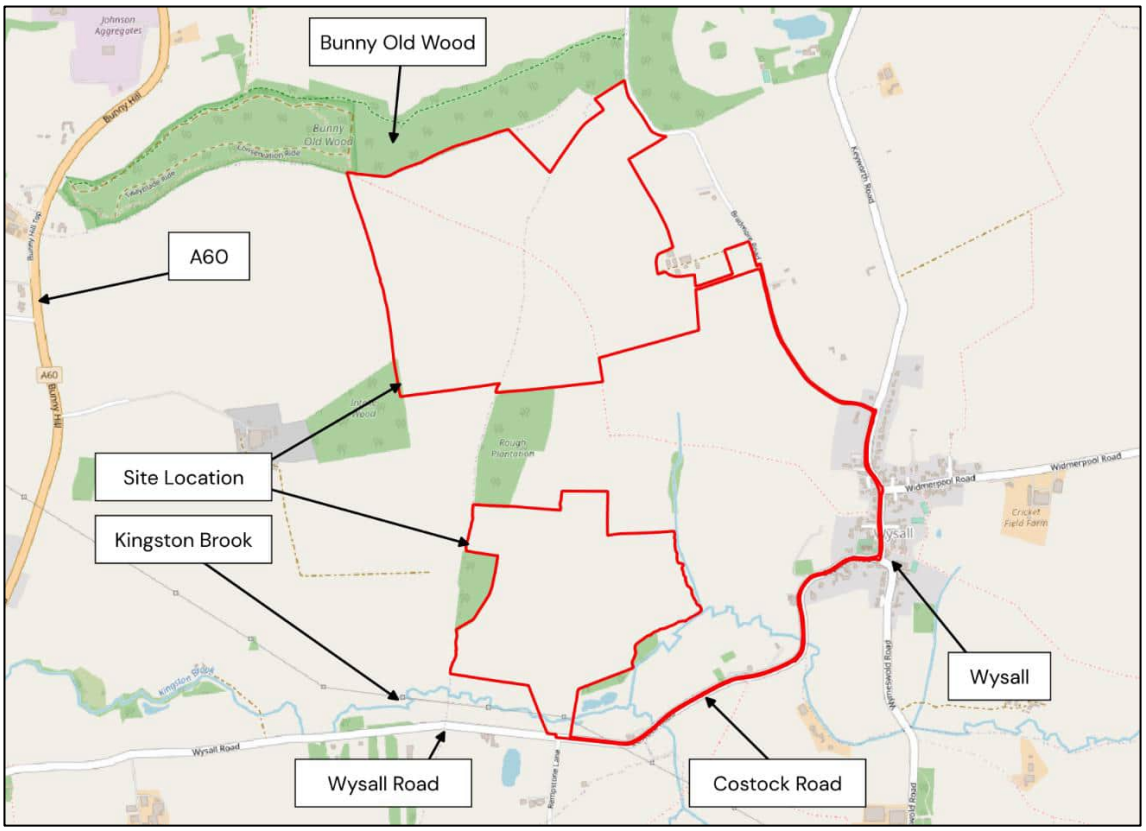
2.1. The Development is located over two land parcels to the west of Wysall, the northern parcel which will host solar arrays and associated solar farm infrastructure and the southern parcel which will also host solar farm infrastructure as well as the BESS and substation, towards the south.

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 then the A60 to the west. Kingston Brook runs through the southern part of the southern land 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 11km to the south of the site.

2.6. There are, however, several Ordinary Watercourses flowing through the site. Kingston Brook flows through the southern part of the southern parcel and is considered a primary Ordinary Watercourse.

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.

2.9. As the site is currently used for agricultural farming, it is unlikely that there is an existing underground drainage network located within the site boundary, however there may be private land drains.

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. BGS also record superficial deposits at the site comprised of 'Alluvium - Clay, silt, sand and gravel'.

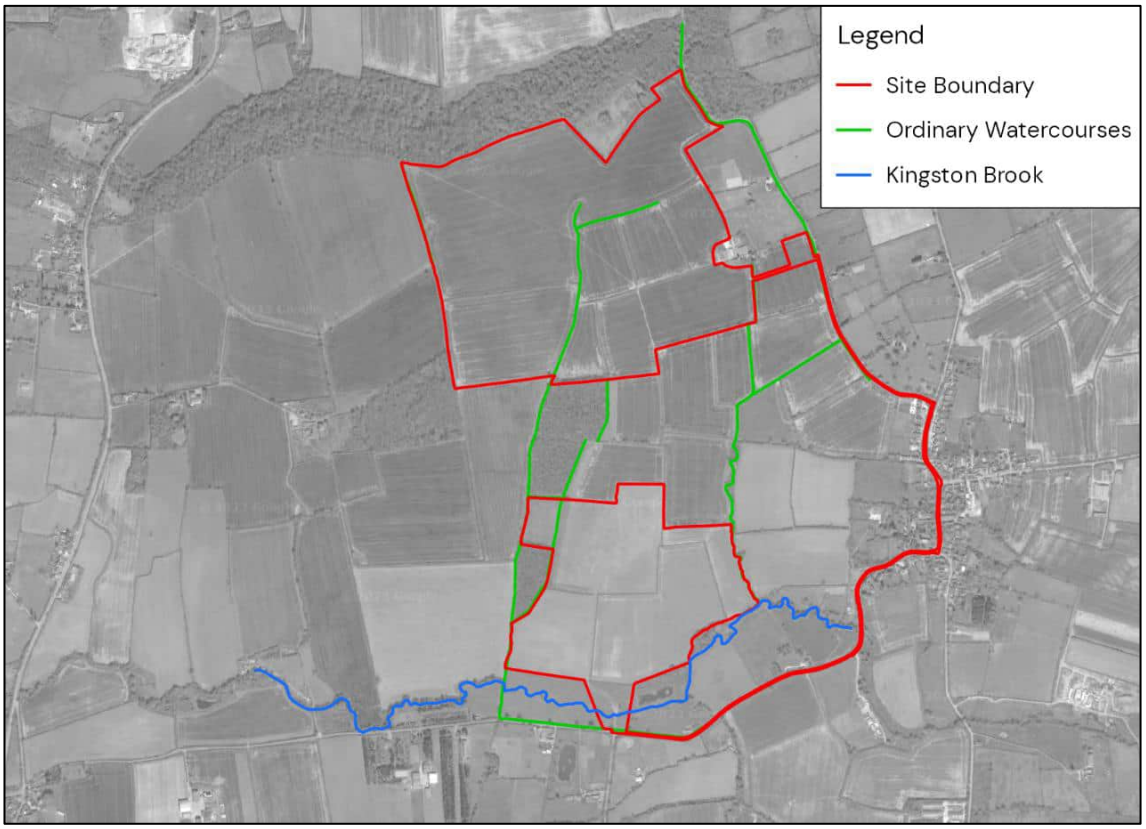
2.11. SoilScapes mapping shows both 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' with 'impeded drainage' and 'Slightly acid loamy and clayey soils with impeded drainage' present at the site.

2.12. It is also noted that there are gypsum works in area and mineral rights beneath the site for gypsum.

2.13. The topography of the northern parcel generally falls to the southeast from roughly 90mAOD to 75mAOD.

2.14. The topography of the southern parcel falls to the south from roughly 68mAOD to 58mAOD. The topographic survey of the site is included in **Appendix A**.

**Figure 2.2 –Watercourses**



# 3. Proposed Development

3.1. The site is proposed for “renewable energy development" comprising a solar farm and BESS along with associated infrastructure including:

- Solar panels mounted on frames raised off the ground on poles
- Perimeter deer fencing of wooden post and wire mesh construction around the solar arrays
- Palisade fencing around the BESS and substation compounds
- Access tracks of impermeable type 2 aggregate construction
- Central inverters
- Battery storage containers
- Battery storage inverters
- Auxiliary transformer
- CCTV
- Substation infrastructure
- POC infrastructure
- POC cable connection
- Solar connection infrastructure including a buried cable linking the two land parcels that would be laid in the public highway.

3.2. The site layout is in included in **Appendix B**.

# 4. Development Vulnerability & Flood Zone Classification

National Planning Policy Framework (NPPF)

4.1. Local Planning Authorities, (LPAs) have a statutory obligation to consult the Environment Agency (EA) on all applications in the flood zones. The EA will consider the effects of flood risk in accordance with the NPPF.

4.2. 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.

4.3. Table 1 of NPPF 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 year for fluvial events and 1 in 1000 – 1 in 200 year 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)

4.4. The NPPF sets out a matrix indicating the types of development that are acceptable in different Flood Zones (see Table 4.1). The Development is a solar farm and BESS which is classified as 'Essential Infrastructure'. The vast majority of the Site is located in Flood Zone 1 with only small areas of Flood Zone 2 (see further details below). Essential Infrastructure is appropriate in all flood zones (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

4.5. The Sequential Test is required for all developments proposed in Flood Zone 2 or 3 unless the proposals are for minor development or change of use.

4.6. As mentioned above, the Development is generally entirely located in Flood Zone 1. There is a very small encroachment of a proposed battery storage unit just on the edge of Flood Zone 2. Approximately 8m$^2$ (0.0008ha) of development across the approximately 101ha site is proposed in Flood Zone 2 (see Figure 6.1). As the battery is right on the edge of the defined Flood Zone 2 outline, it is also possible that a higher resolution hydraulic model than that used for the Flood Map for Planning here would not define this battery to be at risk. It is therefore not considered necessary to conduct a Sequential Test for the proposed development.

Exception Test

4.7. There is no development proposed in Flood Zone 3. The Exception Test is therefore not required for the proposals (see Table 4.1 above).

# 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.

5.3. Small areas of Flood Zone 2 and 3 are defined at the southern end of the southern parcel. Flood Zones on site are however, associated with fluvial flooding (see below) and not reflective of tidal flooding at the site.

5.4. The site is also located inland, with the nearest coastline sited approximately 80km east of the site. Overall, tidal flood risk at the site is considered to be **Very Low.**

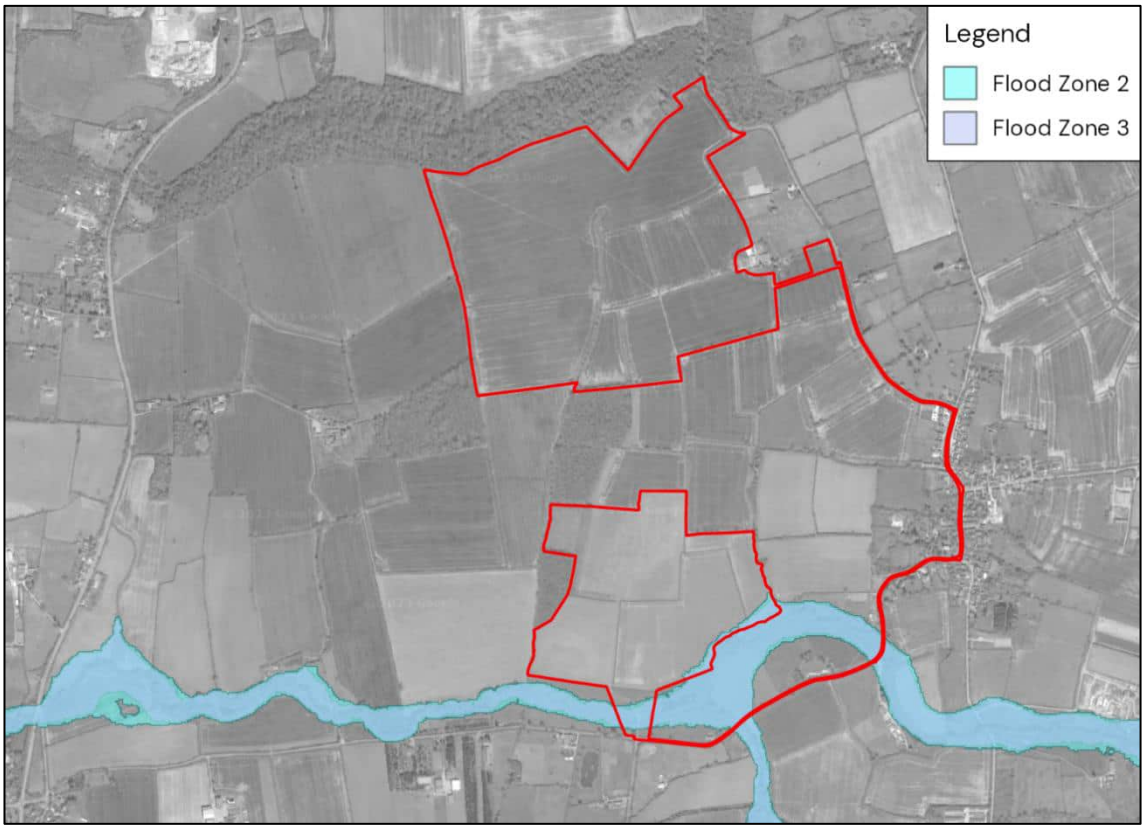
Fluvial Flooding

5.5. 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.

5.6. There are small areas at the southern end of the site defined as Flood Zone 2 and 3, at Medium to High fluvial flood risk, respectively. Risk here is associated with Kingston Brook. In general, Flood Zone 2 and 3 are not developed, with fluvial flood risk mitigation measures discussed further in Section 6.

5.7. 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

5.8. 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 are at Very Low risk of surface water flooding (see Figure 5.2). The dataset also highlights areas of High to Low risk, impacted by a 1 in 30 and 1 in 1,000 year rainfall event, respectively, throughout the site.

5.9. The RoFSW dataset also predicts the depths of surface water flooding across the site during a 1 in 1000 year rainfall event. Within the site, 1 in 1,000 year surface water flood depths generally remain shallow and are typically predicted to remain below 300mm (see Figure 5.3). Maximum surface water flood depths of 900-1200mm are predicted on site, located at the southern end of the southern parcel (see Figure 5.3).

5.10. The lowest edge of all proposed solar panels will be raised above the predicted 1 in 1,000 year surface water flood depths. Solar panels are therefore not predicted to be impacted by surface water flooding, nor negatively impact flood risk elsewhere. Purposefully through design, there are no inverters within the solar area proposed on site within the 1 in 1,000 year surface water flood extent. The proposed BESS area has also been located outside of the 1 in 1,000 year surface water flood extent. The proposed solar connection infrastructure in the northern parcel just encroaches the 1 in 1,000 year surface water flood extent, with depths of less than 150mm here predicted during a 1 in 1,000 year rainfall event.

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

**Figure 5.2 – RoFSW Extents**

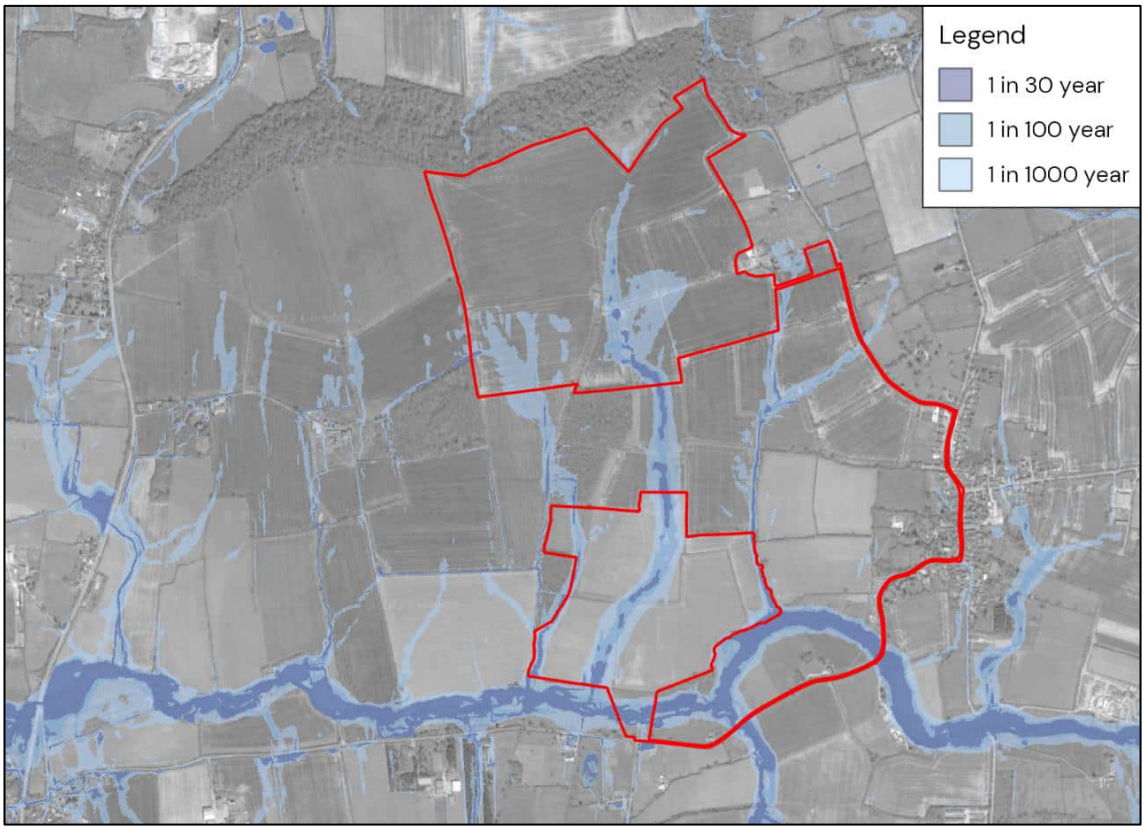
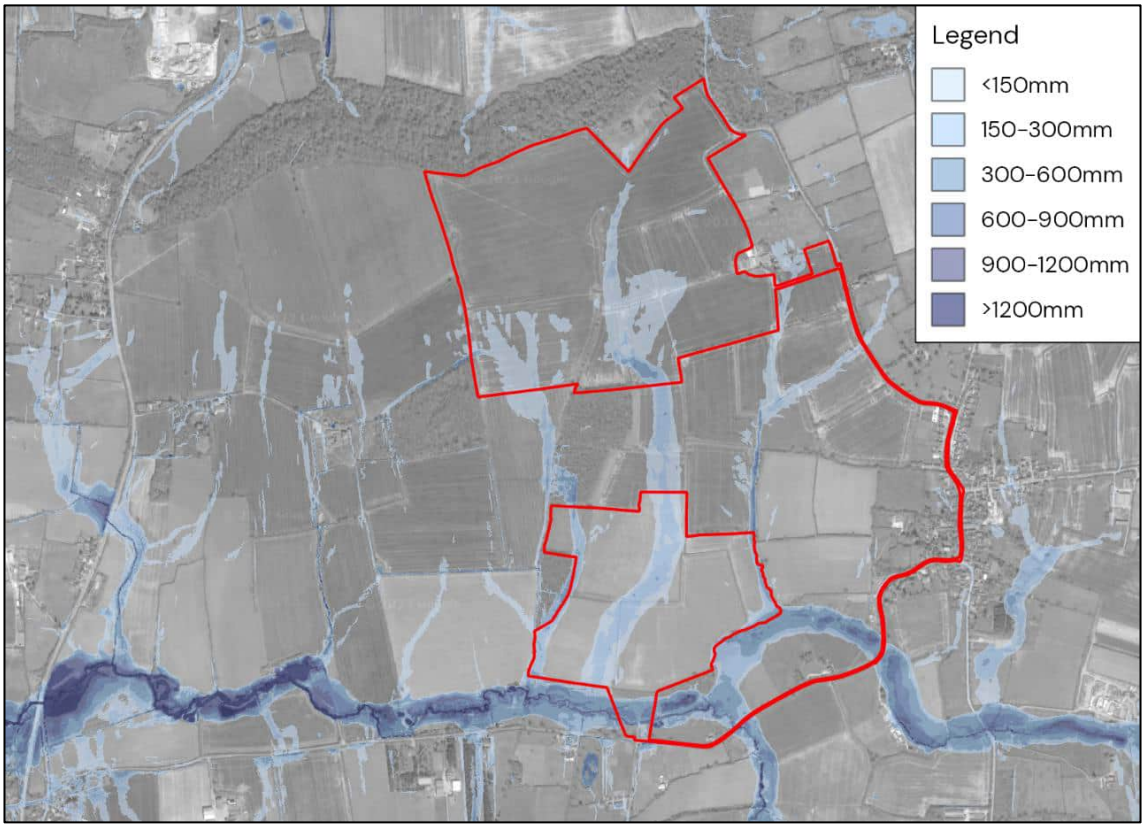



**Figure 5.3 – RoFSW 1 in 1000 year Depths**



Historic Flooding

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

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

5.14. Overall, the historic flood risk to the site is considered to be **Very Low**.

Groundwater Flooding

5.15. 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.

5.16. BGS record superficial deposits at the site comprising of 'alluvium - Clay, silt, 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.

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

5.18. 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 from the site to not be considered.

5.19. Overall, the risk of groundwater flooding at the site is considered to be **Low**.

Flooding from Sewers

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

5.21. 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.

5.22. The risk of flooding from sewers to the site is therefore considered to be **Low.**

Flooding from Artificial Sources

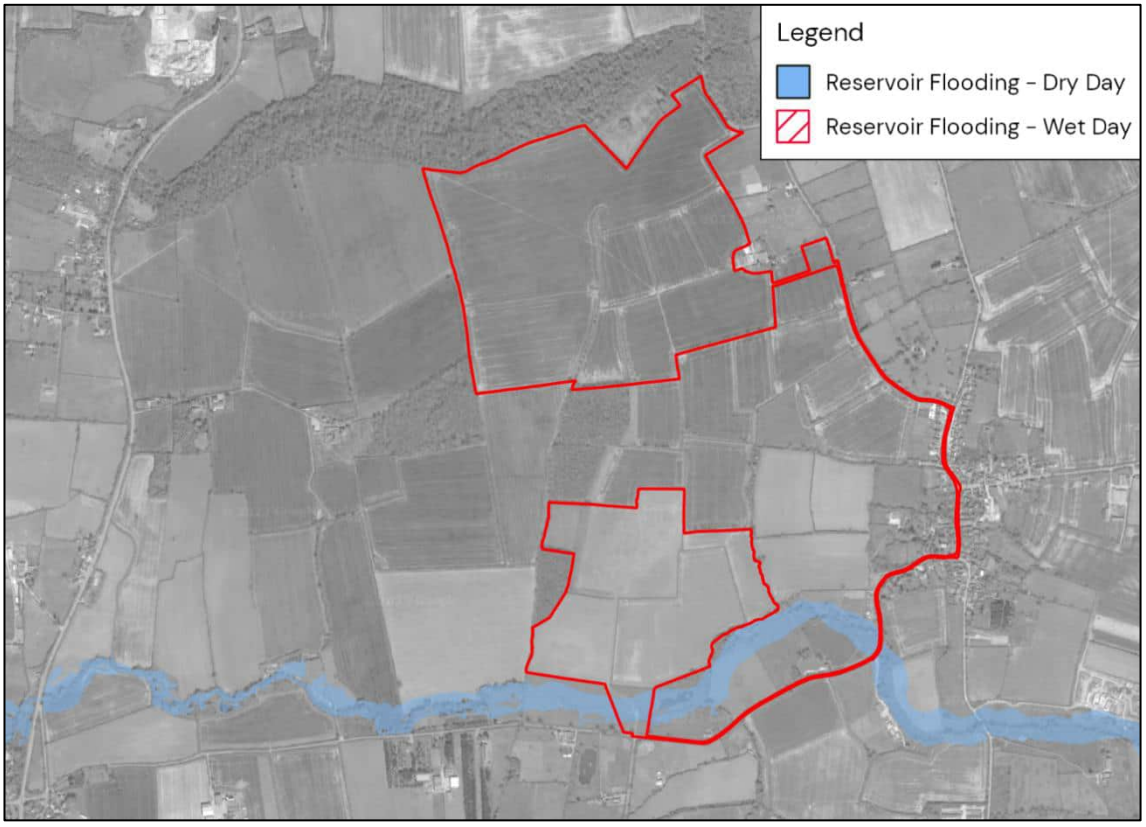
5.23. The EA's Reservoir Flood Extents data shows that a small portion the site at the southern end of the southern parcel is at risk of reservoir flooding should a catastrophic breach occur during a 'Dry Day' when watercourses are flowing under normal conditions (see Figure 5.4). There is no infrastructure proposed in this risk area, with just an access track and buried cable located here.

5.24. The site is shown to have no risk during a 'Wet Day' when local rivers have already overflowed their banks. Risk is contained at the southern end of the site.

5.25. 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.

5.26. 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**




<u>Post Development Flood Risk Summary</u>

5.27. 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 | • The areas of site predicted to be at risk by the Flood Map for Planning are not reflective of tidal flood risk.<br><br>• 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. |
| Surface Water | Low | • Large areas of the site are at Very Low risk, not predicted to be impacted by 1 in 1000 year rainfall event.<br><br>• Generally, no vulnerable infrastructure is proposed in areas predicted to be at risk of surface water flooding.<br><br>• The lowest edge of all solar panels will be raised above the predicted 1 in 1000 year surface water flood depths.<br><br>•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.<br><br>• Topography on site is not conducive to groundwater flooding.<br><br>• 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. Only an access track and buried cable is proposed here.<br><br>• The likelihood of reservoir failure is considered minimal.<br><br>• There are no artificial bodies of water surrounding the site. |

Access & Egress

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

5.29. The access to the southern parcel is located in Flood Zone 2, at risk of fluvial flooding, and also highlighted as an at-risk area by the RoFSW dataset (see above assessment of flood risk).

5.30. 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.

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

5.32. 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. The provision of safe refuge at the southern parcel could also be considered 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 should be provided during detailed design.

5.33. It is also noted that during an extreme flood event when access/egress at the southern parcel may be limited, that the risk of fire will be reduced and as such, it is considered unlikely that emergency services will need access during an extreme flood event.

5.34. 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.

# 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 and does not increase flood risk elsewhere.

**Solar Farm**

Solar Panels

6.3. The majority of the proposed solar farm extent site 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. There will be some exceptions to these levels, as discussed below.

6.4. The RoFSW dataset generally predicts surface water flood depths on site to remain shallow during a 1 in 1,000 year rainfall event. The flood depths generally range between 150-300mm. Maximum surface water flood depths of 900-1200mm are predicted on site. These greater flood depths are located at the southern end of the southern parcel on land surrounding Kingston Brook.

6.5. Furthermore, where solar panels are located, 1 in 1,000 year surface water flood depths are not predicted to exceed 600 to 900mm. All proposed solar panels will be raised so that the lowest edge is above the predicted surface water flood depths, allowing surface water to flow freely beneath.

6.6. Where greatest surface water flood depths are predicted in solar panel locations, the lowest edge of solar panels will therefore be raised 1.2m above the ground, accounting to 0.9m of predicted flooding and 0.3m of freeboard. It is noted that where greater surface water flood depths are predicted, land is generally lower. As a result, panel height here will be similar to those areas with standard raising of 0.8m above the ground (see above).

6.7. No solar panels are proposed within the areas indicated to be in Flood Zone 2 or 3.

6.8. 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.

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

Central Inverters, Solar Connection Infrastructure, Transformers and Auxiliary Transformers

6.10. In addition to solar panels, central inverters, solar connection infrastructure, transformers and auxiliary transformers are proposed within the proposed solar farm site. This proposed infrastructure is very small in area.

6.11. Typical dimensions of the central inverters are approximately 6m x 2.5m. There are 25 central inverters distributed across the two land parcels.

6.12. There are two 15m by 5m buildings associated with the solar connection infrastructure, totalling an area of 150m$^2$.

6.13. There are two transformers 4.5m x 5m in size and two auxiliary transformers 3m x 3m in size.

6.14. In addition to being small, these units are well distributed across the site (see site layout in **Appendix B**).

6.15. It is proposed to site the central inverters 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.

6.16. 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.

6.17. There are generally no proposed central inverters, solar connection infrastructure and auxiliary transformers within Flood Zone 2 or 3 or within an area of surface water flood risk identified by the RoFSW. The solar connection infrastructure is just located in an area predicted to be at risk of surface water flooding. Flood depth here are not predicted to exceed 150mm in depth during a 1,000 year rainfall event. It is noted that during detailed design, it is expected that the site layout is amended to move the solar connection infrastructure outside of the area predicted to be at risk of surface water flooding.

6.18. The proposed solar farm infrastructure will therefore not be at significant risk of flooding, nor will it significantly impact the existing surface water drainage patterns as they are 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. The more significant solar connection infrastructure buildings are also included in the proposed surface water drainage strategy.

6.19. No further mitigation measures are considered necessary.

Access Tracks

6.20. 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 low during the operational phase of the development. This will ensure significant compaction is avoided and infiltration is not resticted.

6.21. Where access tracks are proposed to cross Ordinary Watercourses on site, they will be designed to be clear-span 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.

6.22. As discussed above in Section 5, access to the southern parcel in through Flood Zone 2 and 3 and also an area predicted to be at risk of surface water flooding. 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.

6.23. No further mitigation measures are considered necessary.

Proposed Land Use Change

6.24. 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

6.25. 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.

6.26. 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.

6.27. Additionally, larger meadow type grasses and wildflower vegetation provide high levels of natural attenuation which wills 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 loner-term benefits regarding surface water runoff rates.

6.28. 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

6.29. To ensure maintenance access is not impacted by the proposed development a 3m easement from the top of bank from all Ordinary Watercourses has been kept clear of all development. These easements have been based on LiDAR data and an estimated width of 5m for most Ordinary Watercourses and 6m for the Kingston Brook.

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

Surface Water Drainage Strategy

6.31. As discussed above, the solar farm infrastructure will generally not significantly impact surface water runoff rates and patterns at the site, with a slight exception with regard to the solar connection infrastructure buildings.

6.32. 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.

6.33. 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**

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

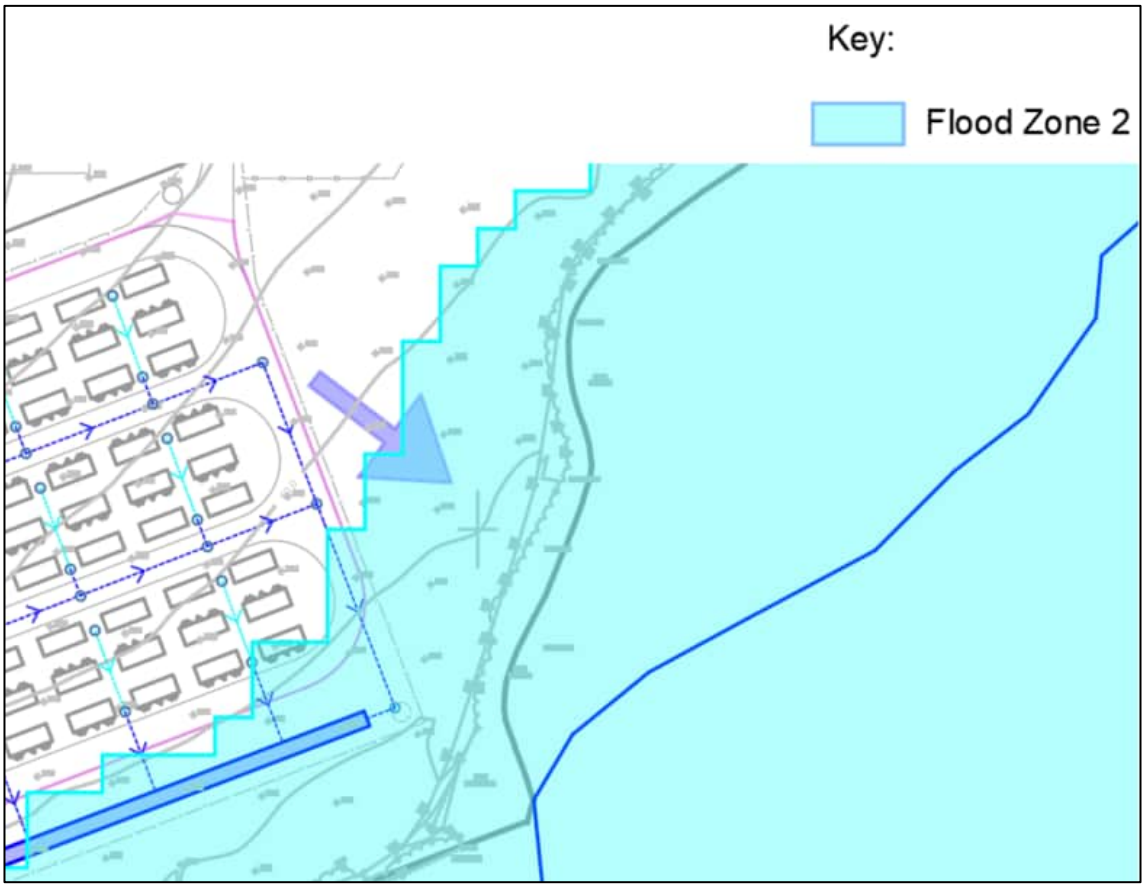
Battery Storage Containers and Inverters

6.35. As discussed in Section 5, there is a band of Flood Zone 2 and 3 at the southern end of the site. In general, the BESS is located in Flood Zone 1 and Flood Zones 2 and 3 are kept undeveloped. There is a very small encroachment of a proposed battery storage unit just on the edge of Flood Zone 2. Approximately 8m2 (0.0008ha) of development across the approximately 101ha site is proposed in Flood Zone 2 (see Figure 6.1 below). As the battery is right on the edge of the defined Flood Zone 2 outline, it is also possible that a higher resolution hydraulic model than that used for the Flood Map for Planning here would not define this battery to be at risk.

6.36. The RoFSW dataset does not predict the BESS area to be at risk of surface water flooding.

6.37. 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).

**Figure 6.1 – Flood Zone 2 and BESS**




Access Tracks

6.38. The proposed BESS access tracks will be constructed with permeable materials, expected to be type 1 or type 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.

6.39. 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.

6.40. No further mitigation measures are considered necessary.

Substation

6.41. 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

6.42. 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 has 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 comprising of 'alluvium - 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 infrastructure into the existing Kingston Brook via an attenuation basin.

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 development. |
| 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. |
| 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 store fire suppression water supply and to contain contaminated fire suppression water. |
| Detention basins & ponds | Yes | Proposed as the main source of surface water storage from the BESS 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 1.322ha 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 (1.322ha) 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 running through the BESS and substation area. Perforated pipes located on the eastern side of the BESS infrastructure will discharge directly into a proposed fire water storage pipe (discussed in further detail below). Perforated pipes located on the western side will first connect into a main storm water drain, prior to discharging into the fire water storage pipe.

7.11. After passing through the fire water storage pipe, 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 existing 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 40% allowance for climate change. The proposed attenuation basin is located in Flood Zone 1.

7.12. 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 1.567 hectares. This area represents the BESS and substation compound comprising 1.322ha, plus a slight boundary buffer. An area of 1.567 ha results in a rate of 5.8 l/s. A hydro-brake is proposed near the outfall to restrict the flow to the calculated greenfield runoff rate of 5.8 l/s.

7.13. The proposed drainage strategy drawing can be found in **Appendix C.** Micro Drainage Source Control Calculations are included in **Appendix D.** Further drainage strategy details could be secured by a planning condition.

Solar Connection Infrastructure Buildings

7.14. 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.

7.15. It is proposed to locate a gravel trench 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.

7.16. The proposed drainage strategy drawing can be found in **Appendix C.** As mentioned above, further drainage strategy details could be secured by a planning condition.

Fire Water Storage Pipe

7.17. In case of a fire event at the site, the National Fire Chiefs Council BESS guidance **(see Appendix E)** 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$^3$. As discussed

above, a fire water storage pipe (tank) is proposed to supply the site with water in case of a fire event. The tank will have a diameter of 2.1m and length of 84m, which gives a total storage volume of 290.79m$^3$. The fire water storage pipe is modelled to always store 228m$^3$ of water, with the additional space for surface water runoff from the BESS infrastructure to help circulate water within the tank. In this instance, stagnant water will be avoided within the tank. Any additional flows in the tank will simply pass through the outfall and continue towards the attenuation basin.

7.18. A penstock is proposed downstream of the fire water storage pipe which, in a case of a fire event would be shut. This feature is proposed to ensure potentially contaminated fire suppression water does not reach the proposed attenuation basin and subsequently enter the Kingston Brook. Instead, water will continue to circulate through the proposed drainage system as it is pumped out of the tank onto site, and re-circulated through the fire water storage pipe until the fire is extinguished. Contaminated water would then be manually pumped out and taken away from the site and the fire water storage pipe would be re-filled.

Water Quality

7.19. 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.

7.20. Table 7.2 shows the pollution indices for the Development.

**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 |

7.21. Table 7.3 shows the pollution mitigation indices for the proposed 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 |
|---|---|---|---|
| Attenuation Basin | 0.7 | 0.7 | 0.5 |

# 8. Summary

8.1. The site is approximately 101ha in area is currently entirely greenfield and predominantly used for arable farming with some smaller areas of modified grassland. 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. 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. Mitigation measures include raising the lowest edge of proposed solar panels above proposed flood depths and ensuring vulnerable infrastructure is sequentially located in areas of lowest flood risk.

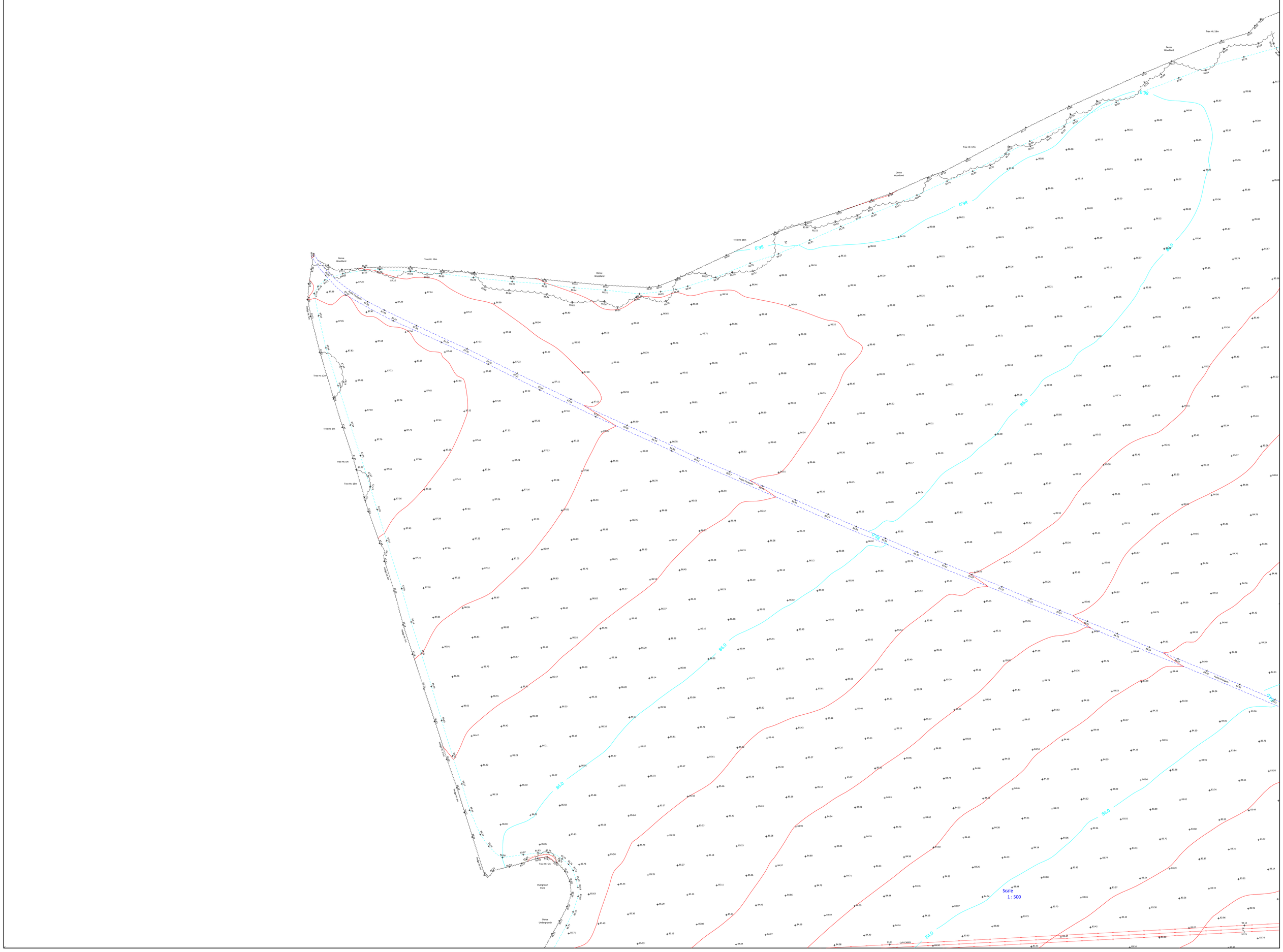
8.3. The site is not considered to be at significant risk of flooding from any source. Access and egress to the northern parcel is not predicted to be impeded during an extreme flood event. Flooding may restrict access and egress at the southern parcel during extreme events, although as the site will 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 proposal 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 – Topographic Survey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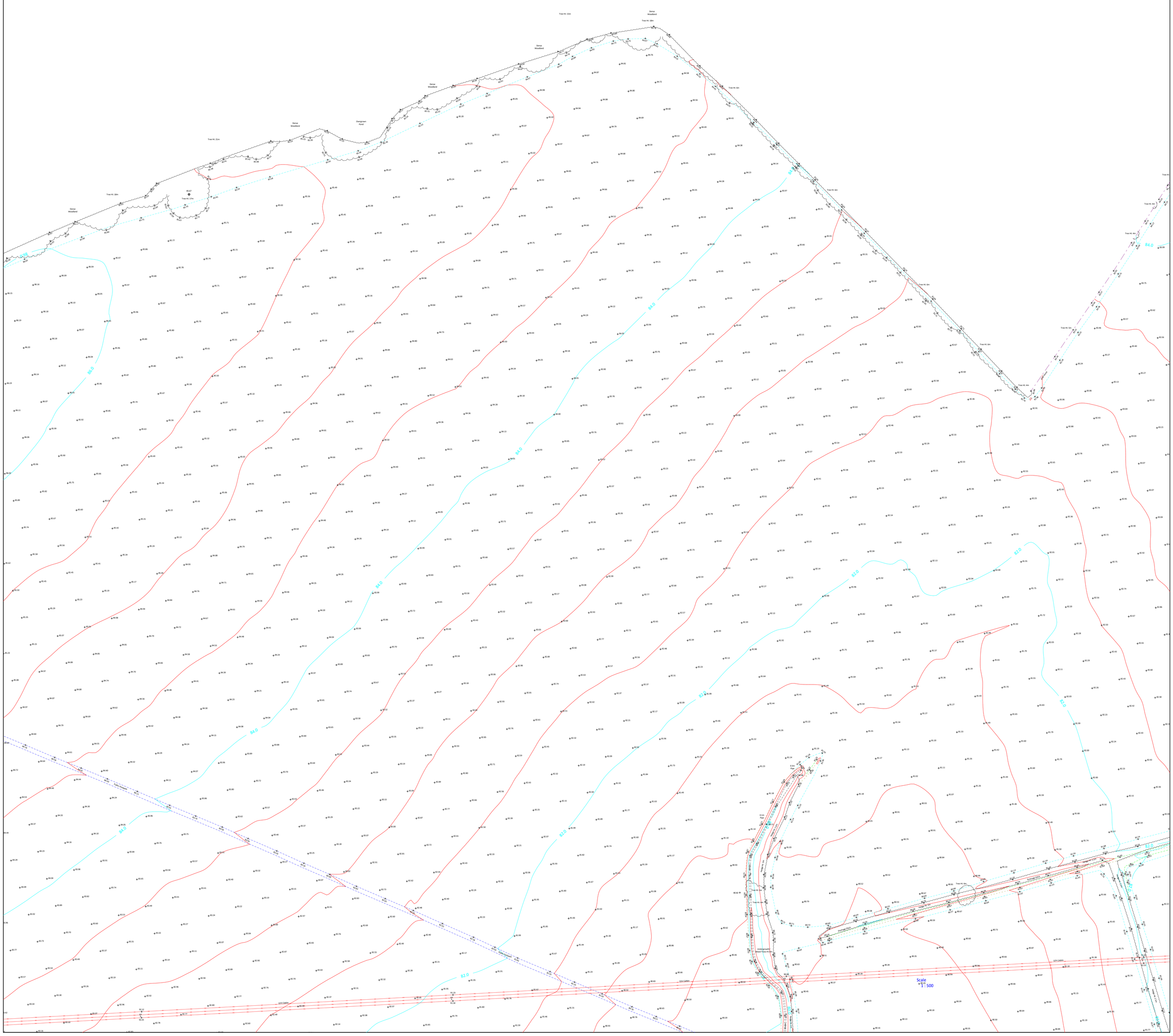
Tree Ht: 15m
Tree Ht: 12m
Tree Ht: 6m
Tree Ht: 5m
Tree Ht: 15m
Tree Ht: 10m
Tree Ht: 8m
Tree Ht: 5m
Public Footpath
Overgrown Pond
Dense Undergrowth
O/H Cables
86.0
85.0
84.0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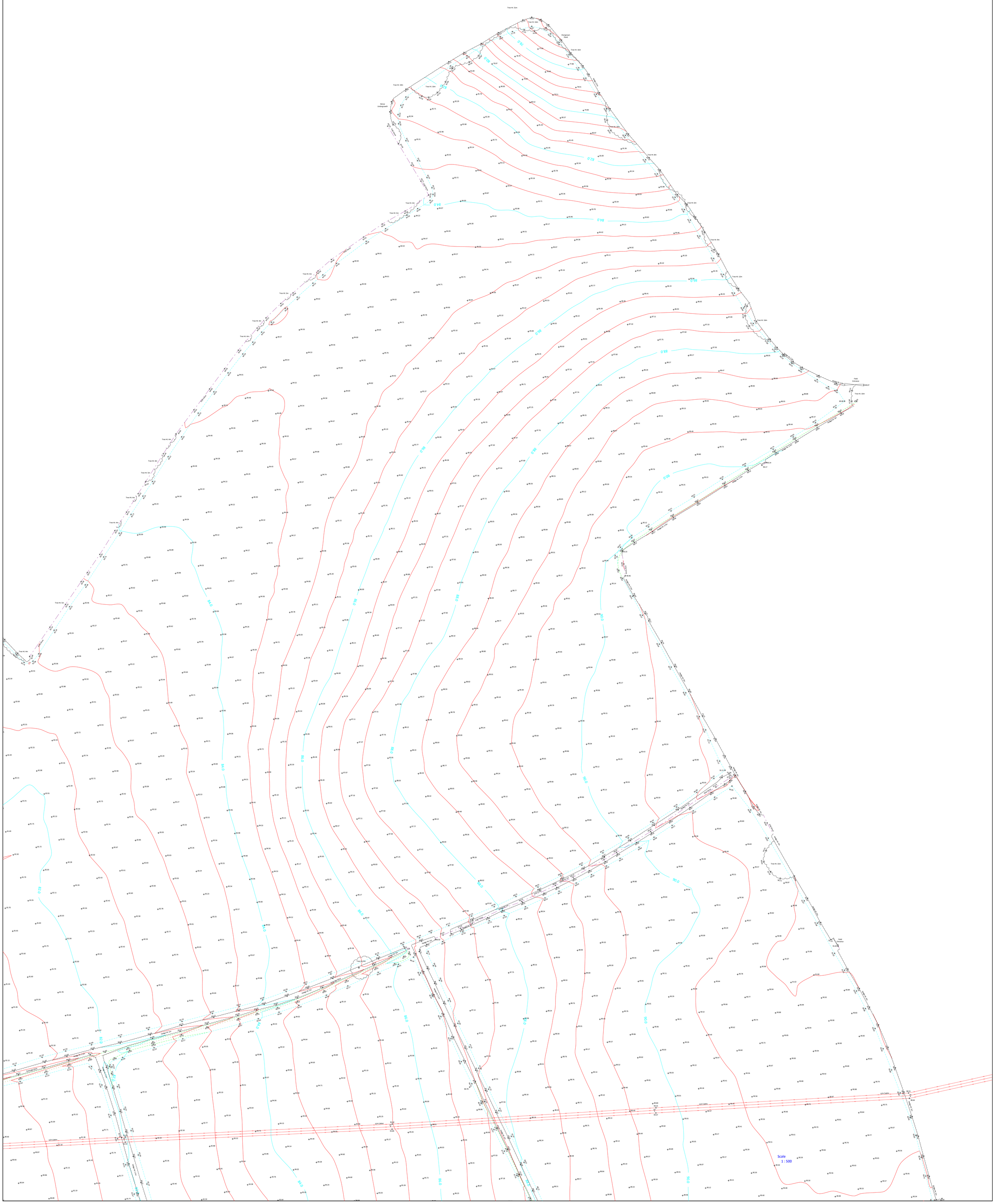
Tree Ht: 15m
Tree Ht: 18m
Tree Ht: 21m
Tree Ht: 17m
Tree Ht: 6m
Tree Ht: 4m
Overgrown Pond
Public Footpath
O/H Cables
Undergrowth Mixed Trees Ht:
Hedge 2m
Hedge 1.5m
Drainge Ditch
0.5m Pipe
Scale 1:500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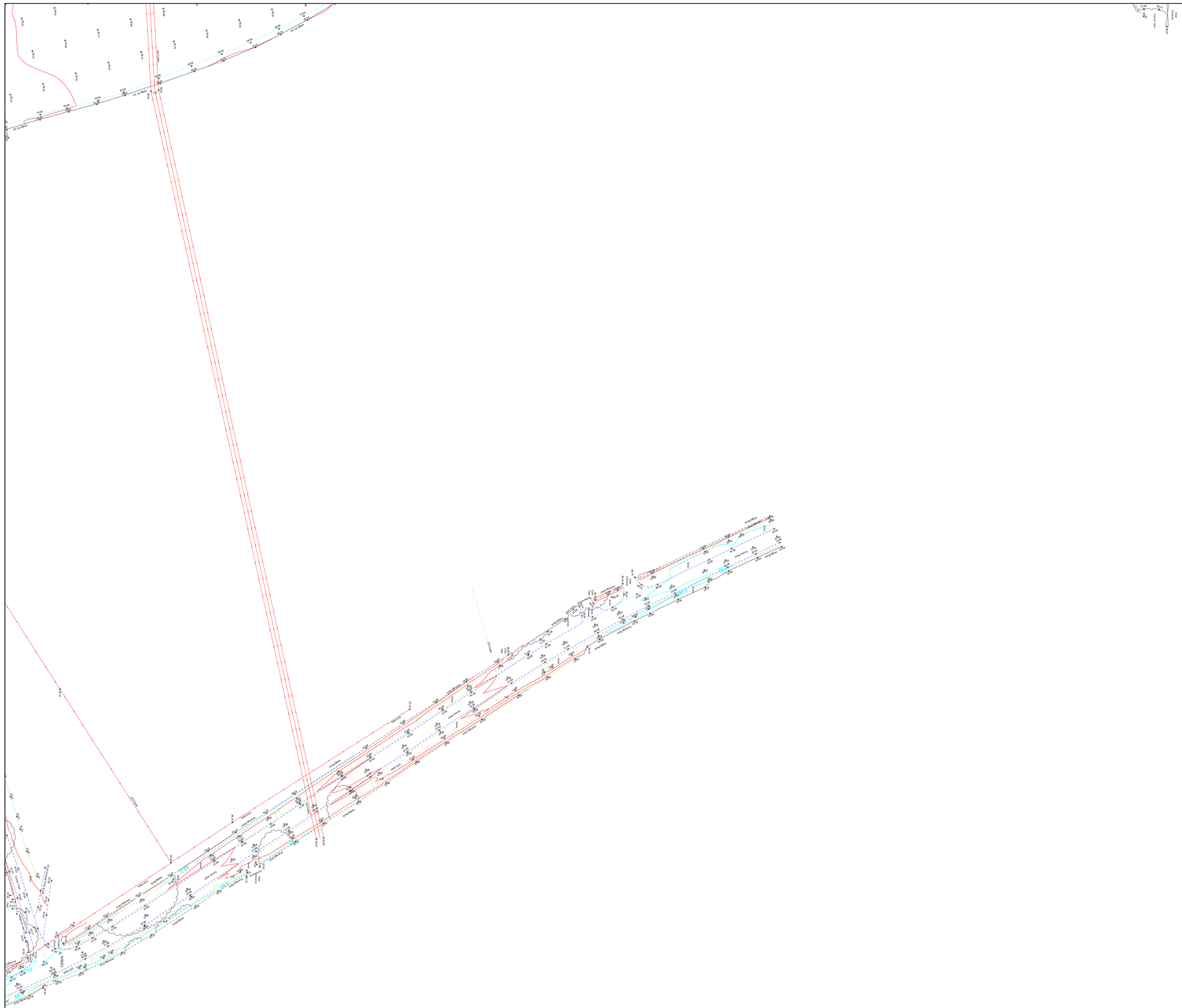

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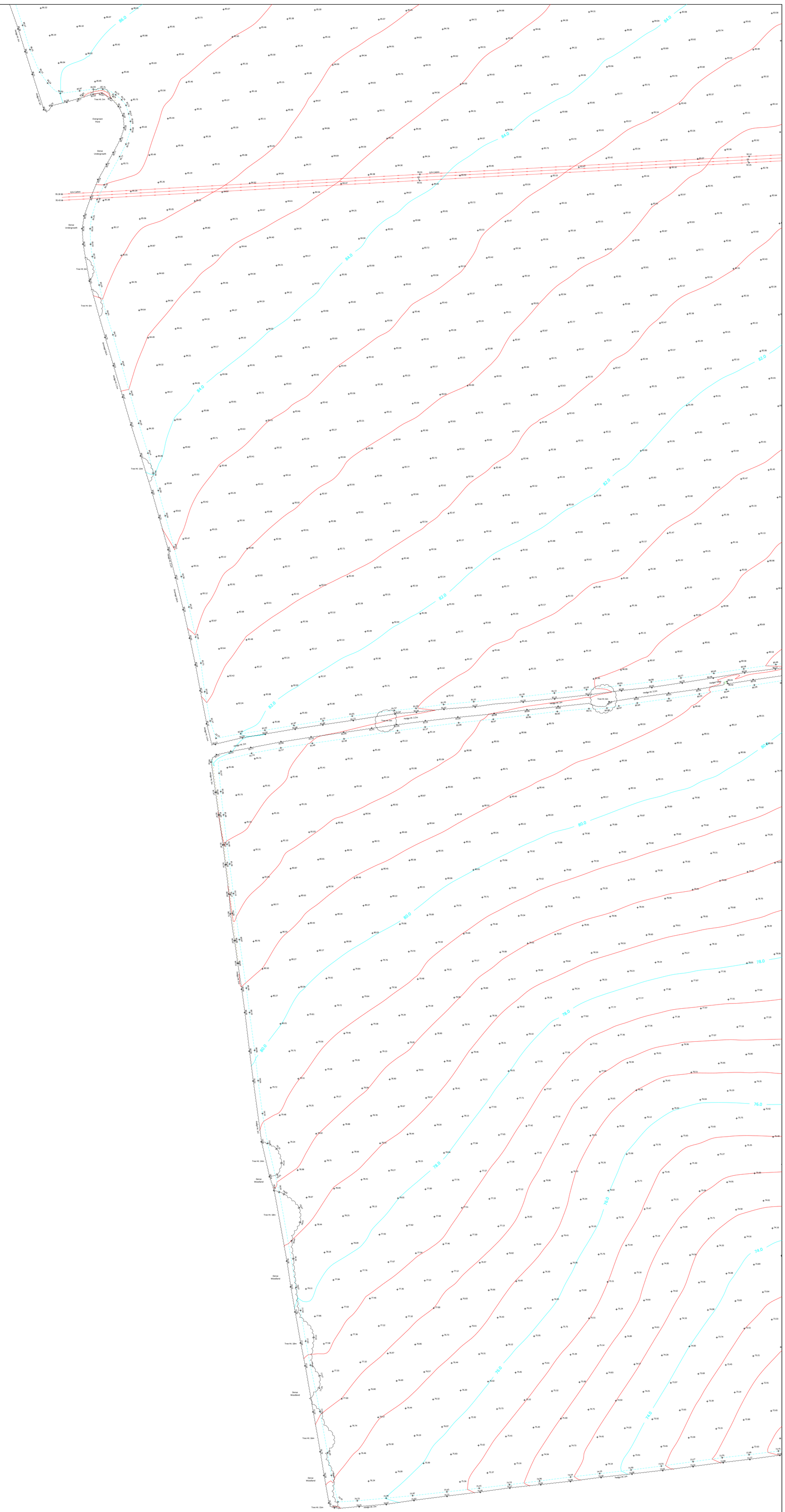
86.0
84.0
82.0
80.0
78.0
76.0
74.0
Overgrown Pond
Dense Undergrowth
O/H Cables
Tree Ht: 5m
Tree Ht: 6m
Tree Ht: 13m
Tree Ht: 14m
Tree Ht: 18m
Tree Ht: 16m
Tree Ht: 15m
Dense Woodland
Hedge Ht: 2m
Hedge Ht: 3m

Scale
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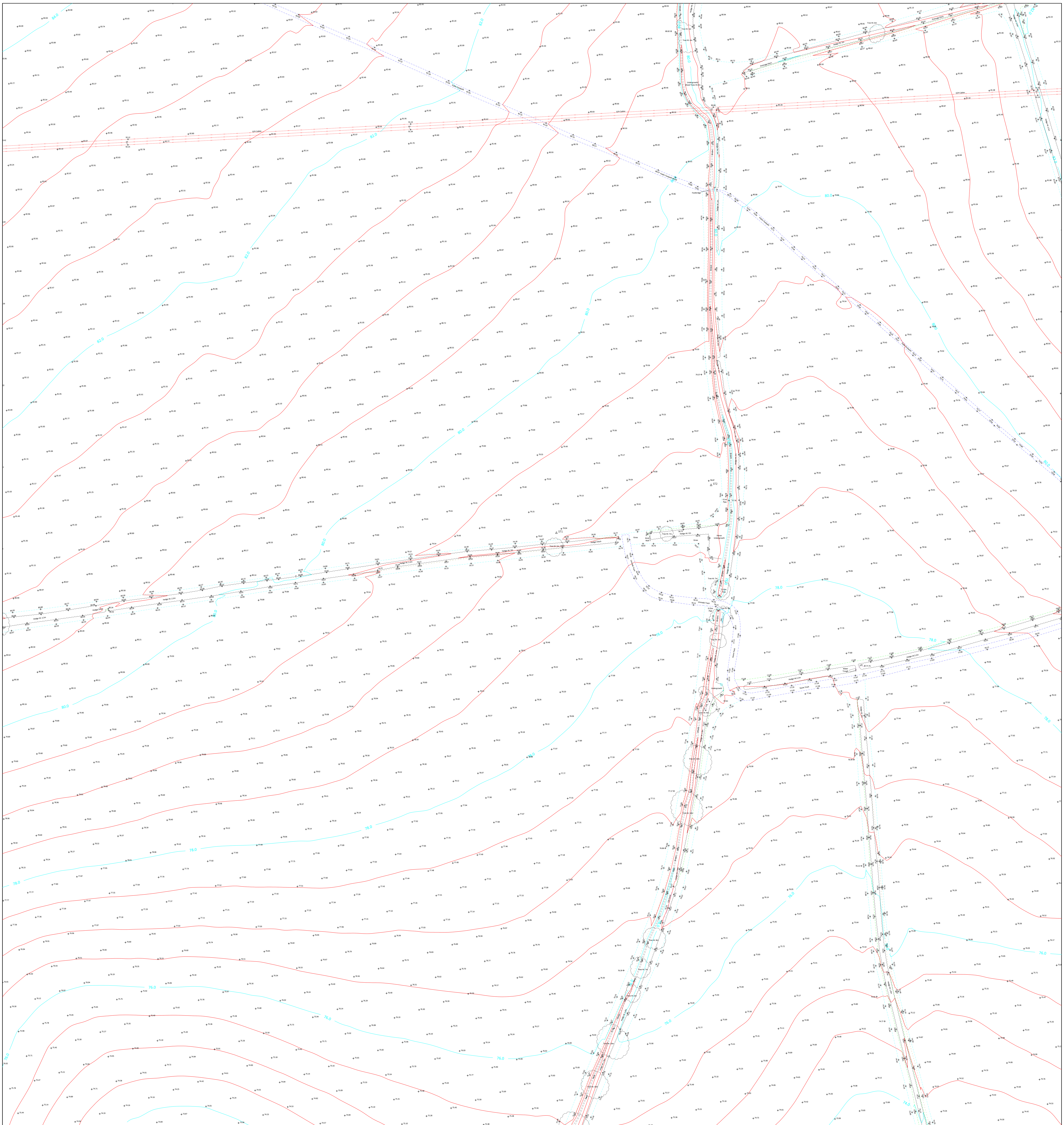
84.0
82.0
80.0
78.0
76.0
74.0
Public Footpath
O/H Cables
Footbridge
Drainage Ditch
Undergrowth Mixed Trees Ht:4m
Hedge/ Ditch
Hedge Ht: 2.2m
Hedge Ht: 2.5m
Brick Wall
Grass
Dense Undergrowth
Unmade Track
Stone Track
Water Trough
Undergrowth
ST1
ST2
0.1m Pipe
0.25m Pipe
P/W Fence
Dense Woodland
Pond
Bin
Tree Ht: 18m
Tree Ht: 16m
Tree Ht: 14m
Tree Ht: 13m
Hedge Ht: 1.8m
Hedge Ht: 2m

Scale
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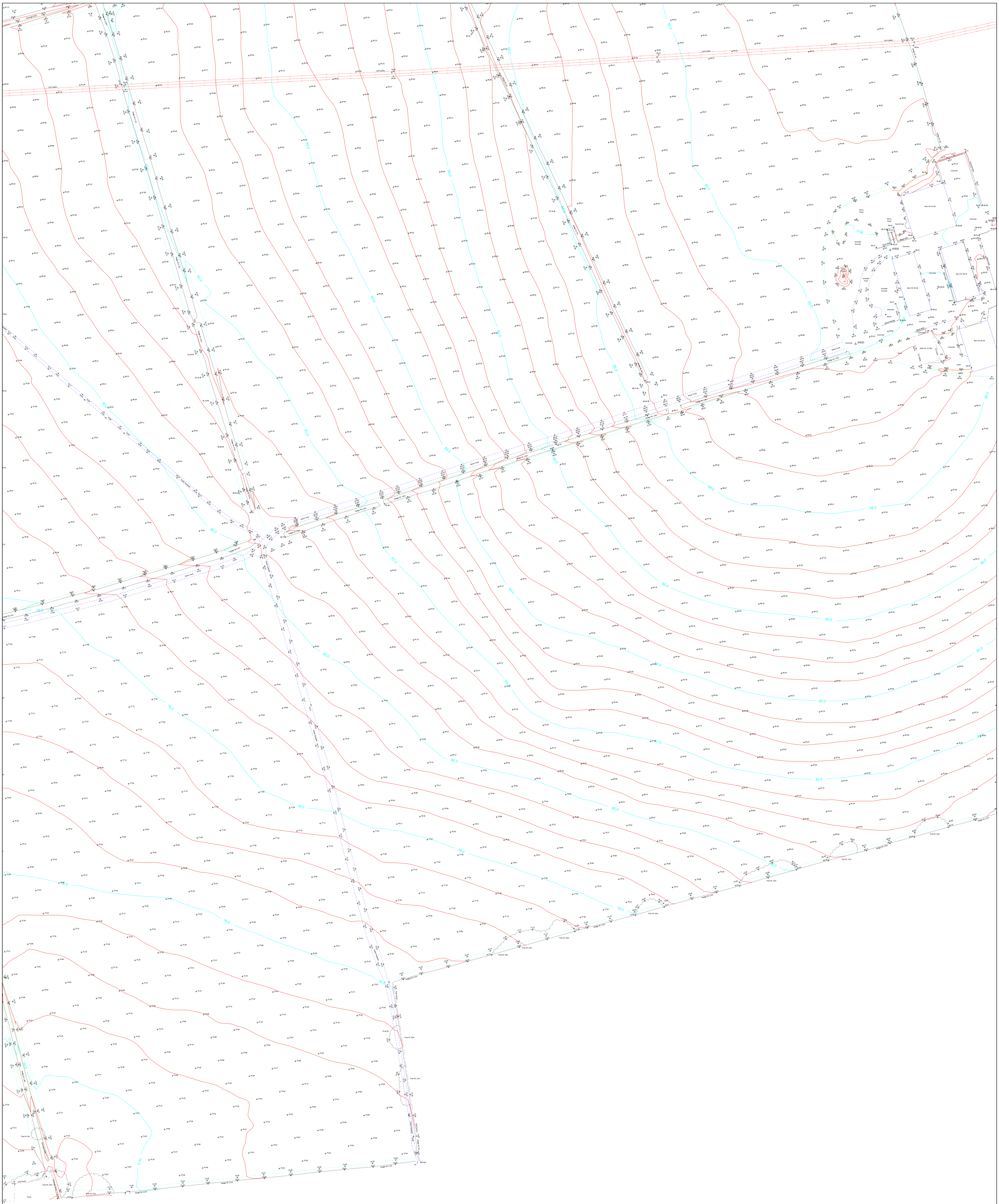

O/H Cables
Drainage Ditch
Hedge Ht: 2.5m
Hedge Ht: 2m
Hedge Ht: 3m
Hedge Ht: 1.8m
Hedge Ht: 2.2m
Stone Track
Public Footpath
P/W Fence
Tree Ht: 6m
Tree Ht: 10m
Tree Ht: 11m
Tree Ht: 13m
Tree Ht: 14m
Tree Ht: 16m
Tree Ht: 17m
Pond
Slurry Pond
Unmade Ground
Unmade Track
Grass Mound
Concrete
Concrete Wall
Block Wall
Metal Railings
Barn Ht: 97.43
Barn Ht: 95.10
Barn Ht: 94.76
Mast Ht: 15.16m
C/L Fence
WB05
WB06
WB07
Grass
Tree
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76.0
78.0
80.0
82.0
84.0
86.0
88.0
90.0


Scale
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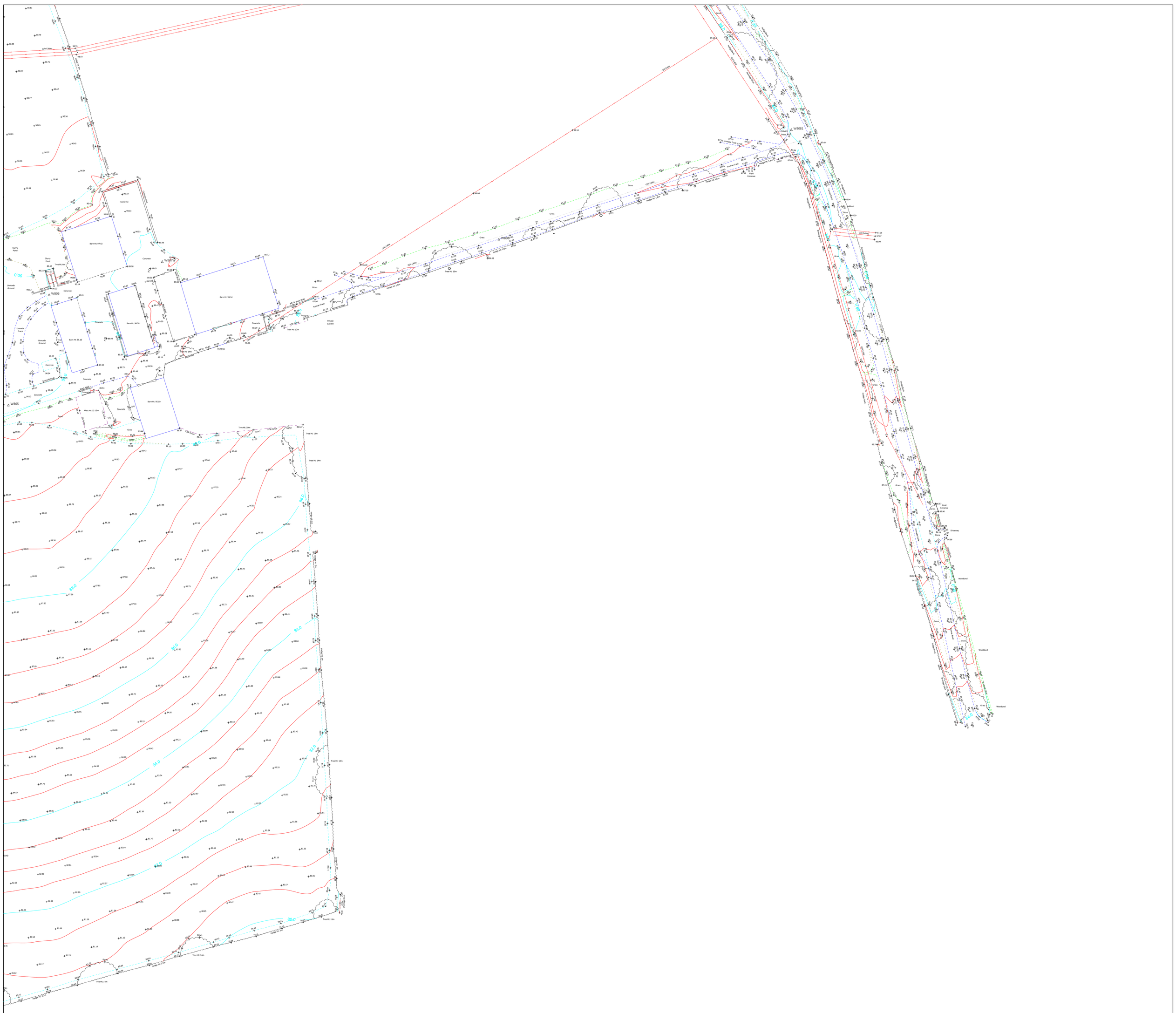
WB05
WB06
WB07
WB08
WB081
Barn Ht: 97.43
Barn Ht: 95.14
Barn Ht: 94.76
Barn Ht: 95.10
Mast Ht: 15.16m
Concrete
Grass
Tree Ht: 14m
Tree Ht: 13m
Tree Ht: 10m
Tree Ht: 12m
Building
Private Garden
Woodland
Field Entrance
Driveway
Stone
Slurry Pond
Unmade Ground
Unmade Track
Tarmac Track
Bridge Ht: 1.8m
Bridge Ht: 2.2m
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
Unmade Track
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
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
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
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Drainage Canal
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Scale
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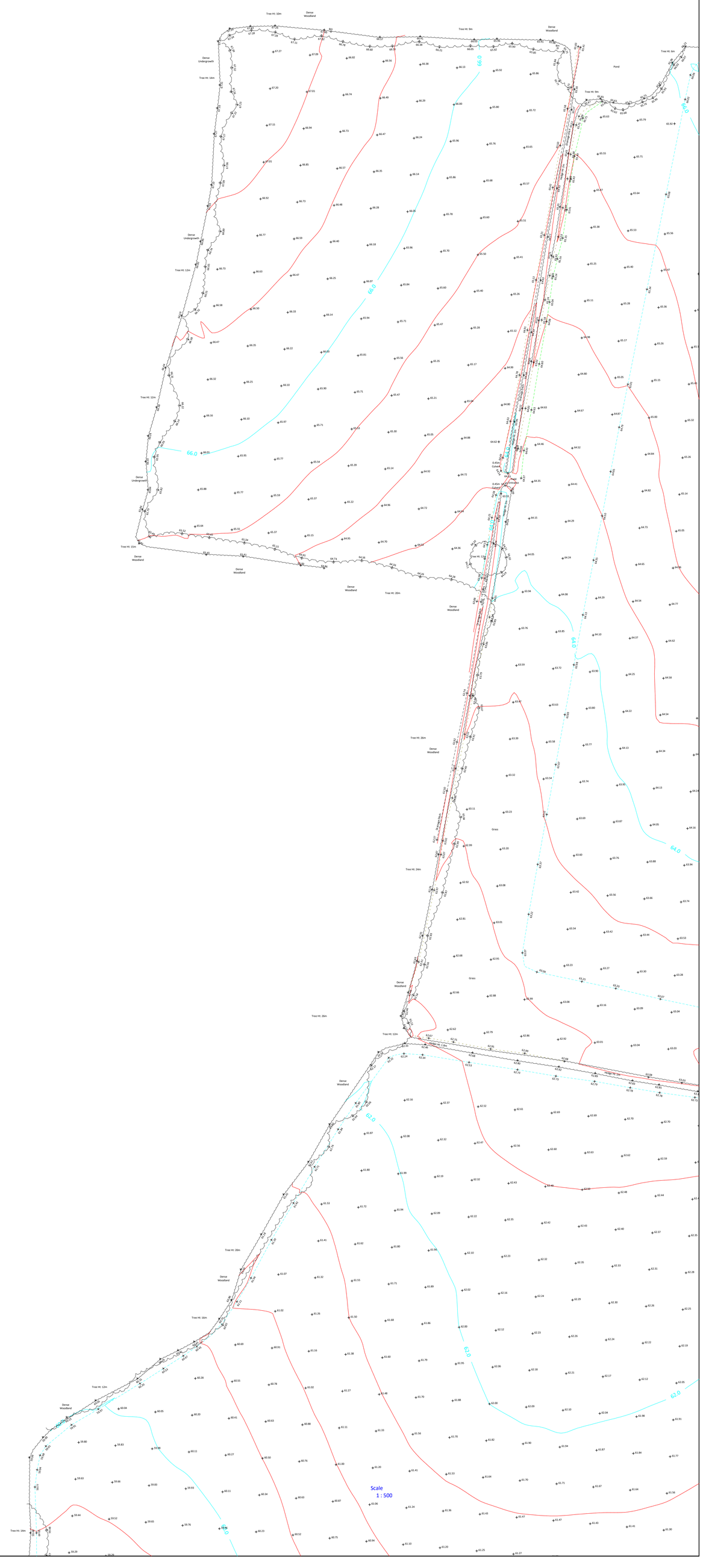
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Dense Undergrowth
Grass
Pond
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Tree Ht: 12m
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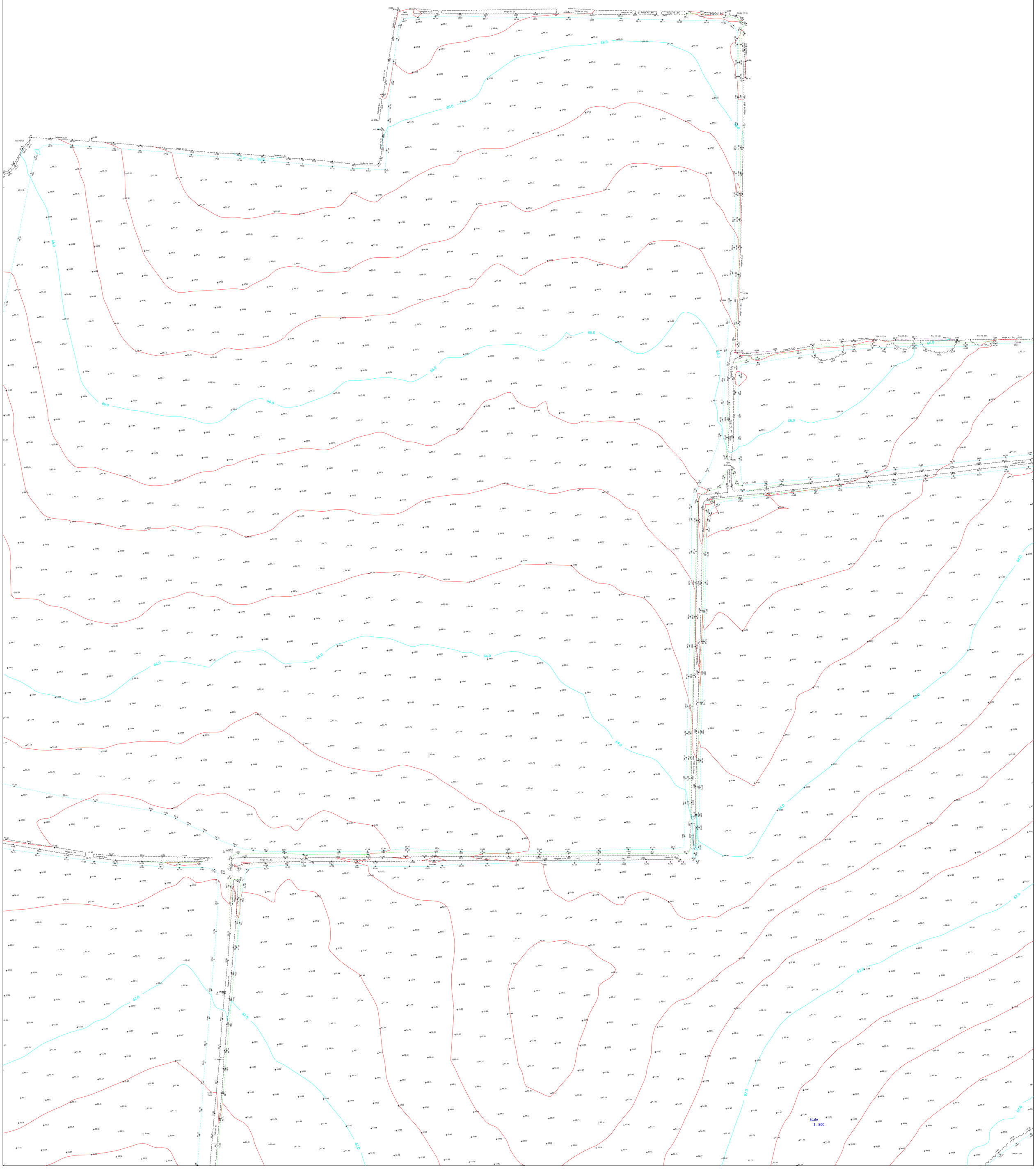
Hedge Ht: 1.8m
Hedge Ht: 2m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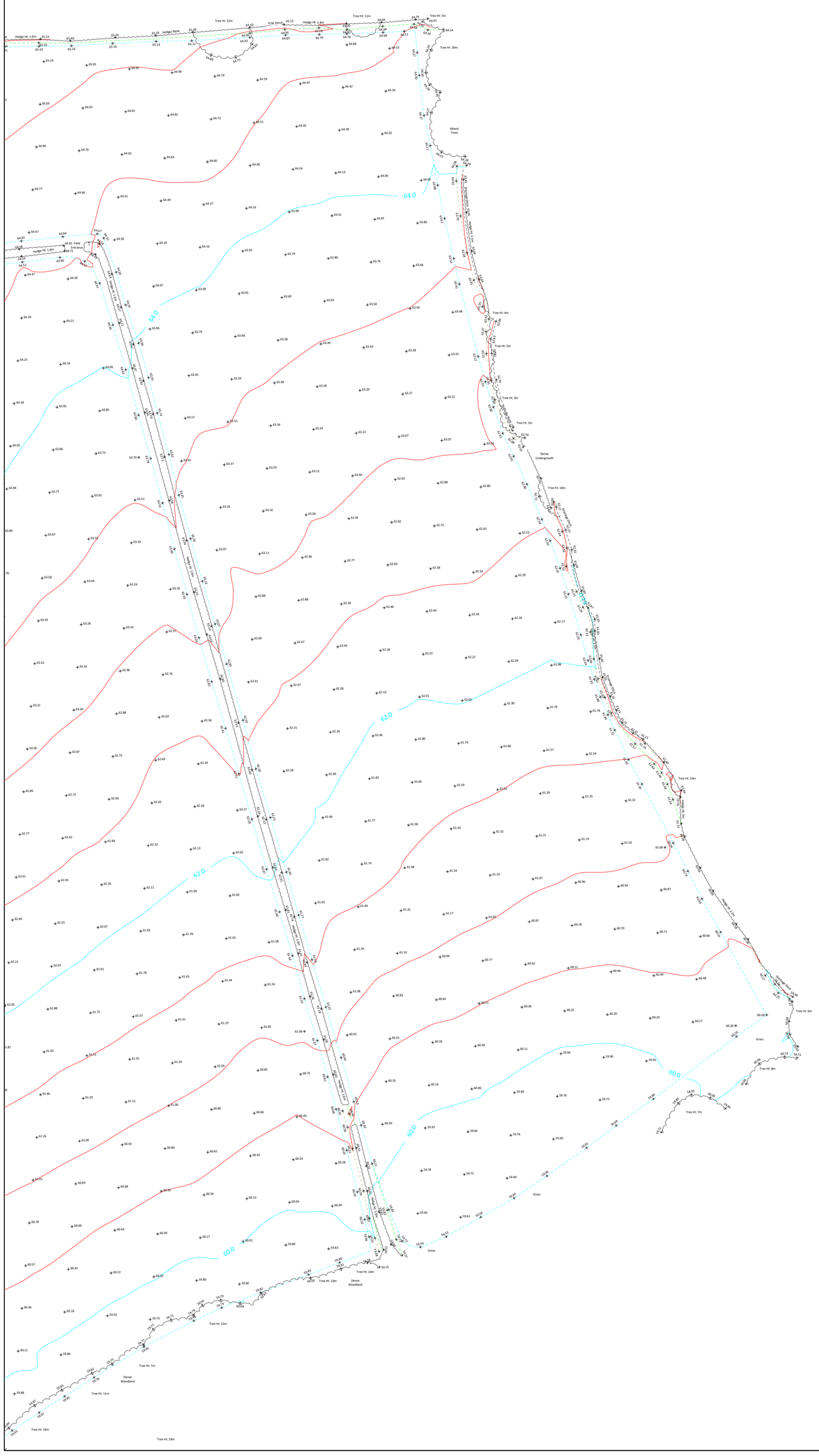
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62.0
61.0
60.0
Hedge Ht: 1.6m
Hedge Ht: 1.8m
Hedge Ht: 2.8m
Tree Ht: 15m
Tree Ht: 13m
Tree Ht: 5m
Tree Ht: 20m
Mixed Trees
Tree Ht: 4m
Tree Ht: 3m
Dense Undergrowth
Tree Ht: 10m
Tree Ht: 6m
Grass
Tree Ht: 8m
Tree Ht: 2m
Tree Ht: 14m
Dense Woodland
Tree Ht: 7m
Tree Ht: 11m
Tree Ht: 19m

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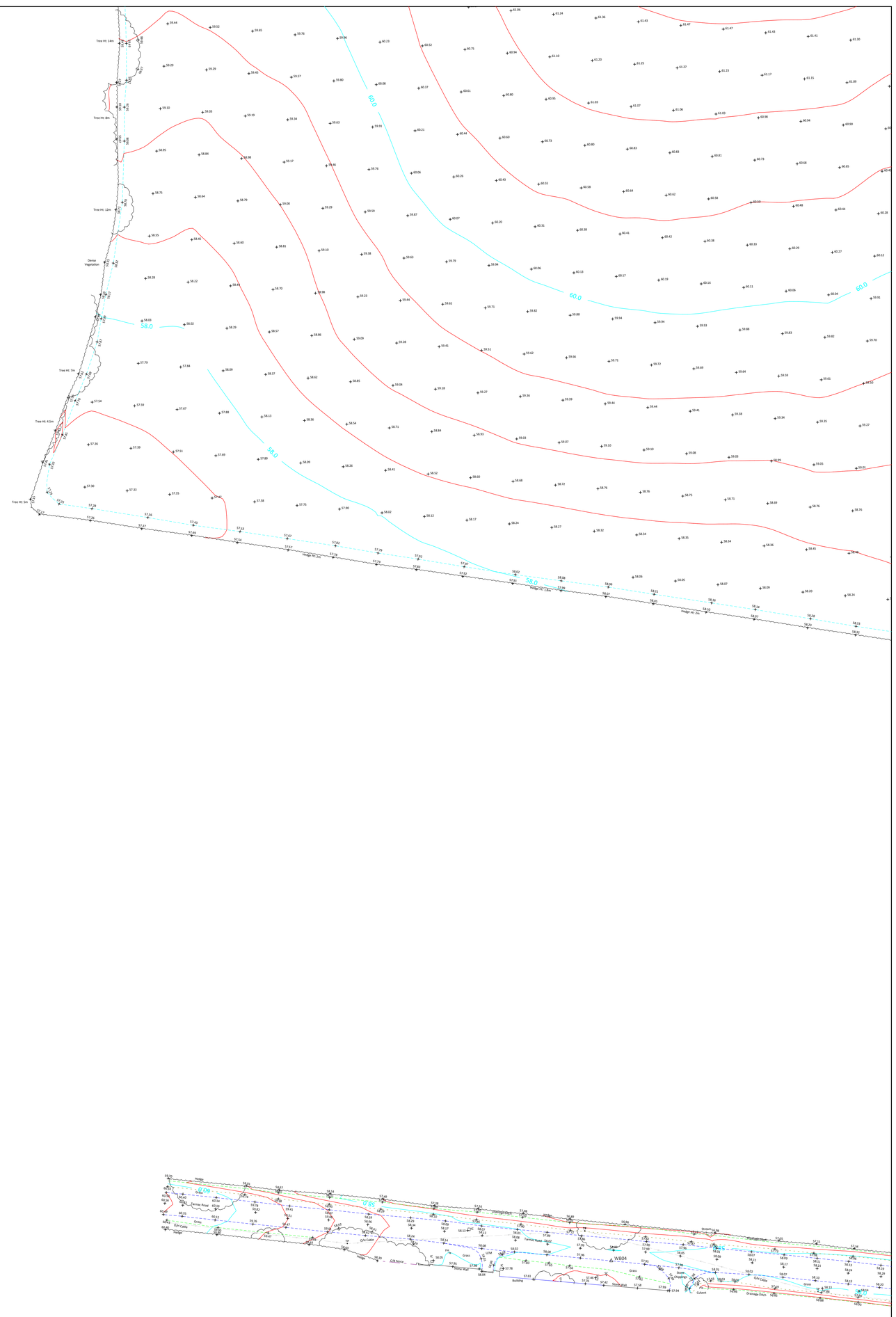
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Tree Ht: 12m
Dense Vegetation
Tree Ht: 7m
Tree Ht: 4.5m
Tree Ht: 5m
Hedge Ht: 2m
Hedge Ht: 1.8m
Hedge Ht: 2m
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58.0
Hedge
Grass
Farmer Road
O/H Cable
Stone Wall
Building
Stream
Culvert
Drainage Ditch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

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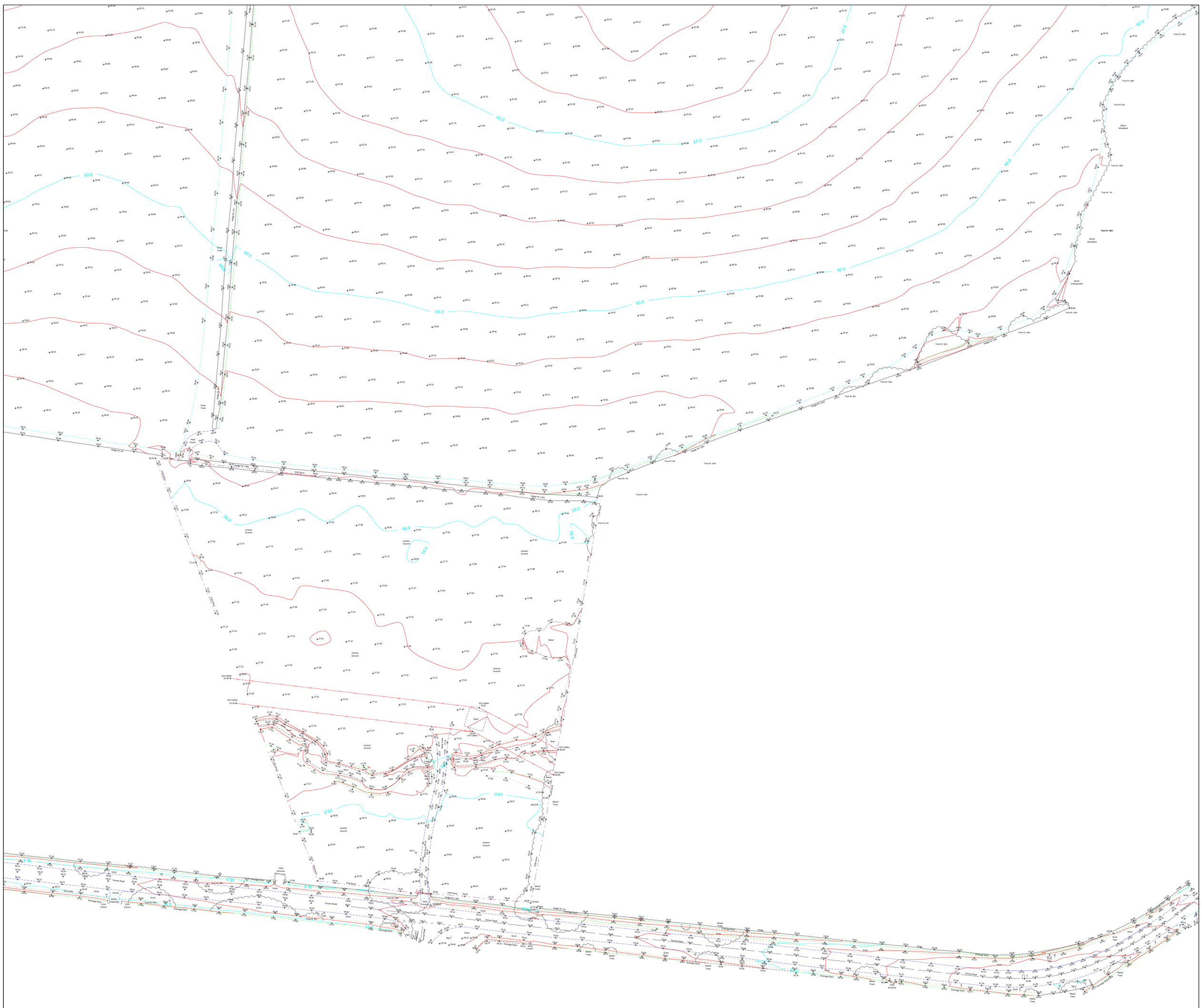
62.0
60.0
58.0
Tarmac Road
Drainage Ditch
Culvert
Uneven Ground
Mixed Trees
Dense Woodland
Dense Undergrowth
River
Water
Pylon
O/H Cables
Field Entrance
Grass Track
Stream

Scale
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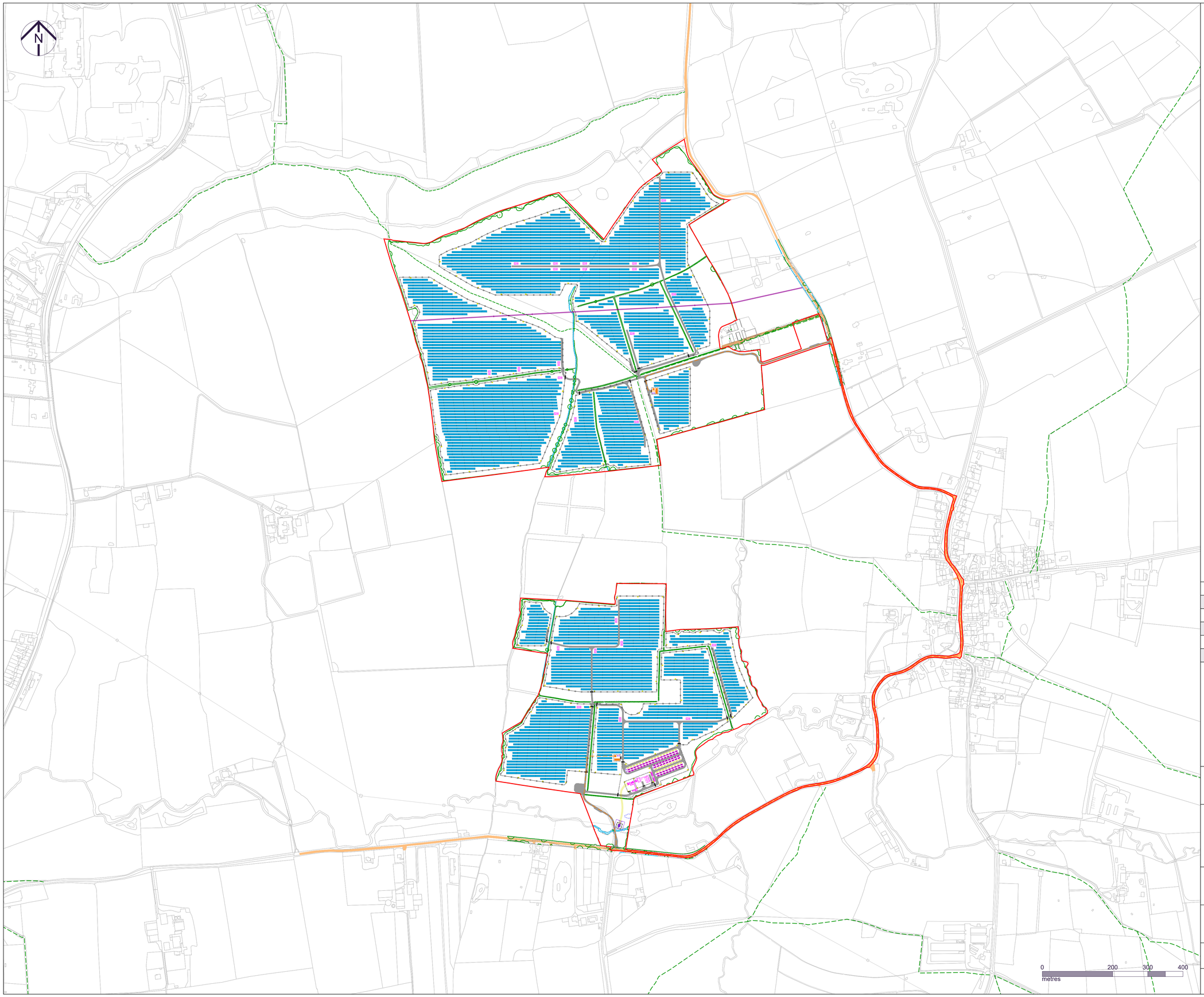
# Appendix B – Site Layout




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

| Rev | Date | Description |
|---|---|---|
| P04 | 05.01.23 | PV and planting changes |
| P03 | 01.08.23 | 2 BESS access, minor aligns |
| P02 | 12.07.23 | Reduced solar, new planting |

exagen

Exagen Development Limited
Millbank Tower
21-24 Millbank
London SW1P 4QP
+44 (0)3300 100 545
info@exagen.co.uk
www.exagen.co.uk

Client
Exagen Development Limited

Drawing title
Site Layout Plan

Project
Old Wood Energy Park

Status
For Information Only

| Date | Scale at A3 | Status code |
|---|---|---|
| 18/05/2023 | 1:5000 | S0 |

| Drawing number | Revision |
|---|---|
| WLL02A-EXG-04-00-D-K001 | P04.08 |

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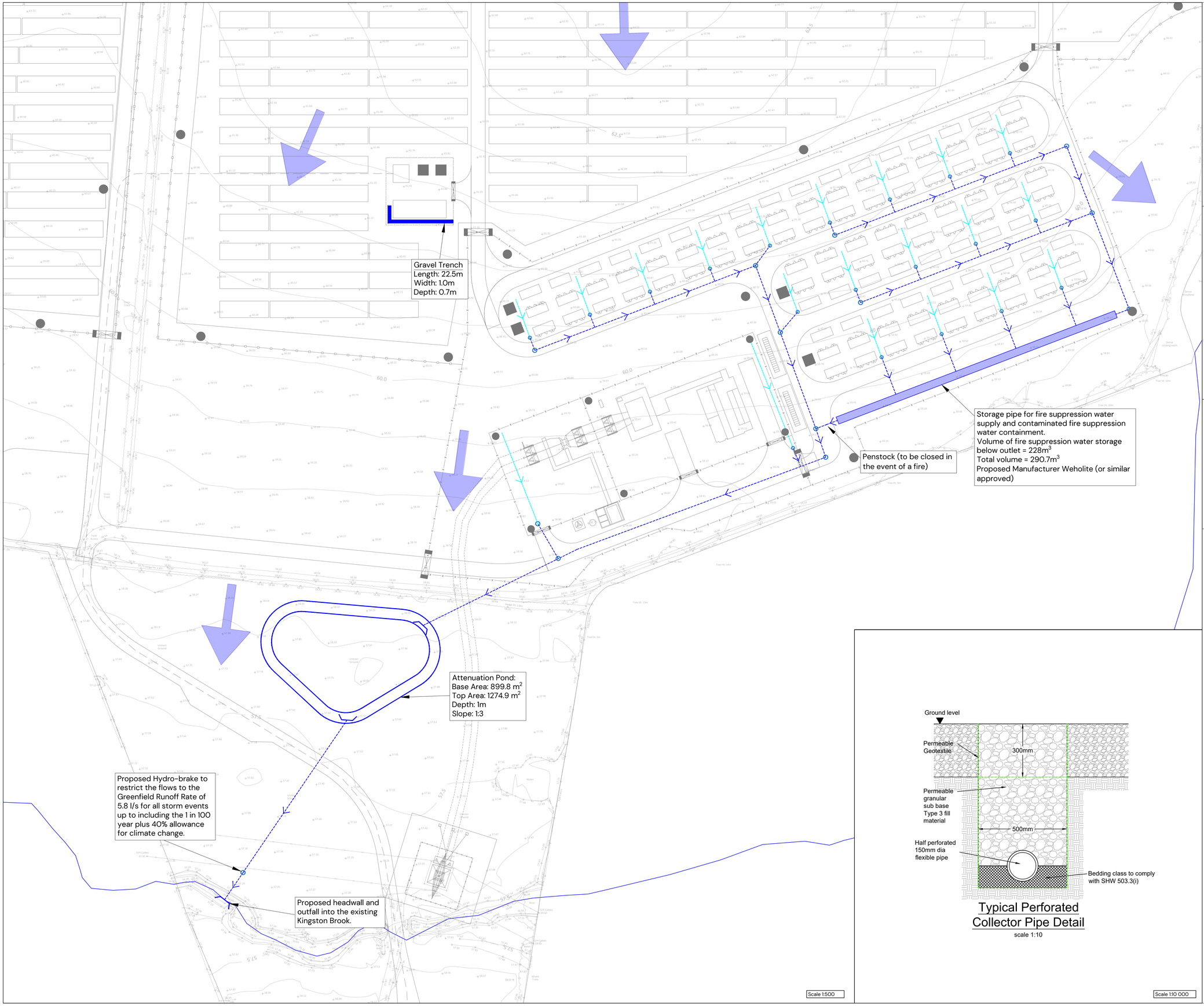
# Appendix C – Drainage Strategy Drawing




N

Notes:

A site specific Topographical Survey was undertaken by Landmark Surveys (Wales), date: March 2023; ref: 6569.

Site Layout was produced by Exagen Old Wood Ltd, date: May 2023; Drawing Number: WLL02A-EXG-04-00-D-K001; Revision: P04.06

Impermeable Area: 1.322 ha
Scale 1: 10 000

Key:

- Perforated collector pipes
- Storm water drain
- Overland flow exceedance
- Storm Water Manhole
- Storm Water inspection Chamber
- Penstock




Typical Perforated Collector Pipe Detail

scale 1:10

Scale 1:10 000

| REV | DATE | DESCRIPTION | REVISED | CHECKED | APPROVED |
|---|---|---|---|---|---|
| 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 - P3
PG OFFICE / TEAM: BRS/IN

PEGASUS REF No: P21-2533
DRAWING STATUS: SO

PEGASUS GROUP

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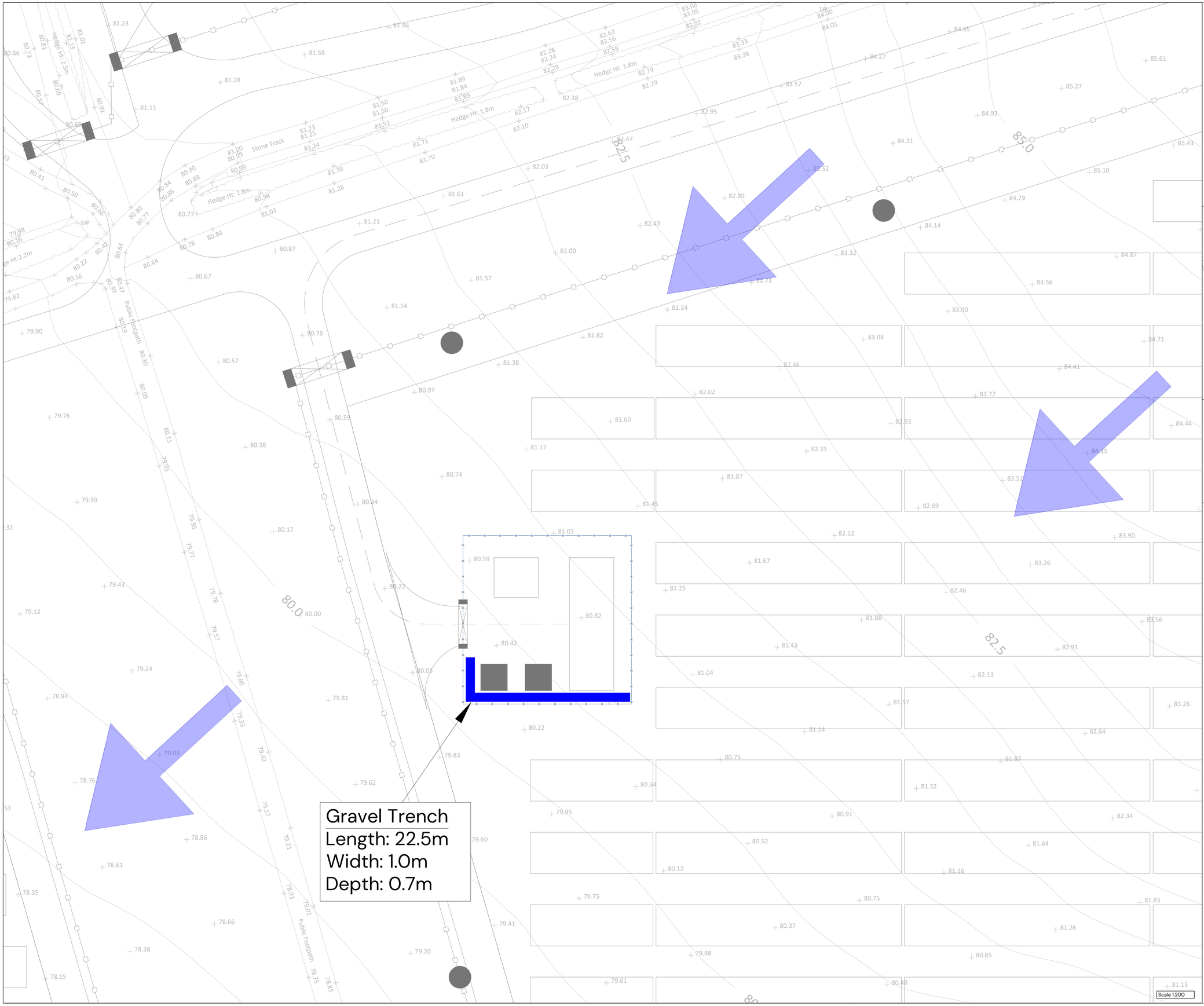
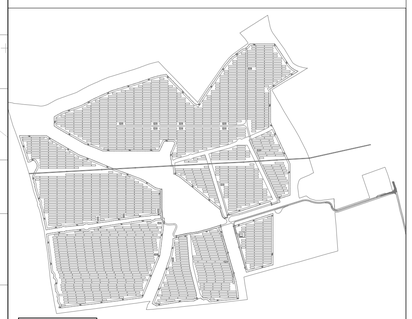



N

Notes:

A site specific Topographical Survey was undertaken by Landmark Surveys (Wales), date: March 2023; ref: 6569.

Site Layout was produced by Exagen Old Wood Ltd, date: May 2023; Drawing Number: WLL02A-EXG-04-00-D-K001; Revision: P04.06



Scale 1: 10 000

Key:

Overland flow exceedance

| REV | DATE | DESCRIPTION | REVISED | CHECKED | APPROVED |
|---|---|---|---|---|---|
| P2 | 17.01.2024. | Updated site layout | LG | LG | LAJ |
| P1 | 30.11.2023. | 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 - P1

PG OFFICE / TEAM: BRS/IN

PEGASUS REF No: P21-2533

DRAWING STATUS: SO

PEGASUS GROUP

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# Appendix D – Micro Drainage and Greenfield Runoff Calculations

## 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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## Summary of Results for 100 year Return Period (+25%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 99.345 | 0.345 | 5.8 | 330.9 | O K |
| 30 min Summer | 99.442 | 0.442 | 5.8 | 432.0 | O K |
| 60 min Summer | 99.539 | 0.539 | 5.8 | 536.5 | O K |
| 120 min Summer | 99.649 | 0.649 | 5.8 | 659.4 | O K |
| 180 min Summer | 99.712 | 0.712 | 5.8 | 731.5 | Flood Risk |
| 240 min Summer | 99.751 | 0.751 | 5.8 | 777.1 | Flood Risk |
| 360 min Summer | 99.791 | 0.791 | 5.8 | 824.7 | Flood Risk |
| 480 min Summer | 99.806 | 0.806 | 5.8 | 841.8 | Flood Risk |
| 600 min Summer | 99.807 | 0.807 | 5.8 | 843.3 | Flood Risk |
| 720 min Summer | 99.801 | 0.801 | 5.8 | 836.2 | Flood Risk |
| 960 min Summer | 99.777 | 0.777 | 5.8 | 807.9 | Flood Risk |
| 1440 min Summer | 99.714 | 0.714 | 5.8 | 733.7 | Flood Risk |
| 2160 min Summer | 99.632 | 0.632 | 5.8 | 639.7 | O K |
| 2880 min Summer | 99.558 | 0.558 | 5.8 | 557.8 | O K |
| 4320 min Summer | 99.449 | 0.449 | 5.8 | 439.1 | O K |
| 5760 min Summer | 99.364 | 0.364 | 5.8 | 350.9 | O K |
| 7200 min Summer | 99.299 | 0.299 | 5.8 | 285.0 | O K |
| 8640 min Summer | 99.249 | 0.249 | 5.8 | 235.0 | O K |
| 10080 min Summer | 99.210 | 0.210 | 5.8 | 197.0 | O K |
| 15 min Winter | 99.384 | 0.384 | 5.8 | 371.2 | O K |
| 30 min Winter | 99.492 | 0.492 | 5.8 | 484.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 135.533 | 0.0 | 335.5 | 19 |
| 30 min Summer | 89.017 | 0.0 | 435.1 | 34 |
| 60 min Summer | 55.903 | 0.0 | 553.9 | 64 |
| 120 min Summer | 34.972 | 0.0 | 693.1 | 124 |
| 180 min Summer | 26.309 | 0.0 | 782.1 | 184 |
| 240 min Summer | 21.321 | 0.0 | 845.1 | 242 |
| 360 min Summer | 15.600 | 0.0 | 898.6 | 362 |
| 480 min Summer | 12.352 | 0.0 | 908.3 | 482 |
| 600 min Summer | 10.241 | 0.0 | 904.3 | 602 |
| 720 min Summer | 8.756 | 0.0 | 898.2 | 722 |
| 960 min Summer | 6.797 | 0.0 | 883.6 | 960 |
| 1440 min Summer | 4.708 | 0.0 | 848.8 | 1254 |
| 2160 min Summer | 3.238 | 0.0 | 1155.5 | 1620 |
| 2880 min Summer | 2.484 | 0.0 | 1181.7 | 1960 |
| 4320 min Summer | 1.718 | 0.0 | 1226.2 | 2724 |
| 5760 min Summer | 1.331 | 0.0 | 1267.1 | 3464 |
| 7200 min Summer | 1.104 | 0.0 | 1312.7 | 4184 |
| 8640 min Summer | 0.954 | 0.0 | 1361.2 | 4928 |
| 10080 min Summer | 0.848 | 0.0 | 1412.8 | 5640 |
| 15 min Winter | 135.533 | 0.0 | 375.9 | 19 |
| 30 min Winter | 89.017 | 0.0 | 466.9 | 33 |

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## Summary of Results for 100 year Return Period (+25%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 60 min Winter | 99.599 | 0.599 | 5.8 | 603.1 | O K |
| 120 min Winter | 99.722 | 0.722 | 5.8 | 742.7 | Flood Risk |
| 180 min Winter | 99.792 | 0.792 | 5.8 | 824.9 | Flood Risk |
| 240 min Winter | 99.836 | 0.836 | 5.8 | 877.9 | Flood Risk |
| 360 min Winter | 99.882 | 0.882 | 5.8 | 934.8 | Flood Risk |
| 480 min Winter | 99.901 | 0.901 | 5.8 | 957.6 | Flood Risk |
| 600 min Winter | 99.905 | 0.905 | 5.8 | 963.0 | Flood Risk |
| 720 min Winter | 99.902 | 0.902 | 5.8 | 958.5 | Flood Risk |
| 960 min Winter | 99.881 | 0.881 | 5.8 | 933.6 | Flood Risk |
| 1440 min Winter | 99.819 | 0.819 | 5.8 | 857.5 | Flood Risk |
| 2160 min Winter | 99.722 | 0.722 | 5.8 | 743.2 | Flood Risk |
| 2880 min Winter | 99.639 | 0.639 | 5.8 | 647.6 | O K |
| 4320 min Winter | 99.477 | 0.477 | 5.8 | 469.8 | O K |
| 5760 min Winter | 99.353 | 0.353 | 5.8 | 339.6 | O K |
| 7200 min Winter | 99.260 | 0.260 | 5.8 | 245.8 | O K |
| 8640 min Winter | 99.192 | 0.192 | 5.7 | 179.4 | O K |
| 10080 min Winter | 99.145 | 0.145 | 5.6 | 133.8 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 60 min Winter | 55.903 | 0.0 | 620.4 | 64 |
| 120 min Winter | 34.972 | 0.0 | 776.2 | 122 |
| 180 min Winter | 26.309 | 0.0 | 871.2 | 180 |
| 240 min Winter | 21.321 | 0.0 | 908.7 | 240 |
| 360 min Winter | 15.600 | 0.0 | 915.0 | 358 |
| 480 min Winter | 12.352 | 0.0 | 909.3 | 474 |
| 600 min Winter | 10.241 | 0.0 | 902.7 | 590 |
| 720 min Winter | 8.756 | 0.0 | 896.1 | 704 |
| 960 min Winter | 6.797 | 0.0 | 882.3 | 932 |
| 1440 min Winter | 4.708 | 0.0 | 851.9 | 1358 |
| 2160 min Winter | 3.238 | 0.0 | 1294.2 | 1708 |
| 2880 min Winter | 2.484 | 0.0 | 1323.9 | 2164 |
| 4320 min Winter | 1.718 | 0.0 | 1373.3 | 2944 |
| 5760 min Winter | 1.331 | 0.0 | 1418.8 | 3696 |
| 7200 min Winter | 1.104 | 0.0 | 1470.2 | 4400 |
| 8640 min Winter | 0.954 | 0.0 | 1524.6 | 5096 |
| 10080 min Winter | 0.848 | 0.0 | 1582.4 | 5744 |

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## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 100 |
| FEH Rainfall Version | 2013 |
| Site Location | GB 459573 326889 SK 59573 26889 |
| Data Type | Point |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Shortest Storm (mins) | 15 |
| Longest Storm (mins) | 10080 |
| Climate Change % | +25 |

## Time Area Diagram

Total Area (ha) 1.322

| Time (mins) From: | To: | Area (ha) |
|---|---|---|
| 0 | 4 | 1.322 |

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## Model Details

Storage is Online Cover Level (m) 100.000

## Tank or Pond Structure

Invert Level (m) 99.000

| Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|
| 0.000 | 899.8 | 1.000 | 1274.9 |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0112-5800-1050-5800 |
| Design Head (m) | 1.050 |
| Design Flow (l/s) | 5.8 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 112 |
| Invert Level (m) | 98.950 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.050 | 5.8 |
| Flush-Flo™ | 0.309 | 5.8 |
| Kick-Flo® | 0.670 | 4.7 |
| Mean Flow over Head Range | - | 5.0 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 3.9 | 1.200 | 6.2 | 3.000 | 9.5 | 7.000 | 14.2 |
| 0.200 | 5.6 | 1.400 | 6.6 | 3.500 | 10.2 | 7.500 | 14.7 |
| 0.300 | 5.8 | 1.600 | 7.1 | 4.000 | 10.9 | 8.000 | 15.1 |
| 0.400 | 5.7 | 1.800 | 7.5 | 4.500 | 11.5 | 8.500 | 15.6 |
| 0.500 | 5.6 | 2.000 | 7.8 | 5.000 | 12.1 | 9.000 | 16.0 |
| 0.600 | 5.2 | 2.200 | 8.2 | 5.500 | 12.7 | 9.500 | 16.4 |
| 0.800 | 5.1 | 2.400 | 8.5 | 6.000 | 13.2 | | |
| 1.000 | 5.7 | 2.600 | 8.9 | 6.500 | 13.7 | | |

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# Appendix E – 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.

---

[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

PEGASUS GROUP

**BRISTOL**
First Floor, South Wing, Equinox North, Great Park Road, Almondsbury, Bristol, BS32 4QL

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