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**ELGIN ENERGY ES CO LIMITED**

**PENTRE BACH, TORFAEN**

# FLOOD CONSEQUENCE ASSESSMENT AND DRAINAGE STRATEGY

**JULY 2024**

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**JULY 2024**

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| 9007 | Indicative Layout Plan | 1:2500 |
| 27002 | Topographical Survey-Drawings 01-11 | 1:500 |
| CA11956-003 | Drainage Strategy | 1:2000 |

## SUPPORTING DOCUMENTS

- Planning Policy Wales Technical Advice Note 15 (TAN) (2004)
- Welsh Government Statutory Standards for Sustainable Drainage Systems (2018)
- Welsh Government Sustainable Drainage SuDS Statutory Guidance (2019)
- CIRIA SuDS Manual C753 (2015)
- Torfaen County Borough Council (TCBC) Preliminary Flood Risk Assessment Addendum (2015)
- TCBC Flood and Water Management Act 2010 Section 19 Flood Investigation Report – Cwmbran (2014)
- TCBC Flood Risk Management Plan (FRMP) (2015)
- TCBC Local Flood Risk Management Strategy (LFRMS) (2013)
- TCBC Local Development Plan (LDP) (2013)

## EXECUTIVE SUMMARY

Wardell Armstrong have been commissioned by Elgin Energy Es Co Limited to produce a Flood Consequence Assessment and Drainage Strategy to accompany a pre-planning application. Table 1 summarises the details of the development, flood risk to the site and proposed drainage strategy.

| **Table 1: Site Summary** | |
|---|---|
| **Site Location** | The site is located at Pentre Bach Farm, which is to the north of Pentre Lane, Torfaen. The closest postcode to the site is NP44 7AR. The grid reference at the centre of the site is ST 28274 92524. |
| **Proposed Development** | The proposed development will comprise a solar farm |
| **National Resources Wales Flood Zone** | Entirely in zone A |
| **Flood Risk Vulnerability Classification** | Less Vulnerable |
| **Fluvial Flood Risk** | Low Risk |
| **Tidal Flood Risk** | Low Risk |
| **Surface Water Flood Risk** | Low Risk |
| **Groundwater Flood Risk** | Low Risk |
| **Sewer Flood Risk** | Very Low |
| **Reservoir, Canal and Lake Flood Risk** | Very Low Risk |
| **Justification Test** | Justification Test not required. |
| **Surface Water Drainage Strategy** | It is proposed to utilise Sustainable Drainage Systems to manage surface water runoff from the proposed development in line with current best practice.<br>The runoff from the solar panels will infiltrate into the ground beneath each row of panels and permeable access tracks will be utilised to allow direct infiltration to the ground.<br>The runoff from twelve of the inverter substations will be directed to infiltration trenches, these will infiltrate directly to ground.<br>The runoff from the remaining six inverter substations will be directed to filter trenches, which will discharge to local watercourses within the site.<br>Permeable surfacing will be provided within the energy storage compound to allow infiltration to ground. Within the energy storage compound runoff from the storage units will be directed via filter trenches to an attenuation tank which will then discharge to a local watercourse via a HydroBrake. |

# 1 INTRODUCTION

1.1.1 Wardell Armstrong have been instructed by Elgin Energy Es Co Limited (the client) to complete a Flood Consequence Assessment (FCA) and Drainage Strategy for the proposed development at Pentre Bach Solar Farm, Torfaen.

1.1.2 As part of the site appraisal process it is necessary to demonstrate that the proposed development has an acceptable risk of flooding over the development's lifetime, taking climate change into account.

1.1.3 This FCA assesses the risk of flooding from all sources, including fluvial, tidal, surface water, groundwater, existing and proposed drainage infrastructure and other artificial sources in accordance with the 2004 Welsh Government Technical Advice Note 15 'Development and Flood Risk' (TAN15).

1.1.4 In addition, this report provides a comprehensive site wide surface water, demonstrating the principles of sustainable surface water management.

1.1.5 This report will form part of a larger suite of information to support an an outline planning application for the proposed development of the site.

## 1.2 Acknowledgement

1.2.1 Within this report data from the British Geological Survey (BGS) website has been 'Reproduced with the permission of the British Geological Survey © NERC. All rights reserved'. Reproduction of any BGS materials does not amount to an endorsement by NERC or any of its employees of any product or service and no such endorsement should be stated or implied.

1.2.2 Data from the National Resources Wales (NRW) has been included within this report. Flood risk data is now classed as open data. 'Open Data can be accessed, used and shared by anybody. It allows access to our data under the Open Government Licence – free of charge and free of restriction, even for commercial use.'

# 2 EXISTING SITE CONDITIONS AND DEVELOPMENT PROPOSALS

## 2.1 The Site and Surrounding Area

2.1.1 The site is located at Pentre Bach Farm, which is to the north of Pentre Lane, to the east of Llantarnam, Torfaen. The closest postcode to the site is NP44 7AR. The grid reference at the centre of the site is ST 28274 92524.

2.1.2 The site is bounded on all sides by agricultural land related to the farms in the area. Pentre Lane runs across the southern border of the site. This approximate redline boundary is shown in Figure 1.


Figure 1 – Site Location Plan
(Source: www.google.co.uk/maps)

## 2.2 Development Proposals

2.2.1 The development proposals comprise a ground mounted photovoltaic solar farm and energy storage facility, together with associated equipment, infrastructure and ancillary works.

2.2.2 The total indicative site area is 44.95ha including area for the substations.

2.2.3 The proposals are for a 40MW photovoltaic solar farm, with panels installed on ground mounted fixed metallic frames. An indicative layout plan of the solar panel arrays provided by Barton Willmore is shown on Drawing No. 9007.

2.2.4 The solar panels will be installed in rows across the site, in an appropriate south facing direction at an angle of approximately 25 degrees from the ground.

2.2.5 There are three module options for the solar panels. There is a single post option, a table post option, and a concrete base option. The details of these three options are shown on Drawing No. 9007 and in Figure 2 below.

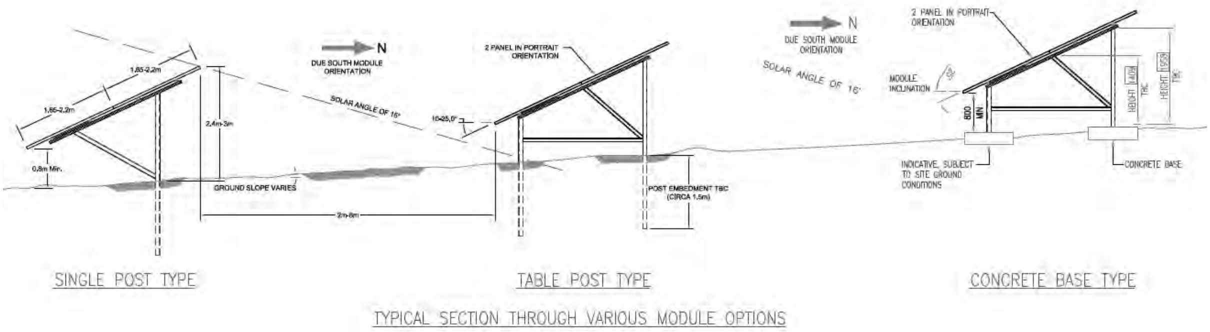



Figure 2 – Solar Panel Module Options
(Source: Barton Willmore)

2.2.6 Panels will not be located on any land with a gradient that exceeds 1:9.5.

2.2.7 Cables will be laid on elevated trays and in trenches hence will not act as flow paths for storm run-off.

## 2.3 Existing Topography

2.3.1 A topographical survey was carried out by Survey Solutions in September 2020, which shows levels falling from approximately 88mAOD in the northwest to approximately 33mAOD in the southeast.

2.3.2 The latest topographical survey (Drawing No. 27002) accompanies this report.

## 2.4 Proximity to Watercourses

2.4.1 There are no main rivers within the vicinity of the site. There are, however, a number of local ordinary watercourses in the vicinity of the site. The first flows southwards, through the eastern part of the site. The second watercourse flows south-westwards from the centre of the site and is a tributary to the third ordinary watercourse which flows southwards adjacent to the western site boundary. These watercourses are shown below in Figure 3.

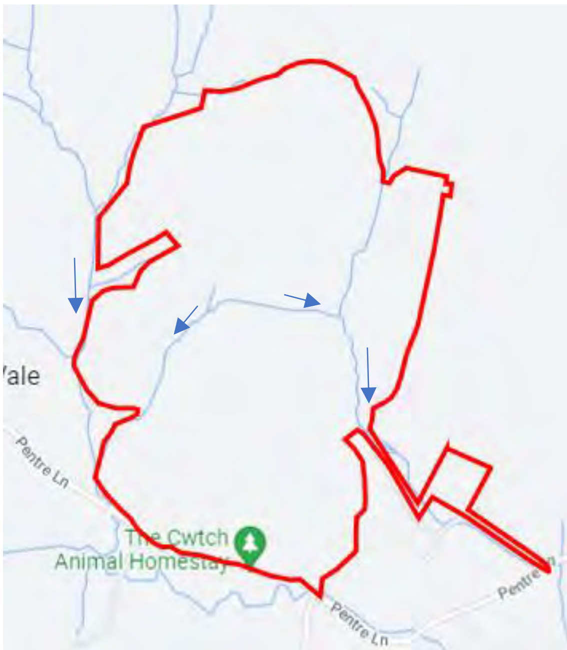



Figure 3 – Watercourse Locations
(Source:  www.google.co.uk/maps)

## 2.5 Geology and Ground Conditions

2.5.1 According to the BGS, bedrock geology in the area comprises 'Maughans Formation-Sandstone'. See Figure 4.

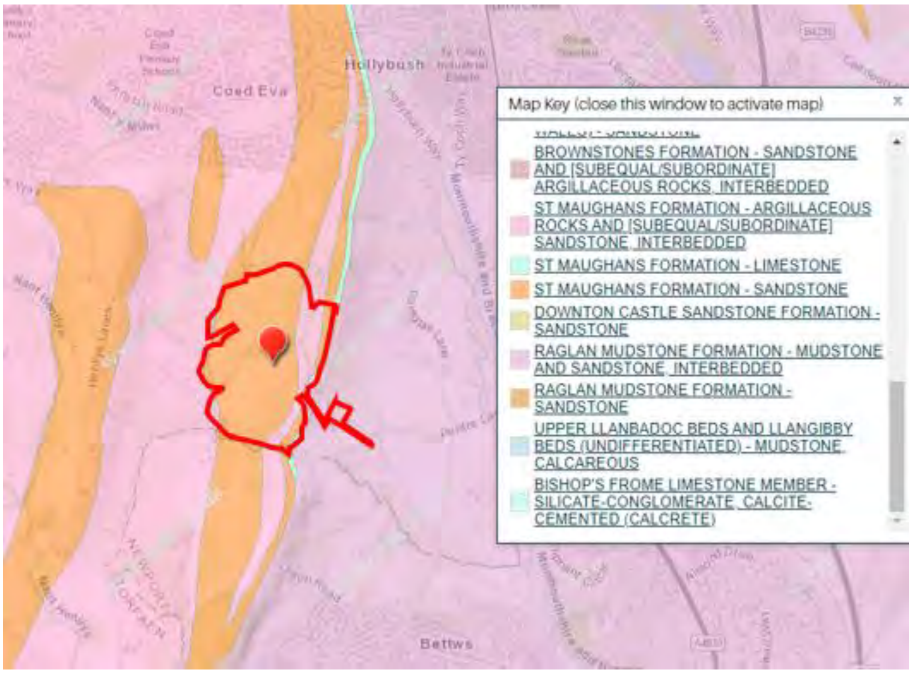



Figure 4 – Bedrock Geology
(Source: http://mapapps.bgs.ac.uk/geologyofbritain/home.html)

2.5.2 BGS records show no recorded superficial deposits at the site.

2.5.3 There are no borehole records in the immediate vicinity of the site for which the bedrock geology is the same as at the site. However, borehole reference number ST29SE24 located around 1.1km east of the site, excavated to 7.0m below ground level (38.7mAOD) does not encounter groundwater.

## 2.6 Hydrogeology

***Source Protection Zones***

2.6.1 Groundwater provides a third of drinking water in England and Wales, and maintains the flow in many of our rivers. The EA have defined Source Protection Zones (SPZ's) for 2000 groundwater sources such as springs, boreholes and wells used for the public drinking supply. These zones show the risk of contamination from any activities that might cause pollution in the area – the closer the activity the greater the risk. The maps show three main zones (inner, outer and total catchment) and a fourth zone of special interest, which occasionally applies to a groundwater source.

2.6.2 Llywodraeth Cymru Welsh Government (LCWG) mapping shows that the site is not within a SPZ.

***Aquifers***

2.6.3 Aquifers are underground layers of water-bearing permeable rock or drift deposits from which groundwater can be extracted. Aquifer designations reflect their importance in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the BGS, which is updated regularly to reflect ongoing improvements.

2.6.4 BGS mapping indicates that the site is underlain by a Secondary A bedrock aquifer, defined as permeable layers supporting water supplies at a local scale and forming a source of base flow to rivers. The site is not underlain by a superficial aquifer.

# 3 ASSESSMENT OF FLOOD RISK

## 3.1 National Planning Policy

3.1.1 TAN 15 was published in 2004 by the National Assembly for Wales. It sets out the Government's national policies on flood risk management in relation to land use planning in Wales. The TAN 15 document is to be read in conjunction with Planning Policy Wales (PPW) published in 2002.

3.1.2 TAN15 expects planning authorities to apply a risk-based approach to development planning and control through a Justification Test involving location justification, type of development and flooding consequences.

3.1.3 The TAN15 Development Advice Maps (DAM's) show areas potentially at risk from flood events of a 0.1% annual probability for river, tidal or coastal areas (i.e. 1 in 1,000 year). The Development Advice Maps divide the land area of Wales into three flood risk zones. These are denoted A, B and C, with Zone C further sub-divided into Zones C1 and C2. The Flood Zones are described in further detail in Table 2 below.

**Table 2: TAN15 Development Advice Map Flood Zones**

| Zone | Description | Use within the precautionary framework |
|---|---|---|
| A | Considered to be at little or no risk of fluvial or tidal/coastal flooding. | Used to indicate that Justification Test is not applicable and no need to consider flood risk further. |
| B | Areas known to have been flooded in the past evidenced by sedimentary deposits. | Used as part of a precautionary approach to indicate where site levels should be checked against the extreme (0.1%) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further. |
| C | Based on Environment Agency extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal). | Used to indicate that flooding issues should be considered as an integral part of decision making by the application of the Justification Test including assessment of consequences. |
| C1 | Areas of the floodplain which are developed and served by significant infrastructure, including flood defences. | Used to indicate that development can take place subject to application of Justification Test, including acceptability of consequences. |
| C2 | Areas of the floodplain without significant flood defence infrastructure. | Used to indicate that only less vulnerable development should be considered subject to application of Justification Test, including acceptability of consequences.<br>Emergency services and highly vulnerable development should not be considered. |

## 3.2 Development Advice Map

3.2.1 The 'Development Advice Map' for flood risk obtained from the Natural Resources Wales website shows the Flood Zones associated with the site (Figure 5). The map should be used alongside Planning Policy Wales and Technical Advice Note (TAN) 15 to guide new development away from areas at risk of flooding wherever possible.

3.2.2 The maps are based on the NRW extreme flood outlines (Zone C) and the British Geological Survey 10k Superficial Geology data (Zone B).

3.2.3 According to the Development Advice Map (DAM) the site, shown on Figure 5, is located entirely in Zone A, considered to be at little or no risk of fluvial or coastal/tidal flooding.

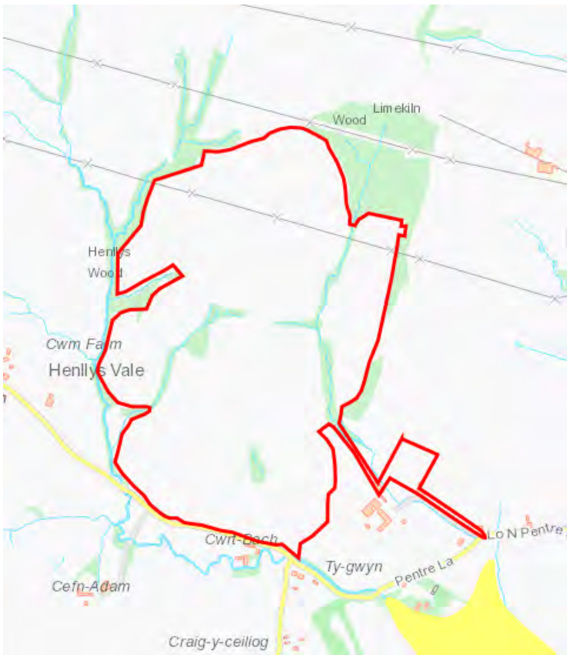



Figure 5 – Development Advice Map
(Source: https://maps.cyfoethnaturiolcymru.gov.uk/)

## 3.3 Flood Risk Vulnerability

3.3.1 TAN 15 identifies the Flood Risk Vulnerability Classification of development types. Development types can be classed as either ‘Emergency Services’, ‘Highly Vulnerable’ and ‘Less Vulnerable’ depending on their proposed use.

3.3.2 As the development is for a solar farm, it is considered to be Less Vulnerable.

## 3.4 Justification Test

3.4.1 The Justification Test, outlined in Section 6 of the 2004 TAN15 aims to direct new developments away from Zone C and towards suitable land in Zone A (or otherwise to Zone B), where river and coastal flooding will be less of an issue.

3.4.2 As the development is wholly located within Zone A, the Justification Test is not required.

## 3.5 Historic Flooding

3.5.1 Natural Resources Wales ‘*Recorded Flood Extents*’ mapping does not display any records of historic flooding to the site or its vicinity.

3.5.2 The 2015 Torfaen County Borough Council (TCBC) Flood Risk Management Plan (FRMP), 2015 TCBC Preliminary Flood Risk Assessment Addendum (PFRA) and 2014 Section 19 Report have been reviewed. There are no records of historical flooding affecting the site.

## 3.6 Consequences of Flooding to the Development

3.6.1 Flooding can occur from a range of sources including, but not limited to rivers, tidal waters and the sea, surface water runoff, groundwater, sewers and drains, and artificial sources such as canals and reservoirs. The presence of a potential flood source does not necessarily translate into a high risk of flooding. Following the source-pathway-receptor approach, flooding can only affect the site (receptor) if there is a pathway from the identified sources.

### Potential Sources of Flooding

3.6.2 Table 3 summarises the flood consequences to the proposed development. The risk is described in further detail in this section.

**Table 3: Summary of Flood Consequences to the Site**

| Type | Source | Pathway | Risk | Description |
|---|---|---|---|---|
| Fluvial Flooding (Rivers) | Yes | Yes | Low | The entire site is not considered at risk of fluvial flooding, with no historic records of fluvial flood risk. Flooding from smaller watercourses appears to be limited to the vicinity of the channel, although hydraulic river modelling has not been undertaken to attain this. |
| Tidal Flooding | No | No | N/A | - |
| Surface Water Flooding (Pluvial) | Yes | Yes | Low | Much of the site is at Very Low risk. Small areas adjacent to watercourses, within the site boundary that are at High, Medium and Low risk. |
| Groundwater Flooding | Yes | Yes | Low | The TCBC FRMP and PFRA Addendum did not identify any incidents of groundwater flooding at the site. |
| Sewer/Drain Flooding | No | No | N/A | Welsh Water records show there are no sewers in the vicinity of the site. The TCBC FRMP and PFRA Addendum contain no records of historical sewer flooding affecting the site. |
| Artificial Flooding | No | No | N/A | No reservoirs, canals or lakes near the vicinity of the site. |

**Fluvial Flooding**

3.6.3 The Natural Resources Wales fluvial flood map assigns Low, Medium and High risk to areas susceptible to fluvial flooding. These are defined as follows:

- Very Low – each year, these areas have a chance of flooding of less than 1 in 1000 (<0.1%);
- Low – each year, these areas have a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%);
- Medium – each year, these areas have a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%);
- High – each year, these areas have a chance of flooding of greater than 1 in 30 (>3.3%).

3.6.4 Natural Resources Wales Fluvial Flood Risk Mapping shows the site is at a Very Low risk of fluvial flooding. As can be seen from Figure 3, multiple watercourses are located across the site. Flooding from these smaller watercourses within the site appears to be limited to the vicinity of the channel, shown on Figure 6. It must, however, be noted that hydraulic river modelling has not been undertaken on these smaller watercourses.

3.6.5 The TCBC FRMP, PFRA Addendum and 2014 Section 19 Report do not contain any records of historical fluvial flooding affecting the site.

3.6.6 Based on the available information, the risk of fluvial flooding to the site is generally considered to be Low. However, without detailed flood risk modelling, the extents and depths of flooding from the ordinary watercourses cannot be confirmed.

**Tidal Flooding**

3.6.7 Tidal flooding is caused by exceptionally high sea levels and extreme wave heights. Tidal flooding is incorporated into the Development Advice Map and Flood Zone designation.

3.6.8 Due to the site's inland location, tidal flooding is not considered to be a risk at this site.

**Surface Water Flooding**

3.6.9 Surface water flooding is caused by rain falling onto the surface which does not reach watercourses or drainage infrastructure. The Natural Resources Wales 'Risk of Flooding from Surface Water' mapping examines the risk of flooding from surface water assuming local estimates of sewer infiltration losses. The likelihood of surface water flooding is split into four categories; 'Very Low', 'Low', 'Medium' and 'High' risk.

3.6.10 The 'Risk of Flooding from Surface Water' mapping is shown in Figure 6.

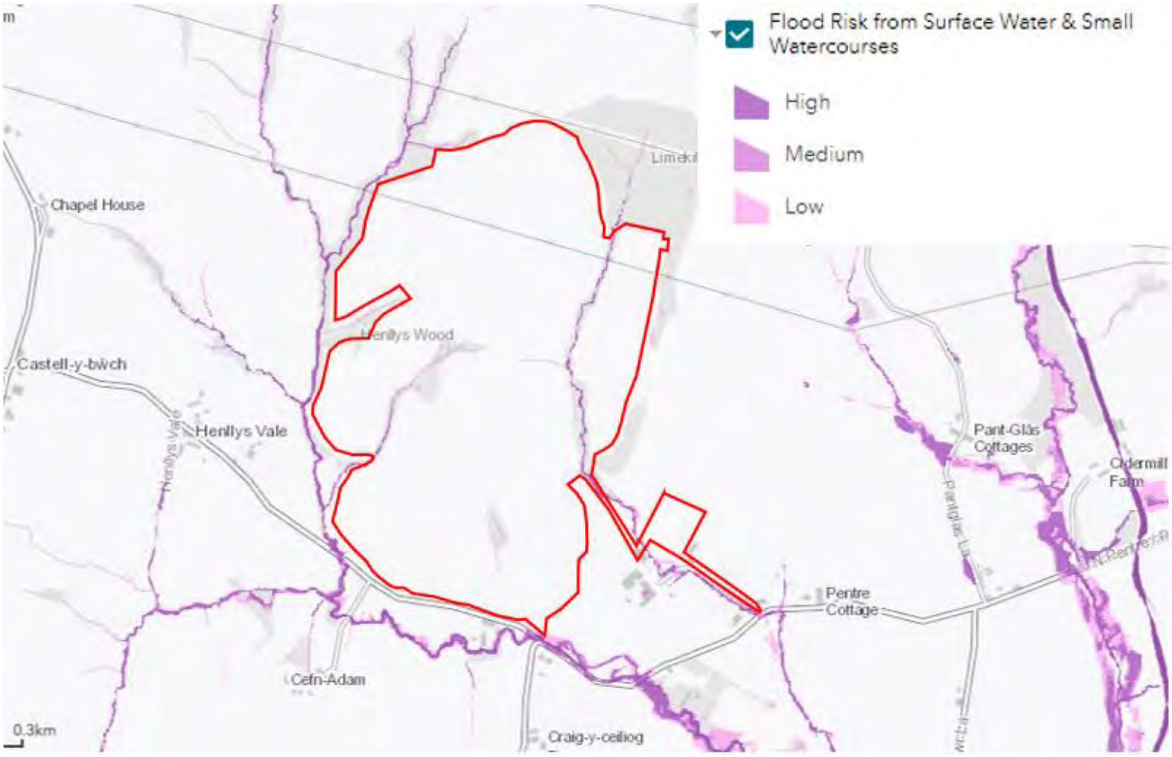



Figure 6 – Flood Risk from Surface Water
(Source: https: //maps.cyfoethnaturiolcymru.gov.uk)

3.6.11 Natural Resources Wales mapping indicates that most of the site lies in a Very Low probability of flooding from surface water. However, there are small areas within the site boundary adjacent to watercourses that fall within the High, Medium and Low flood risk probability.

3.6.12 The TCBC FRMP and TCBC PFRA Addendum have been reviewed. However, there are no records of historical fluvial flooding affecting the site.

3.6.13 It is therefore considered that the risk of flooding from surface water is Low.

**Groundwater Flooding**

3.6.14 Groundwater flooding can occur anywhere where groundwater levels rise above the ground surface. Groundwater flooding can be difficult to predict and identify and is often associated with surface water flooding.

3.6.15 The risk of groundwater flooding was assessed in the TCBC FRMP and TCBC PFRA Addendum. This identified no incidents of groundwater flooding at the site.

3.6.16 There are no borehole records in the immediate vicinity of the site for which the bedrock geology is the same as which underlays the site. However, borehole reference number ST29SE24 located around 1.1km east of the site, excavated to 7.0m below ground level (38.7mAOD) does not encounter groundwater.

3.6.17 Based upon information provided within the FRMP, PFRA Addendum and BGS borehole records the site is considered to be at Low risk of groundwater flooding.

**Existing Sewers and Drains**

3.6.18 Flooding from sewers and drains can occur when capacity is exceeded or there is a blockage or collapse in the network.

3.6.19 Sewer records have been obtained from Dwr Cymru Welsh Water (DCWW). There are no sewers within the vicinity of the site. The sewer records are attached in Appendix A.

3.6.20 The TCBC FRMP and TCBC PFRA Addendum contains no records of historical sewer flooding affecting the site.

3.6.21 Private drainage may be present in the adjacent farm buildings, although this is likely to be small and self-contained, prosing minimal risk to the site.

3.6.22 Based on the available information, the risk of sewer flooding is considered to be Very Low.

**Reservoirs, Canals and Lakes**

3.6.23 Flooding from reservoirs, canals and lakes occurs when their associated dams, embankments or other retaining structures fail or are breached.

3.6.24 There are no reservoirs near the site. The Natural Resources Wales 'Risk of Flooding from Reservoirs' mapping indicates that the site is not at risk of reservoir flooding.

3.6.25 There are no canals or lakes near the site. Therefore, the risk of flooding from reservoirs, canals and lakes in this location is considered to be Very Low.

## 3.7 Flooding Consequences from the Proposed Development

3.7.1 New developments can pose a risk of flooding to neighbouring properties and areas downstream of the site, often as a result of an increase in impermeable area which has the effect of increasing the rate and volume of surface water runoff. Additionally, climate change can be expected to cause an increase in rainfall intensity and surface water runoff over the lifetime of the development.

3.7.2 Flood risk can also be increased as a result of new development if the development reduces the floodplain storage area or alters flood flow paths, ultimately displacing flood water and resulting in an increased risk to the surrounding area.

***Fluvial Flooding***

3.7.3 Natural Resources Wales mapping shows the site is at a Very Low risk of Fluvial Flooding. Flooding from smaller watercourses, shown on Figure 6, shows flooding is limited to the vicinity of the channel, presenting no risk to the wider site. It must, however, be noted that hydraulic river modelling has not been undertaken on these smaller watercourses. As no floodplain is identified on NRW fluvial flood maps and flooding smaller watercourses mapping, it is unlikely floodplain compensation will be required.

3.7.4 Fluvial flood risk should also be effectively managed to make the consequences of flooding within the proposed development acceptable. Measures to manage the potential consequences of fluvial flooding will include:

- ensuring all future occupiers are aware of the flooding risks and consequences;
- providing effective flood warnings;
- having flood emergency plans and procedures in place to ensure no operatives stay on site during flood events;
- ensuring evacuation routes are operational under all conditions;
- Remain up to date with local flood warnings and prepare for possible flood events.

***Pluvial Flooding***

3.7.5 Natural Resources Wales mapping shows the site is largely at a Very Low risk of surface water flooding, with the exception of small areas adjacent to watercourses at High, Medium and Low risk.

3.7.6 As solar panels are raised above ground level, on piles, flood flows will generally not be impacted by their presence. Flood flows can pass between the piles without being impeded or diverted, creating minimal impact on flood routes. Substations are to be well-spaced across the development, also posing minimal impact on flood flow routes.

***Surface Water Runoff***

3.7.7 As the existing site largely comprises agricultural land, the impermeable area of the site will increase as a result of the proposed development, potentially causing an increase in the rates and volumes of surface water runoff generated during storm events. Mitigation measures will be required to ensure the risk of flooding to downstream areas does not increase.

***Climate Change***

3.7.8 It is also necessary to take account of climate change for the lifetime of the development when assessing future flood risk. NRW and UK Government guidance provides predictions of anticipated changes to peak river flows and rainfall intensity for consideration on new developments. In assessing fluvial flooding from the proposed development, the climate change predictions for peak rainfall intensity for the lifetime of the development need to be considered. An increase of intensity and frequency of rainfall is likely to raise river levels and increase the likelihood of a river overtopping its banks.

3.7.9 An increase in rainfall intensity could also increase the rate and volume of surface water generated during a storm event and this should be considered when assessing surface water flood risk. The Welsh Government 'Flood Consequences Assessment: Climate Change Allowances' report states that non-residential development should have an assumed lifespan of 75 years and, based on Table 2 from the report, the Upper estimate of a 40% increase in rainfall intensity should be considered.

3.7.10 It is, therefore, considered that the risk of surface water flooding as a result of climate change would increase, and so mitigation measures are required.

# 4 FLOOD RISK MITIGATION AND RESIDUAL RISK

***Surface Water Management***

4.1.1 To mitigate the potential increase in flood risk, surface water runoff from the proposed development will be restricted to existing rates. Flows which exceed the restricted discharge rates will be attenuated within the site areas for all storm events up to and including the 1 in 100-year event, including a 40% allowance for climate change. To help achieve this, Sustainable Drainage Systems (SuDS) will be incorporated into the development to provide attenuation. Further details are included in the Drainage Strategy (see Section 5).

4.1.2 The risk of flooding to areas of the site will not, therefore, increase as a result of the proposed development.

***Residual Risk***

4.1.3 There is always a possibility of a storm event that exceeds the design standards of the proposed flood risk management measures for new developments. Potential risks include the exceedance of the surface water attenuation facilities during extreme storm events.

4.1.4 As the proposed attenuation will have sufficient capacity for the 1 in 100-year storm event (plus a 40% allowance for climate change) it is considered that the risk of exceedance is low.

4.1.5 It is proposed that if an exceedance event does occur, any exceedance flows not taken up by vegetation, will follow the topography of the site, towards existing watercourses, causing no risk to those previously unaffected.

# 5 PROPOSED SURFACE WATER DRAINAGE STRATEGY

## 5.1 Background

5.1.1 The Flood and Water Management Act 2010 (Schedule 3), which came into effect in Wales on 7 January 2019, requires new developments to include Sustainable Drainage Systems (SuDS) features that comply with national standards.

5.1.2 From 7 January 2019, new developments of more than one dwelling or where the area covered by construction work equals or exceeds 100 square metres require approval before construction can commence from the SuDS Approval Body (SAB). Adoption and management arrangements, including a funding mechanism for maintenance of SuDS infrastructure and all drainage elements are to be agreed by the SAB as part of this approval. This will ensure that SuDS infrastructure is properly maintained and functions effectively for its design life.

## 5.2 Sustainable Drainage (SuDS) Statutory Guidance

5.2.1 The Welsh Government Statutory Standards for SuDS contains a set of principles which must be applied in the design of any surface water drainage scheme in order to obtain approval from the SAB Body. There are 6 SuDS standards, Standard S1 is a Hierarchy Standard which gives criteria for prioritising the choice of runoff destination, while S2 to S6 are Fixed Standards. The fixed standards state the minimum design criteria, how SuDS should be built, maintained, and operated.

5.2.2 S1 - Runoff destination:

- The runoff destination should be prioritised as follows: collect for use; infiltrated to ground; discharge to a surface water body; discharge to a surface water sewer, highway drain, or another drainage system; discharged to a combined sewer.

5.2.3 S2 - Hydraulic control:

- Surface water should be managed to prevent, so far as possible, any discharge from the site for the majority of rainfall events of less than 5mm.
- The surface water runoff rate for the 1 in 1-year return period event (or agreed equivalent) should be controlled to help mitigate the negative impacts of the development runoff on the morphology and associated ecology of the receiving surface water bodies.
- The surface water runoff (rate and volume) for the 1% (1 in 100 year) return period event (or agreed equivalent) should be controlled to help mitigate negative impacts of the development on flood risk in the receiving water body.

- The surface water runoff for events up to the 1% (1 in 100 year) return period (or agreed equivalent) should be managed to protect people and property on and adjacent to the site from flooding from the drainage system.
- The risks (both on site and off site) associated with the surface water runoff for events greater than the 1% (1 in 100 year) return period should be considered. Where the consequences are excessive in terms of social disruption, damage, or risk to life, mitigating proposals should be developed to reduce these impacts.
- Drainage design proposals should be examined for the likelihood and consequences of any potential failure scenarios (e.g. structural failure or blockage), and the associated flood risks managed where possible.

5.2.4 S3 – Water quality:

- Treatment for surface water runoff should be provided to prevent negative impacts on the receiving water quality and/or protect downstream drainage systems, including sewers.

5.2.5 S4 – Amenity:

- The design of the surface water management system should maximise amenity benefits.

5.2.6 S5 – Biodiversity:

- The design of the surface water management system should maximise biodiversity benefits.

5.2.7 S6 - Construction, operation, and maintenance:

- All elements of the surface water drainage system should be designed so that they can be constructed easily, safely, cost-effectively, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).
- All elements of the surface water drainage system should be designed to ensure maintenance and operation can be undertaken (by the relevant responsible body) easily, safely, cost-effectively, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).
- The surface water drainage system should be designed to ensure structural integrity of all elements under anticipated loading conditions over the design life of the development site, taking into account the requirement for reasonable levels of maintenance.

5.2.8 The statutory SuDS Standards encourage SuDS techniques such as wetlands, swales, ponds, and vegetated systems which can help increase access to green spaces and provide community facilities to bring people together.

## 5.3 Local Requirements

5.3.1 The TCBC Local Development Plan (LDP) has been reviewed for any policies relevant to this assessment. Policy S3 states:

"Development proposals shall seek to mitigate the causes of further climate change and adapt to the current and future effects of climate change; and will be supported where they demonstrate consideration of the following hierarchy of criteria (where appropriate):

a) Ensuring that locational decisions are sustainable and avoid areas susceptible to flooding unless justified by national planning policy;

b) Achieving Sustainable Design to ensure residual energy requirements are minimised through: -

i. Supporting climate responsive development through location, orientation, density, layout, built form, materials and landscaping;

ii. Reducing surface water run-off and flood risk through the use of Sustainable Urban Drainage Schemes (SUDS) unless it is shown that these measures are uneconomic or impractical;

iii. Promoting water efficiency by reducing the demand for water; and iv) Exploring opportunities to maintain habitat connectivity through the provision of green infrastructure in design."

5.3.2 The TCBC Local Flood Risk Management Strategy (LFRMS) has also been reviewed. Policy 1.6 states:

"The philosophy of SUDS is to replicate, as closely as possible, the natural drainage from a site before development. The objectives of sustainable drainage are quality, quantity and amenity and biodiversity.

It is anticipated that SUDS will achieve the following:

i. Reduce runoff rates, thus reducing the risk of downstream flooding
ii. Reducing the additional runoff volumes and runoff frequencies that tend to be increased as a result of urbanisation, and which can exacerbate flood risk and damage receiving water quality

iii. Encourage natural groundwater recharge to minimise the impact on aquifers and river base flows in the receiving catchment

iv. Reducing pollutant concentration in stormwater, thus protecting the quality of the receiving water body

v. Acting as a buffer for the accidental spills by preventing direct discharge of high concentrations of contaminants to the receiving water body

vi. Reducing the volume of surface water runoff discharging to combined sewer systems, thus reducing discharges of polluted water to watercourses via Combined Overflows (CSO) spills

vii. Contributing to the enhanced amenity and aesthetic value of developed areas."

5.3.3 TCBC refer to CIRIA C753 for guidance in relation to SuDS. Key requirements in this guidance include:

- Discharge hierarchy; Re-use, Infiltration, Watercourse, Surface Water Sewer, Combined Sewer
- Run-off rate; Limit flows to the greenfield runoff rate. If rate is considered unachievable then a runoff rate of 2l/s should be used as a minimum.
- Volume control; An interception value of 5mm required storage per every m2 of impermeable area will be implemented in SuDS design.

5.3.4 The following surface water strategy has been developed in line with the local policy and SuDS requirements.

## 5.4 Discharge Hierarchy

5.4.1 In accordance with Building Regulations (and CIRIA C753) the preferred hierarchy for disposal of surface water is: infiltration; watercourse; sewer.

5.4.2 Infiltration testing has not been carried out at this stage. Based upon review of BGS data, the site is underlain by 'Maughans Formation-Sandstone' and information from the National Soil Resources Institute (NSRI) of Cranfield University describes the soils at the site as 'Slightly acid loamy and clayey soils with impeded drainage'.

5.4.3 Confirmation of the infiltration rates at the location of the SuDS features will be needed to set the masterplan. The typical infiltration rates for sandstone are $1x10^{-6}$m/s. This infiltration rate is lower than the minimum infiltration rate of $1x10^{-5}$m/s (0.036m/hr) required by the SAB. Infiltration testing will be required and discharge rates will need to be agreed with the SAB as part of the SAB pre-app process.

5.4.4 For the purposes of this drainage strategy, it is assumed that infiltration alone will not be a suitable means of surface water discharge from the site. It is proposed, therefore, that surface water runoff from any impermeable areas within the site will be discharged to the local watercourses where possible. Any hardstanding areas remote from the watercourses will discharge surface water runoff via infiltration.

## 5.5 Surface Water Drainage Strategy

5.5.1 CIRIA report C753 'The SuDS Manual' outlines the various types of SuDS, their benefits and limitations and design considerations associated with each. Not all SuDS components/methods are feasible or appropriate for all developments due to factors such as ground conditions, available space, and site levels, which will influence the different methods adopted as part of a particular development. Given the nature of the site and existing ground conditions the following surface water drainage strategy is proposed.

5.5.2 The rainfall landing on the proposed solar panels will drain off the panel onto the ground beneath and between each row of panels. From there, it will infiltrate into the existing ground, mimicking the existing situation. There will be no increase in the volume of run off leaving the site from the solar panels.

5.5.3 It is proposed that the access roads are surfaced with coarsely graded aggregate that will act as a permeable surface allowing storm runoff to percolate through into the soil beneath at the grounds natural infiltration rate.

5.5.4 The Indicative Site Layout includes sixteen invertor substations (7.5m x 2.5m) at various locations across the site (this is a worst case scenario for assessment purposes as the final number of inverters will be confirmed when the final site layout is approved under a planning condition). Due to the small size of the invertor substations and distance from the watercourses within the site, it is not practical to discharge to watercourse, therefore it is proposed that twelve of the invertor substations will discharge to infiltration trenches located alongside the edge of each substation. The infiltration trenches will then discharge to the ground at the natural infiltration rate.

5.5.5 There are a number of watercourses that run through the site. Six of the invertor substations are located in the vicinity of these watercourses. The runoff from these invertor substations will discharge to filter trenches located alongside the edge of each substation before discharging to the closest ditch at a natural discharge rate.

5.5.6 It is proposed that the ground surface within the energy storage compound will be permeable to allow storm runoff to percolate through into the soil beneath. The runoff from the storage units located at the compound will also drain via filter trenches to an attenuation tank located within the compound. The attenuation tank will then discharge to a local watercourse via a HydroBrake at 2.0l/s.

5.5.7 Refer to drawing CA11956-003 for the full drainage strategy.

5.5.8 The final discharge to the watercourse from the proposed development will require consent from the Local Authority.

5.5.9 The strategy set out above will need to be confirmed with onsite infiltration testing and agreed with the SAB through the pre-app SAB approval process.

## 5.6 Greenfield Runoff Rate

5.6.1 Greenfield runoff rates for the site have been calculated using the FEH Method in MicroDrainage. The QBAR greenfield runoff rate for this site has been calculated to be 3.85 l/s/ha. Full MicroDrainage calculations are included in Appendix B.

5.6.2 The combination of low greenfield run off rates with small contributing areas, results in very low discharge rates. As such a maximum discharge rate of 2.0l/s has been proposed for the Energy Storage Compound. The proposed flow rate has been set to 2.0l/s to avoid small orifices and to limit the risk of blockage of the control structure. The area of the invertor substations is so small that it is not practical to restrict the runoff.

## 5.7 Attenuation Requirements Energy Storage Compound

5.7.1 To achieve greenfield runoff rates, attenuation storage is required for the Energy Storage Compound. MicroDrainage software has been used to size the attenuation.

5.7.2 An attenuation tank is proposed for the impermeable surfaces within the energy storage compound as shown in Table 4 and as set out in the MicroDrainage calculation in Appendix B.

**Table 4: Energy Storage Compound Attenuation Tank Details**

| Catchment | Approx. Total Area (ha) | Approx. Impermeable Area (ha) | Max. allowable discharge rate (l/s) | Approx. Attenuation Vol. Required ($m^3$) | Approx. Attenuation Plan Area Required ($m^2$) | Attenuation Feature(s) |
|---|---|---|---|---|---|---|
| Energy Storage Compound | 0.096 | 0.029 | 2.0 | 8.8 | 24 | Attenuation Tank |

5.7.3 The surface water drainage strategy is based on the following parameters:

- Attenuation volumes based on 1 in 100yr rainfall event, including a 40% allowance for climate change;
- Attenuation tank depth of 0.4m with 1m of cover;
- Greenfield runoff rate of 2.0l/s to avoid blockage in the control structure.

## 5.8 Filter and Infiltration Trench Design

5.8.1 The Invertor substations discharging to the ditches will have filter trenches located along the edge of each side of the substation. The filter trench will then discharge directly to the ditch via a pipe. The detail of the trench is shown in Table 5.

**Table 5: Invertor Substation Filter Trench**

| Catchment | Approx. Total Area (ha) | Approx. Impermeable Area (ha) | Filter Trench Depth (m) | Filter Trench Width (m) | Filter Trench Length (m) | Pipe Size (mm) | Attenuation Feature(s) |
|---|---|---|---|---|---|---|---|
| Half Invertor Substation Roof | 0.0018 | 0.0018 | 0.5 | 0.7 | 7.0 | 150 | Trench |

5.8.2 The invertor substations infiltrating to the ground will have infiltration trenches located along the edge of each side of the invertor substations, each serving half the roof, these will discharge directly to ground. The details of the infiltration trench are shown in Table 6.

**Table 6: Invertor Substation Infiltration Trench**

| Catchment | Approx. Total Area (ha) | Approx. Impermeable Area (ha) | Max Assumed Infiltration Rate (m/s) | Infiltration Trench Depth (m) | Infiltration Trench Width (m) | Infiltration Trench Length (m) | Attenuation Feature(s) |
|---|---|---|---|---|---|---|---|
| Half Invertor Substation Roof | 0.0018 | 0.0018 | 1x10-6 | 0.5 | 0.7 | 7.0 | Infiltration Trench |

# 6 WATER QUALITY TREATMENT AND POLLUTION PREVENTION

## 6.1 Water Quality

6.1.1 The surface water drainage system, which will incorporate SuDS, will ensure that a sufficient level of water quality treatment is provided to make sure that the proposed development does not have any adverse impact on of the receiving network.

6.1.2 Runoff from the invertor substations and energy storage unit is considered to present a 'low' source of runoff pollution in accordance with CIRIA C753 and The Simple Index Approach should be used. The pollution hazard index is outlined Table 7.

**Table 7: Pollution Hazard Index (After Table 26.2 CIRIA C753)**

| Land use | Pollution Hazard | Total Suspended Solids (TSS) | Metals | Hydrocarbons |
|---|---|---|---|---|
| Invertor Substation Roof – to watercourse | Low | 0.3 | 0.2 | 0.05 |
| Energy Storage Unit Roof | Low | 0.3 | 0.2 | 0.05 |

6.1.3 The mitigation indices indicate that filter drains will provide the mitigation set out in Table 8.

**Table 8: Mitigation Indices (After Table 26.3 CIRIA C753)**

| Land use | SuDS Feature | TSS | Metals | Hydrocarbons |
|---|---|---|---|---|
| Invertor Substation Roof – to watercourse | Filter Drain | 0.4 | 0.4 | 0.4 |
| Energy Storage Unit Roof | Filter Drain | 0.4 | 0.4 | 0.4 |

6.1.4 The mitigation indices have been applied to the invertor substations and energy storage units to demonstrate that the pollution hazard has been addressed as outlined in Table 9.

**Table 9: Mitigation Indices Calculations**

| Feature | TSS | Metals | Hydrocarbons |
|---|---|---|---|
| Invertor Substation Roof – to watercourse | 0.3 | 0.2 | 0.05 |
| Filter Drain | -0.4 | -0.4 | -0.4 |
| Total | ≤ 0 | ≤ 0 | ≤ 0 |
| Pollution Hazard Addressed | | | |
| **Feature** | **TSS** | **Metals** | **Hydrocarbons** |
| Energy Storage Unit Roof | 0.3 | 0.2 | 0.05 |
| Filter Drain | -0.4 | -0.4 | -0.4 |
| Total | ≤ 0 | ≤ 0 | ≤ 0 |
| Pollution Hazard Addressed | | | |

## 6.2 Soil and Vegetation Management

6.2.1 Soil compaction and disturbance will be kept to a minimum. Any disturbances caused by the installation of the solar farm should be harrowed and seeded prior to final commissioning.

6.2.2 During construction soil compaction will be avoided by placing ground protection mats on temporary access routes. These mats will distribute the vehicle weight along the surface to minimise the risk of compaction.

6.2.3 Upon completion of the solar farm the vegetative cover of the site should be maintained reducing the risk of soil erosion and reducing potential runoff.

# 7 ADOPTION AND MAINTENANCE

7.1.1 As part of the planning application approval process and SAB approval, the Local Planning Authorities and Lead Local Flood Authority must satisfy themselves that the proposed minimum standards of operation are appropriate and that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

## 7.2 SuDS Features

7.2.1 As the SuDS serve a single development, they are not adoptable by the SAB and therefore will be maintained by Elgin Energy Es Co Limited or a private management company appointed by Elgin Energy Es Co Limited. Maintenance of the access roads and vegetation will need to be provided in order to ensure that soil erosion is kept to a minimum and that the existing drainage regime is not altered.

7.2.2 Typical maintenance schedules for the drainage elements are included in Appendix C.

# 8 CONCLUSIONS

8.1.1 The proposed development at Pentre Bach, Torfaen, will comprise the construction of a solar farm.

8.1.2 Natural Resource Wales mapping indicates that the site is located entirely in Zone A therefore this site is suitable for development in terms of fluvial flood risk. Flooding from the smaller watercourses within the site appears to be limited to the vicinity of the channel, although it must be noted that hydraulic river modelling has not been undertaken to attain this. The flood risk to the development is considered to be Low overall.

8.1.3 BGS records indicates that underlain by sandstone. Infiltration testing will be required to determine the preferred method of surface water disposal, this is a requirement of the SAB application and should be undertaken to support the next stage of the design process.

8.1.4 To ensure that the development does not have any adverse offsite impacts and increases flood risk elsewhere surface water runoff should be sustainably managed and disposed of using SuDS techniques.

8.1.5 To replicate pre-developed conditions, it is proposed that run-off from the solar panels will infiltrate directly into the ground and the access tracks will be permeable to allow surface water to discharge directly to the ground at the natural infiltration rate.

8.1.6 It is proposed runoff from 12 of the invertor substations will discharge to infiltration trenches located alongside the buildings, these will infiltrate to the ground at the natural infiltration rate.

8.1.7 It is proposed runoff from the remaining 6 invertor substations will discharge to filter trenches located alongside the buildings, these will discharge to watercourses located close to the substations.

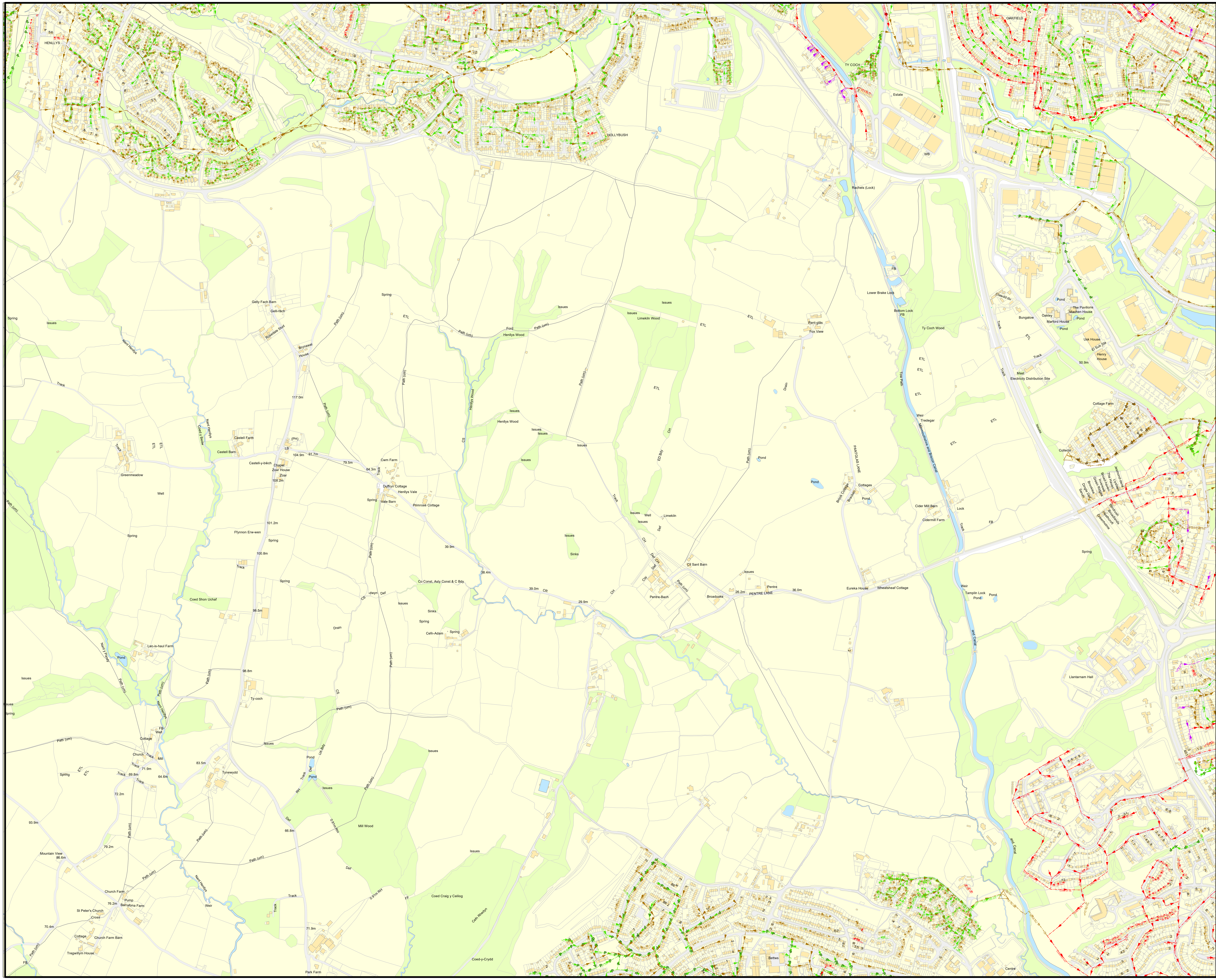
8.1.8 It is proposed runoff from the buildings at the energy storage compound will all be directed to filter trenches. These filter trenches will then discharge to an attenuation tank located within the substation. This tank will then discharge to the local watercourse via a HydroBrake at 2.0l/s.

8.1.9 The surface water drainage strategy will need consider other SuDS and incorporate SuDS principles to satisfy the Welsh Government Sustainable Drainage Systems Standards for Wales and secure SAB approval for the development.

8.1.10 In conclusion, it has been demonstrated that the site can be developed in compliance with Planning Policy Wales, TAN 15 and the Welsh Government Sustainable Drainage Systems Standards for Wales.

# APPENDICES

# APPENDIX A
# SEWER RECORDS




Dŵr Cymru
Welsh Water

Pentre Bach Solar Farm Llantarnam Torfaen
NP44 7AR

N
W E
S

**LEGEND(Representative of most common features)**

Waste network:

| | | | |
|---|---|---|---|
| Foul chamber | | Outfall | |
| Surface water chamber | | Lamphole | LH |
| Combined chamber | | Storm Overflow | |
| Combined sewer overflow | C O | Rising main | |
| Special purpose chamber | SPC | Gravity sewer | |
| Treatment works | | Private sewer | P |
| Pumping station | | Private sewer subject to Sect. 104 adoption agreement | S 104 P |
| | | Private Sewer Transfer | T |
| | | Lateral Drain | L |
| | | Inspection Chamber | |

NB: Sewer symbol colour indicates the type.

RED - Combined
GREEN - Surface Water
BROWN - Foul
Purple - Former S24 sewers (for indicative purposes only)

## Notes:

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases, pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be asbestos cement (AC) or Pitch Fibre (PF) . It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

Dŵr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only and on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the company's apparatus. The onus of locating apparatus before carrying out any excavations rests entirely on you. The information which is supplied by the Company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 which is based upon the best Information available and, in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclose the existence of a water main, service pipe, sewer, lateral drain or disposal main and any associated apparatus laid before 1 September 1989, or, if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the Company's right to be compensated for any damage to its apparatus.

Service pipes are not generally shown but their presence should be anticipated.

**EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.**



Map Ref: 328373,192374
Map scale: 1:3750
Printed by: Zara Howells
Printed on: 19 Apr 2022


Dŵr Cymru
Welsh Water

Pentre Bach Solar Farm Llantarnam Torfaen
NP44 7AR

N
W E
S

## LEGEND

Clean network:

| | | | |
|---|---|---|---|
| Sluice valve | | Stop tap | |
| Pressure reducing valve | | Water Treatment Works | |
| Meter | | Water Pumping Station | |
| Bulk meter | | Existing main | |
| Hydrant (FH) | | Non-operational main | |
| Cap end | | Raw Water | |
| Air valve | | | |

NB: Water main symbol colour indicates the type.

LIGHT BLUE - Trunk
DARK BLUE - Distribution
YELLOW - Raw Water

**Notes:**

Whilst every reasonable effort has been taken to correctly record the pipe material of DCWW assets, there is a possibility that in some cases, pipe material (other than Asbestos Cement or Pitch Fibre) may be found to be asbestos cement (AC) or Pitch Fibre (PF) . It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation

Dŵr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only and on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in the vicinity of the company's apparatus. The onus of locating apparatus before carrying out any excavations rests entirely on you. The information which is supplied by the Company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 which is based upon the best Information available and, in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclose the existence of a water main, service pipe, sewer, lateral drain or disposal main and any associated apparatus laid before 1 September 1989, or, if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the Company's right to be compensated for any damage to its apparatus.

Service pipes are not generally shown but their presence should be anticipated.

**EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.**



Map Ref: 328367,192325
Map scale: 1:3750
Printed by: Zara Howells
Printed on: 19 Apr 2022

# APPENDIX B
# MICRODRAINAGE CALCULATIONS

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

Half Drain Time : 39 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 69.218 | 0.218 | 0.0 | 2.0 | 2.0 | 5.0 | O K |
| 30 min Summer | 69.293 | 0.293 | 0.0 | 2.0 | 2.0 | 6.7 | O K |
| 60 min Summer | 69.338 | 0.338 | 0.0 | 2.0 | 2.0 | 7.7 | O K |
| 120 min Summer | 69.331 | 0.331 | 0.0 | 2.0 | 2.0 | 7.5 | O K |
| 180 min Summer | 69.311 | 0.311 | 0.0 | 2.0 | 2.0 | 7.1 | O K |
| 240 min Summer | 69.286 | 0.286 | 0.0 | 2.0 | 2.0 | 6.5 | O K |
| 360 min Summer | 69.228 | 0.228 | 0.0 | 2.0 | 2.0 | 5.2 | O K |
| 480 min Summer | 69.176 | 0.176 | 0.0 | 2.0 | 2.0 | 4.0 | O K |
| 600 min Summer | 69.137 | 0.137 | 0.0 | 2.0 | 2.0 | 3.1 | O K |
| 720 min Summer | 69.109 | 0.109 | 0.0 | 2.0 | 2.0 | 2.5 | O K |
| 960 min Summer | 69.085 | 0.085 | 0.0 | 1.8 | 1.8 | 1.9 | O K |
| 1440 min Summer | 69.066 | 0.066 | 0.0 | 1.4 | 1.4 | 1.5 | O K |
| 2160 min Summer | 69.053 | 0.053 | 0.0 | 1.0 | 1.0 | 1.2 | O K |
| 2880 min Summer | 69.047 | 0.047 | 0.0 | 0.9 | 0.9 | 1.1 | O K |
| 4320 min Summer | 69.040 | 0.040 | 0.0 | 0.7 | 0.7 | 0.9 | O K |
| 5760 min Summer | 69.036 | 0.036 | 0.0 | 0.5 | 0.5 | 0.8 | O K |
| 7200 min Summer | 69.033 | 0.033 | 0.0 | 0.5 | 0.5 | 0.8 | O K |
| 8640 min Summer | 69.032 | 0.032 | 0.0 | 0.4 | 0.4 | 0.7 | O K |
| 10080 min Summer | 69.030 | 0.030 | 0.0 | 0.4 | 0.4 | 0.7 | O K |
| 15 min Winter | 69.250 | 0.250 | 0.0 | 2.0 | 2.0 | 5.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 122.304 | 0.0 | 6.6 | 21 |
| 30 min Summer | 85.098 | 0.0 | 9.2 | 33 |
| 60 min Summer | 56.647 | 0.0 | 12.3 | 52 |
| 120 min Summer | 35.256 | 0.0 | 15.3 | 86 |
| 180 min Summer | 26.829 | 0.0 | 17.5 | 120 |
| 240 min Summer | 22.109 | 0.0 | 19.2 | 156 |
| 360 min Summer | 16.782 | 0.0 | 21.9 | 218 |
| 480 min Summer | 13.699 | 0.0 | 23.8 | 276 |
| 600 min Summer | 11.663 | 0.0 | 25.4 | 332 |
| 720 min Summer | 10.206 | 0.0 | 26.6 | 386 |
| 960 min Summer | 8.243 | 0.0 | 28.7 | 498 |
| 1440 min Summer | 6.064 | 0.0 | 31.6 | 738 |
| 2160 min Summer | 4.472 | 0.0 | 35.0 | 1104 |
| 2880 min Summer | 3.623 | 0.0 | 37.8 | 1468 |
| 4320 min Summer | 2.727 | 0.0 | 42.7 | 2172 |
| 5760 min Summer | 2.260 | 0.0 | 47.2 | 2928 |
| 7200 min Summer | 1.984 | 0.0 | 51.8 | 3672 |
| 8640 min Summer | 1.802 | 0.0 | 56.4 | 4352 |
| 10080 min Summer | 1.672 | 0.0 | 61.1 | 5128 |
| 15 min Winter | 122.304 | 0.0 | 7.4 | 22 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 30 min Winter | 69.335 | 0.335 | 0.0 | 2.0 | 2.0 | 7.6 | O K |
| 60 min Winter | 69.385 | 0.385 | 0.0 | 2.0 | 2.0 | 8.8 | O K |
| 120 min Winter | 69.367 | 0.367 | 0.0 | 2.0 | 2.0 | 8.4 | O K |
| 180 min Winter | 69.332 | 0.332 | 0.0 | 2.0 | 2.0 | 7.6 | O K |
| 240 min Winter | 69.288 | 0.288 | 0.0 | 2.0 | 2.0 | 6.6 | O K |
| 360 min Winter | 69.191 | 0.191 | 0.0 | 2.0 | 2.0 | 4.4 | O K |
| 480 min Winter | 69.122 | 0.122 | 0.0 | 2.0 | 2.0 | 2.8 | O K |
| 600 min Winter | 69.090 | 0.090 | 0.0 | 1.9 | 1.9 | 2.0 | O K |
| 720 min Winter | 69.079 | 0.079 | 0.0 | 1.7 | 1.7 | 1.8 | O K |
| 960 min Winter | 69.065 | 0.065 | 0.0 | 1.4 | 1.4 | 1.5 | O K |
| 1440 min Winter | 69.053 | 0.053 | 0.0 | 1.0 | 1.0 | 1.2 | O K |
| 2160 min Winter | 69.044 | 0.044 | 0.0 | 0.8 | 0.8 | 1.0 | O K |
| 2880 min Winter | 69.039 | 0.039 | 0.0 | 0.6 | 0.6 | 0.9 | O K |
| 4320 min Winter | 69.033 | 0.033 | 0.0 | 0.5 | 0.5 | 0.8 | O K |
| 5760 min Winter | 69.030 | 0.030 | 0.0 | 0.4 | 0.4 | 0.7 | O K |
| 7200 min Winter | 69.028 | 0.028 | 0.0 | 0.3 | 0.3 | 0.6 | O K |
| 8640 min Winter | 69.026 | 0.026 | 0.0 | 0.3 | 0.3 | 0.6 | O K |
| 10080 min Winter | 69.025 | 0.025 | 0.0 | 0.3 | 0.3 | 0.6 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 30 min Winter | 85.098 | 0.0 | 10.4 | 34 |
| 60 min Winter | 56.647 | 0.0 | 13.8 | 56 |
| 120 min Winter | 35.256 | 0.0 | 17.2 | 92 |
| 180 min Winter | 26.829 | 0.0 | 19.6 | 130 |
| 240 min Winter | 22.109 | 0.0 | 21.5 | 168 |
| 360 min Winter | 16.782 | 0.0 | 24.5 | 226 |
| 480 min Winter | 13.699 | 0.0 | 26.7 | 278 |
| 600 min Winter | 11.663 | 0.0 | 28.4 | 322 |
| 720 min Winter | 10.206 | 0.0 | 29.8 | 382 |
| 960 min Winter | 8.243 | 0.0 | 32.1 | 500 |
| 1440 min Winter | 6.064 | 0.0 | 35.4 | 738 |
| 2160 min Winter | 4.472 | 0.0 | 39.2 | 1076 |
| 2880 min Winter | 3.623 | 0.0 | 42.4 | 1448 |
| 4320 min Winter | 2.727 | 0.0 | 47.8 | 2208 |
| 5760 min Winter | 2.260 | 0.0 | 52.8 | 2872 |
| 7200 min Winter | 1.984 | 0.0 | 58.0 | 3576 |
| 8640 min Winter | 1.802 | 0.0 | 63.2 | 4256 |
| 10080 min Winter | 1.672 | 0.0 | 68.4 | 4984 |

## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 100 |
| FEH Rainfall Version | 2013 |
| Site Location | GB 328217 192530 ST 28217 92530 |
| 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 % | +40 |

## Time Area Diagram

Total Area (ha) 0.029

| Time From: | (mins) To: | Area (ha) | Time From: | (mins) To: | Area (ha) | Time From: | (mins) To: | Area (ha) |
|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 0.009 | 4 | 8 | 0.010 | 8 | 12 | 0.010 |

## Model Details

Storage is Online Cover Level (m) 70.000

## Cellular Storage Structure

Invert Level (m) 69.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| **Depth (m)** | **Area (m²)** | **Inf. Area (m²)** | **Depth (m)** | **Area (m²)** | **Inf. Area (m²)** |
|---|---|---|---|---|---|
| 0.000 | 24.0 | 0.0 | 0.401 | 0.0 | 0.0 |
| 0.400 | 24.0 | 0.0 | | | |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0076-2000-0400-2000 |
| Design Head (m) | 0.400 |
| Design Flow (l/s) | 2.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 76 |
| Invert Level (m) | 69.000 |
| Minimum Outlet Pipe Diameter (mm) | 100 |
| Suggested Manhole Diameter (mm) | 1200 |

| **Control Points** | **Head (m)** | **Flow (l/s)** |
|---|---|---|
| Design Point (Calculated) | 0.400 | 2.0 |
| Flush-Flo™ | 0.124 | 2.0 |
| Kick-Flo® | 0.286 | 1.7 |
| Mean Flow over Head Range | - | 1.7 |

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 | 2.0 | 1.200 | 3.3 | 3.000 | 5.1 | 7.000 | 7.6 |
| 0.200 | 1.9 | 1.400 | 3.5 | 3.500 | 5.4 | 7.500 | 7.9 |
| 0.300 | 1.8 | 1.600 | 3.8 | 4.000 | 5.8 | 8.000 | 8.2 |
| 0.400 | 2.0 | 1.800 | 4.0 | 4.500 | 6.1 | 8.500 | 8.4 |
| 0.500 | 2.2 | 2.000 | 4.2 | 5.000 | 6.5 | 9.000 | 8.7 |
| 0.600 | 2.4 | 2.200 | 4.4 | 5.500 | 6.8 | 9.500 | 8.9 |
| 0.800 | 2.7 | 2.400 | 4.6 | 6.000 | 7.1 | | |
| 1.000 | 3.0 | 2.600 | 4.7 | 6.500 | 7.4 | | |

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

Half Drain Time : 0 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 99.533 | 0.033 | 0.0 | 0.6 | 0.6 | 0.0 | O K |
| 30 min Summer | 99.530 | 0.030 | 0.0 | 0.5 | 0.5 | 0.0 | O K |
| 60 min Summer | 99.526 | 0.026 | 0.0 | 0.4 | 0.4 | 0.0 | O K |
| 120 min Summer | 99.520 | 0.020 | 0.0 | 0.3 | 0.3 | 0.0 | O K |
| 180 min Summer | 99.517 | 0.017 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 240 min Summer | 99.516 | 0.016 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 360 min Summer | 99.513 | 0.013 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 480 min Summer | 99.512 | 0.012 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 600 min Summer | 99.511 | 0.011 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 720 min Summer | 99.511 | 0.011 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 960 min Summer | 99.510 | 0.010 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 1440 min Summer | 99.509 | 0.009 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 2160 min Summer | 99.507 | 0.007 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 2880 min Summer | 99.506 | 0.006 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 4320 min Summer | 99.506 | 0.006 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 5760 min Summer | 99.505 | 0.005 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 7200 min Summer | 99.504 | 0.004 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 8640 min Summer | 99.505 | 0.005 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 10080 min Summer | 99.504 | 0.004 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 15 min Winter | 99.532 | 0.032 | 0.0 | 0.6 | 0.6 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 127.076 | 0.0 | 0.2 | 10 |
| 30 min Summer | 85.090 | 0.0 | 0.3 | 17 |
| 60 min Summer | 54.368 | 0.0 | 0.4 | 32 |
| 120 min Summer | 33.548 | 0.0 | 0.5 | 62 |
| 180 min Summer | 24.925 | 0.0 | 0.6 | 92 |
| 240 min Summer | 20.048 | 0.0 | 0.6 | 122 |
| 360 min Summer | 14.708 | 0.0 | 0.7 | 184 |
| 480 min Summer | 11.803 | 0.0 | 0.7 | 240 |
| 600 min Summer | 9.942 | 0.0 | 0.7 | 288 |
| 720 min Summer | 8.637 | 0.0 | 0.8 | 360 |
| 960 min Summer | 6.911 | 0.0 | 0.8 | 498 |
| 1440 min Summer | 5.039 | 0.0 | 0.9 | 730 |
| 2160 min Summer | 3.666 | 0.0 | 1.0 | 1084 |
| 2880 min Summer | 2.922 | 0.0 | 1.0 | 1448 |
| 4320 min Summer | 2.118 | 0.0 | 1.1 | 2144 |
| 5760 min Summer | 1.684 | 0.0 | 1.2 | 2512 |
| 7200 min Summer | 1.409 | 0.0 | 1.2 | 3352 |
| 8640 min Summer | 1.218 | 0.0 | 1.3 | 4080 |
| 10080 min Summer | 1.077 | 0.0 | 1.3 | 4944 |
| 15 min Winter | 127.076 | 0.0 | 0.3 | 10 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 30 min Winter | 99.528 | 0.028 | 0.0 | 0.5 | 0.5 | 0.0 | O K |
| 60 min Winter | 99.523 | 0.023 | 0.0 | 0.3 | 0.3 | 0.0 | O K |
| 120 min Winter | 99.517 | 0.017 | 0.0 | 0.2 | 0.2 | 0.0 | O K |
| 180 min Winter | 99.514 | 0.014 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 240 min Winter | 99.513 | 0.013 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 360 min Winter | 99.511 | 0.011 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 480 min Winter | 99.511 | 0.011 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 600 min Winter | 99.510 | 0.010 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 720 min Winter | 99.509 | 0.009 | 0.0 | 0.1 | 0.1 | 0.0 | O K |
| 960 min Winter | 99.509 | 0.009 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 1440 min Winter | 99.507 | 0.007 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 2160 min Winter | 99.506 | 0.006 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 2880 min Winter | 99.506 | 0.006 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 4320 min Winter | 99.505 | 0.005 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 5760 min Winter | 99.504 | 0.004 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 7200 min Winter | 99.504 | 0.004 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 8640 min Winter | 99.503 | 0.003 | 0.0 | 0.0 | 0.0 | 0.0 | O K |
| 10080 min Winter | 99.503 | 0.003 | 0.0 | 0.0 | 0.0 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 30 min Winter | 85.090 | 0.0 | 0.4 | 18 |
| 60 min Winter | 54.368 | 0.0 | 0.5 | 34 |
| 120 min Winter | 33.548 | 0.0 | 0.6 | 64 |
| 180 min Winter | 24.925 | 0.0 | 0.6 | 86 |
| 240 min Winter | 20.048 | 0.0 | 0.7 | 128 |
| 360 min Winter | 14.708 | 0.0 | 0.7 | 180 |
| 480 min Winter | 11.803 | 0.0 | 0.8 | 252 |
| 600 min Winter | 9.942 | 0.0 | 0.8 | 294 |
| 720 min Winter | 8.637 | 0.0 | 0.9 | 362 |
| 960 min Winter | 6.911 | 0.0 | 0.9 | 484 |
| 1440 min Winter | 5.039 | 0.0 | 1.0 | 688 |
| 2160 min Winter | 3.666 | 0.0 | 1.1 | 1116 |
| 2880 min Winter | 2.922 | 0.0 | 1.1 | 1336 |
| 4320 min Winter | 2.118 | 0.0 | 1.3 | 2040 |
| 5760 min Winter | 1.684 | 0.0 | 1.3 | 2496 |
| 7200 min Winter | 1.409 | 0.0 | 1.4 | 3400 |
| 8640 min Winter | 1.218 | 0.0 | 1.4 | 2368 |
| 10080 min Winter | 1.077 | 0.0 | 1.5 | 6976 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 19.200 | Shortest Storm (mins) | 15 |
| Ratio R | 0.358 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 0.001

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.001 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Infiltration Trench Structure

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00000 | Trench Width (m) | 0.7 |
| Infiltration Coefficient Side (m/hr) | 0.00000 | Trench Length (m) | 7.5 |
| Safety Factor | 2.0 | Slope (1:X) | 100.0 |
| Porosity | 0.30 | Cap Volume Depth (m) | 0.000 |
| Invert Level (m) | 99.500 | Cap Infiltration Depth (m) | 0.000 |

## Pipe Outflow Control

| | | | |
|---|---|---|---|
| Diameter (m) | 0.150 | Entry Loss Coefficient | 0.500 |
| Slope (1:X) | 150.0 | Coefficient of Contraction | 0.600 |
| Length (m) | 10.000 | Upstream Invert Level (m) | 99.500 |
| Roughness k (mm) | 0.600 | | |

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

Half Drain Time : 756 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 99.686 | 0.186 | 0.0 | 0.2 | O K |
| 30 min Summer | 99.735 | 0.235 | 0.0 | 0.3 | Flood Risk |
| 60 min Summer | 99.786 | 0.286 | 0.0 | 0.4 | Flood Risk |
| 120 min Summer | 99.834 | 0.334 | 0.0 | 0.5 | Flood Risk |
| 180 min Summer | 99.858 | 0.358 | 0.0 | 0.5 | Flood Risk |
| 240 min Summer | 99.872 | 0.372 | 0.0 | 0.5 | Flood Risk |
| 360 min Summer | 99.885 | 0.385 | 0.0 | 0.5 | Flood Risk |
| 480 min Summer | 99.889 | 0.389 | 0.0 | 0.6 | Flood Risk |
| 600 min Summer | 99.888 | 0.388 | 0.0 | 0.6 | Flood Risk |
| 720 min Summer | 99.887 | 0.387 | 0.0 | 0.6 | Flood Risk |
| 960 min Summer | 99.883 | 0.383 | 0.0 | 0.5 | Flood Risk |
| 1440 min Summer | 99.871 | 0.371 | 0.0 | 0.5 | Flood Risk |
| 2160 min Summer | 99.850 | 0.350 | 0.0 | 0.5 | Flood Risk |
| 2880 min Summer | 99.828 | 0.328 | 0.0 | 0.5 | Flood Risk |
| 4320 min Summer | 99.790 | 0.290 | 0.0 | 0.4 | Flood Risk |
| 5760 min Summer | 99.757 | 0.257 | 0.0 | 0.3 | Flood Risk |
| 7200 min Summer | 99.728 | 0.228 | 0.0 | 0.3 | Flood Risk |
| 8640 min Summer | 99.704 | 0.204 | 0.0 | 0.3 | Flood Risk |
| 10080 min Summer | 99.683 | 0.183 | 0.0 | 0.2 | O K |
| 15 min Winter | 99.704 | 0.204 | 0.0 | 0.3 | Flood Risk |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 15 min Summer | 127.076 | 0.0 | 19 |
| 30 min Summer | 85.090 | 0.0 | 34 |
| 60 min Summer | 54.368 | 0.0 | 64 |
| 120 min Summer | 33.548 | 0.0 | 122 |
| 180 min Summer | 24.925 | 0.0 | 182 |
| 240 min Summer | 20.048 | 0.0 | 242 |
| 360 min Summer | 14.708 | 0.0 | 360 |
| 480 min Summer | 11.803 | 0.0 | 480 |
| 600 min Summer | 9.942 | 0.0 | 546 |
| 720 min Summer | 8.637 | 0.0 | 600 |
| 960 min Summer | 6.911 | 0.0 | 722 |
| 1440 min Summer | 5.039 | 0.0 | 994 |
| 2160 min Summer | 3.666 | 0.0 | 1408 |
| 2880 min Summer | 2.922 | 0.0 | 1816 |
| 4320 min Summer | 2.118 | 0.0 | 2636 |
| 5760 min Summer | 1.684 | 0.0 | 3408 |
| 7200 min Summer | 1.409 | 0.0 | 4176 |
| 8640 min Summer | 1.218 | 0.0 | 4928 |
| 10080 min Summer | 1.077 | 0.0 | 5648 |
| 15 min Winter | 127.076 | 0.0 | 19 |

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

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 30 min Winter | 99.759 | 0.259 | 0.0 | 0.3 | Flood Risk |
| 60 min Winter | 99.816 | 0.316 | 0.0 | 0.4 | Flood Risk |
| 120 min Winter | 99.872 | 0.372 | 0.0 | 0.5 | Flood Risk |
| 180 min Winter | 99.900 | 0.400 | 0.0 | 0.6 | Flood Risk |
| 240 min Winter | 99.916 | 0.416 | 0.0 | 0.6 | Flood Risk |
| 360 min Winter | 99.933 | 0.433 | 0.0 | 0.6 | Flood Risk |
| 480 min Winter | 99.940 | 0.440 | 0.0 | 0.6 | Flood Risk |
| 600 min Winter | 99.941 | 0.441 | 0.0 | 0.6 | Flood Risk |
| 720 min Winter | 99.939 | 0.439 | 0.0 | 0.6 | Flood Risk |
| 960 min Winter | 99.933 | 0.433 | 0.0 | 0.6 | Flood Risk |
| 1440 min Winter | 99.917 | 0.417 | 0.0 | 0.6 | Flood Risk |
| 2160 min Winter | 99.886 | 0.386 | 0.0 | 0.5 | Flood Risk |
| 2880 min Winter | 99.855 | 0.355 | 0.0 | 0.5 | Flood Risk |
| 4320 min Winter | 99.800 | 0.300 | 0.0 | 0.4 | Flood Risk |
| 5760 min Winter | 99.753 | 0.253 | 0.0 | 0.3 | Flood Risk |
| 7200 min Winter | 99.715 | 0.215 | 0.0 | 0.3 | Flood Risk |
| 8640 min Winter | 99.682 | 0.182 | 0.0 | 0.2 | O K |
| 10080 min Winter | 99.654 | 0.154 | 0.0 | 0.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 30 min Winter | 85.090 | 0.0 | 33 |
| 60 min Winter | 54.368 | 0.0 | 62 |
| 120 min Winter | 33.548 | 0.0 | 120 |
| 180 min Winter | 24.925 | 0.0 | 180 |
| 240 min Winter | 20.048 | 0.0 | 238 |
| 360 min Winter | 14.708 | 0.0 | 352 |
| 480 min Winter | 11.803 | 0.0 | 462 |
| 600 min Winter | 9.942 | 0.0 | 570 |
| 720 min Winter | 8.637 | 0.0 | 670 |
| 960 min Winter | 6.911 | 0.0 | 758 |
| 1440 min Winter | 5.039 | 0.0 | 1068 |
| 2160 min Winter | 3.666 | 0.0 | 1516 |
| 2880 min Winter | 2.922 | 0.0 | 1960 |
| 4320 min Winter | 2.118 | 0.0 | 2808 |
| 5760 min Winter | 1.684 | 0.0 | 3632 |
| 7200 min Winter | 1.409 | 0.0 | 4400 |
| 8640 min Winter | 1.218 | 0.0 | 5184 |
| 10080 min Winter | 1.077 | 0.0 | 5856 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 19.200 | Shortest Storm (mins) | 15 |
| Ratio R | 0.358 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 0.001

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.001 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Infiltration Trench Structure

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00500 | Trench Width (m) | 0.7 |
| Infiltration Coefficient Side (m/hr) | 0.00500 | Trench Length (m) | 7.5 |
| Safety Factor | 2.0 | Slope (1:X) | 100.0 |
| Porosity | 0.30 | Cap Volume Depth (m) | 0.000 |
| Invert Level (m) | 99.500 | Cap Infiltration Depth (m) | 0.000 |

## FEH Mean Annual Flood

### Input

| | |
|---|---|
| Site Location | GB 328250 192000 ST 28250 92000 |
| Area (ha) | 195.750 |
| SAAR (mm) | 1228 |
| URBEXT (1990) | 0.0134 |
| SPRHOST | 42.500 |
| BFIHOST | 0.532 |
| FARL | 1.000 |

### Results

QMED Rural (l/s) 754.6 QMED Urban (l/s) 767.0

| FEH Greenfield Runoff Rates |
|---|
| |

**Fill in yellow cells with MicroDrainage QMED results and change MicroDrainage snipping box**

## Greenfield Run off Rates

## Greenfield Run off Rates

**FEH Mean Annual Flood ($Q_{MED}$)**

| | | |
|---|---|---|
| QMED (from MicroDrainage) | 754.6 | l/s |
| Catchment Area (from MicroDrainage) | 195.75 | ha |
| | 3.85 | l/s/ha |

| | |
|---|---|
| **Hydrometric Area** | 9 |
| QMED to QBAR factor | Suggested |

**Table X: Greenfield Runoff Rates FEH Method**

| Storm Event | Growth Curve Factors (CIRIA Table 24.2) | Greenfield Runoff Rate (l/s/ha) | | |
|---|---|---|---|---|
| QMED | - | 3.85 | | |
| **QBAR** | 1.11 | 4.28 | | |
| Q1 | 0.88 | 3.39 | | |
| Q2 | 0.93 | 3.59 | | |
| Q10 | 1.42 | 5.47 | | |
| Q30 | 1.80 | 6.94 | | |
| Q100 | 2.18 | 8.40 | | |

| | | |
|---|---|---|
| Wardell Armstrong LLP | | Page 1 |
| Suite 2/3 Great Michael House<br>14 Links Place<br>Edinburgh EH6 7EZ | | |
| Date 28/11/2022 11:45<br>File | Designed by overseas<br>Checked by | |
| XP Solutions | Source Control 2018.1 | |

FEH Mean Annual Flood

Input

| | |
|---|---|
| Site Location GB 328250 192000 ST 28250 92000 | |
| Area (ha) | 195.750 |
| SAAR (mm) | 1228 |
| URBEXT (1990) | 0.0134 |
| SPRHOST | 42.500 |
| BFIHOST | 0.532 |
| FARL | 1.000 |

Results

QMED Rural (l/s) 754.6 QMED Urban (l/s) 767.0

# APPENDIX C
# TYPICAL MAINTENANCE SCHEDULES

# Sustainable Drainage Systems (SuDS):

## Maintenance Schedule

### Attenuation Tank

| Regular Maintenance | |
|---|---|
| Monthly | • Inspect and identify any areas that are not operating correctly. If required, take remedial action (for 3 months following installation) |
| Six Monthly | • Inspect and identify any areas that are not operating correctly. If required, take remedial action (following initial 3 month period) |
| Annually | • Remove sediment from pre-treatment structures |
| As Required | • De-silt as required |
| **Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events** | |
| Following all significant storm events | • Inspect and carry out essential recovery works to return the feature to full working order |

# Sustainable Drainage Systems (SuDS):
# Maintenance Schedule

## Catchpits, Manholes and Pipes

| **Regular Maintenance** | |
|---|---|
| Monthly | • Inspect all inlets, outlet and chambers to ensure they are in good condition, free from blockage and operating as designed. If required, take remedial action (for 3 months following installation) |
| Six Monthly | • Inspect all inlets, outlet and chambers to ensure they are in good condition, free from blockage and operating as designed. If required, take remedial action |
| Annually | • Not applicable |
| As Required | • Remove sediment from catchpit manholes<br>• Where sediment has accumulated into manholes and pipes jet the associated pipes.<br>• Where significant accumulation of silt or evidence of defects are present undertake CCTV survey of pipe and carry out remedial repairs as required. |
| **Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events** | |
| Following all significant storm events | • Inspect and carry out essential recovery works to return the feature to full working order |

# Sustainable Drainage Systems (SuDS):

## Maintenance Schedule

### Filter Drain

| **Regular Maintenance** | |
|---|---|
| Monthly | • Litter and debris removal<br>• Mow grasses (where required to promote lateral runoff inflow) and remove resultant clippings (during growing season only)<br>• Remove nuisance and invasive vegetation (for 12 months following installation)<br>• Inspect/check all inlets, outlets, surface and overflows (where required) to ensure that they are in good condition, free from blockages and operating as designed. Take action where required |
| Six Monthly | • Not applicable |
| Annually | • Not applicable |
| Annually | • Remove nuisance and invasive vegetation<br>• Inspect and document the presence of wildlife |
| As Required | • Repair erosion or other damage by re-turfing, reseeding or replacing filter material<br>• Re-level uneven surfaces and reinstate design levels (typically every 60 month period)<br>• Remove and replace top 300 - 500mm of gravel, clean and replace where required (typically every 60 month period)<br>• Remove and dispose of oils or petrol residues using safe standard practices |
| **Remedial Actions: Significant storms may cause significant damage to SuDS. As such, a number of actions may be required following such events** | |
| Following all significant storm events | • Inspect and carry out essential recovery works to return the feature to full working order |

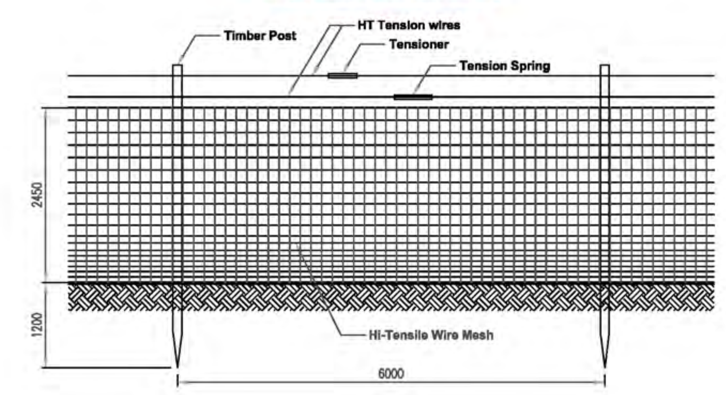
**DRAWINGS**




TYPICAL STORAGE UNIT
TYPICAL DIMENSIONS 12.2m x 2.4m x 2.6m HIGH
ALL SUBJECT TO FINAL DESIGN

TYPICAL INVERTOR SUBSTATION
DIMENSIONS: 7m x 2.5m x 3m HIGH. ALL SUBJECT TO FINAL DESIGN

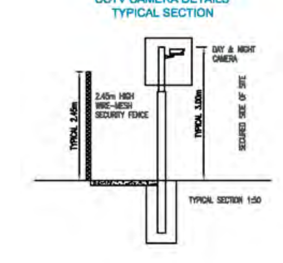
TYPICAL SECURITY DEER FENCE DETAILS



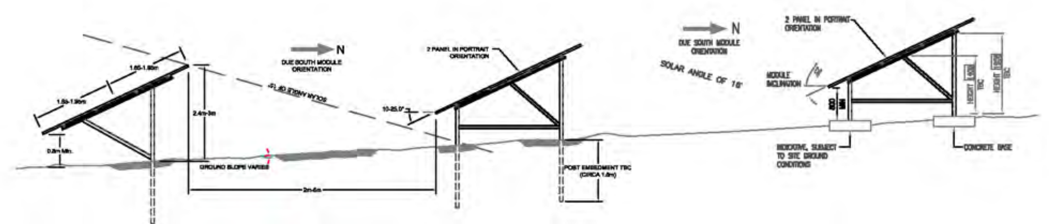

TYPICAL HIGH TENSILE FIXED KNOT FENCING:

1. 2.45M HIGH PRESSURE TREATED TIMBER POSTS AT 6M CENTRES.
2. HIGH TENSILE GALVANISED WIRE TO BS EN 10223 AND BS EN 10244.
3. 20 NO. HORIZONTAL LINES, 2.5MM WIRE, SPACING VARIES BETWEEN 75MM AND 175MM.
4. VERTICAL LINES, 2.5 WIRE AT 150MM CENTRES.
5. HIGH TENSILE TENSION WIRE TO TOP FITTED WITH TENSIONER AND TENSION SPRING.

CCTV CAMERA DETAILS
TYPICAL SECTION



TYPICAL IMAGE



SINGLE POST TYPE | TABLE POST TYPE | CONCRETE BASE TYPE

TYPICAL SECTION THROUGH VARIOUS MODULE OPTIONS

SCALE 1:50

The scaling of this drawing cannot be assured

| Revision | | Date | Drn | Ckd |
|---|---|---|---|---|
| I | Layout updated in accordance with arboricultural survey | 19.05.22 | KT | TE |

- Site Boundary
- Access Point A
- Access Point B
- Access Point C
- Energy Storage compound
- Substation
- 3.5m wide access track
- Inverter Substations
- Energy Storage Containers
- Public Right of Way
- Public Right of Way to be diverted
- Proposed new route for Public Right of Way
- Existing Hedgerow
- Fence (5m ecological buffer)
- 3m buffer from fence
- 2x12 Typical Module Panel
- 2x24 Typical Module Panel
- Existing Vegetation Retained
- Reinforce Existing Hedgerow - (To ensure no intervisibility between proposed panels and Pentre Bach Farmhouse)
- Construction Area
- 15m landscape buffer
- Extended buffer to mitigate views from PRoW and long distance views from wider landscape to the west

Trees are indicated by symbols below, colour coded to indicate their 'Retention Categories'.

- Category U (defective, negligible or redundant trees)
- Category A (high retention value)
- Category B (moderate retention value)
- Category C (low retention value)
- APPROXIMATE crown spread of individual trees

The nominal ROOT PROTECTION AREA (RPA) of each tree is indicated by a solid line using the colour coding above

**NOTES:**

Final details all subject to final design. Arrangement of the panels shown is based on the following data:

1. Typical panel size = 2.2 x 1.3 approx.
2. Panel typical inclination = 25 degrees and south facing.
3. Module length = Typical 15.6 run with 0.2m gaps supported on four post/frames.
4. The typical module section shows two panels in portrait orientation. Three Panels in portrait, four panels in landscape or six panels in landscape may also be required. Details are subject to final design.
5. For clear aisles distance between panels refer to section.
6. Panels at lowest point set at 0.8m above ground level increasing to 2.4m to 3m approximate.
7. Panels not located where land gradient exceeds 1 in 9.5 (6 degrees) due to excessive leg heights.
8. Minimum 5m ecology buffer allowed to all boundaries.
9. Access tracks to consist of clause 804 material where required i.e. areas of soft sport, final extent and design to be confirmed. Only permeable material to be used.
10. For extent and type of screening required refer to landscape and visual assessment report for proposals.
11. Number and location of invertor substations subject to final design.
12. Location of security fence subject to final design.
13. Where necessary, gaps approximately 10cm high will be created below the fencing for wildlife movement
14. Existing hedgerow locations are indicative.
15. Existing hedgerows adjacent to the Site boundary are not shown but are assumed to lie within the Site boundary.
16. Footpath locations are indicative.
17. Diversion to be secured under a separate planning application under Section 257 of the Town and Country Planning 1990.

Project
Land at Pentre Farm
Torfaen

Drawing Title
# Indicative Layout Plan

| Date | Scale | Drawn by | Check by |
|---|---|---|---|
| 30.07.21 | Various | KT | TE |

| Project No | Drawing No | Revision |
|---|---|---|
| 29522 | 9007 | I |

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## TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

### ABBREVIATIONS & SYMBOLS

| | | | | | |
|---|---|---|---|---|---|
| AH | Arch Head Height | ER | Earth Rod | RSD | Roller Shutter Door |
| A/B | Air Brick | ET | EP+Transformer | RSJ | Rolled Steel Joist |
| AR | Assumed Route | FB | Flower Bed | SI | Sign Post |
| AV | Air Valve | FBD | Floor Board Direction | SP | Arch Spring Point Height |
| BB | Belisha Beacon | FH | Fire Hydrant | SV | Stop Valve |
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| B/W | Barbed Wire Fence | IC | Inspection Cover | TL | Traffic Light |
| BX | Box (Utilities) | IL | Invert Level | ToW | Top of Wall |
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| C-Lev | Ceiling Level | MP | Marker Post | UC | Unknown Cover |
| Col | Column | NB | Name Board | UK | Unknown Tree |
| C/P | Chestnut Paling Fence | OHL | Overhead Line (approx) | UMG | Unmade Ground |
| CR | Cable Riser | Pan | Panel Fence | USB | Under Side Beam |
| C/W | Chicken Wire | PB | Post Box | UTL | Unable To Lift |
| DC | Drainage Channel | PM | Parking Meter | UTS | Unable To Survey |
| DH | Door Head Height | PO | Post | VP | Vent Pipe |
| Dil. | Dilapidated | P/R | Post & Rail Fence | WB | Waste Bin |
| DP | Down Pipe | P/W | Post & Wire Fence | WH | Weep Hole |
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| | | | | △ | Survey Control Station |

### DRAWING NOTES

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Detail, services and features may not have been surveyed if obstructed or not reasonably visible at the time of the survey.

Surveyed physical features may not necessarily represent the legal boundary line.

#### Measured Building Surveys

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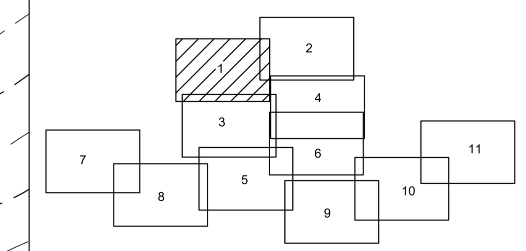
Sheet Layout




SURVEY CONTROL CO-ORDINATES

| STATIONS | EASTINGS | NORTHINGS | LEVEL | DESCRIPTION |
|---|---|---|---|---|

SURVEY GRID AND LEVEL DATUM

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| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|

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IPSWICH BRENTWOOD COVENTRY GLASGOW NORWICH NOTTINGHAM YEOVIL

PROJECT TITLE
TORFAEN SOLAR FARM
TY COCH, NP44 7HF

DRAWING DETAIL
TOPOGRAPHICAL SURVEY
Sheet 1 of 11

| CLIENT | | | | SCALE |
|---|---|---|---|---|
| ELGIN ENERGY | | | | 1:500 |
| SURVEYOR | SURVEY DATE | CHECKED BY | APPROVED BY | DWG STATUS |
| TG/JG/NW | 03/09/2020 | RAH | RAH | FINAL |
| DRAWING NUMBER | | | REVISION | ISSUE DATE |
| 27002swg-01 | | | | 11/9/2020 |

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Original Sheet Size A0H


# TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

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| | | | | △ | Survey Control Station |

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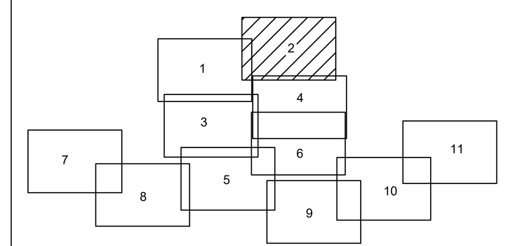
Sheet Layout




SURVEY CONTROL CO-ORDINATES

| STATIONS | EASTINGS | NORTHINGS | LEVEL | DESCRIPTION |
|---|---|---|---|---|

SURVEY GRID AND LEVEL DATUM

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| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|

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| | | | | |
|---|---|---|---|---|
| PROJECT TITLE<br>TORFAEN SOLAR FARM<br>TY COCH, NP44 7HF | | | | |
| DRAWING DETAIL<br>TOPOGRAPHICAL SURVEY<br>Sheet 2 of 11 | | | | |
| CLIENT<br>ELGIN ENERGY | | | | SCALE<br>1:500 |
| SURVEYOR<br>TG/JG/NW | SURVEY DATE<br>03/09/2020 | CHECKED BY<br>RAH | APPROVED BY<br>RAH | DWG STATUS<br>FINAL |
| DRAWING NUMBER<br>27002swg-02 | | | REVISION | ISSUE DATE<br>11/9/2020 |





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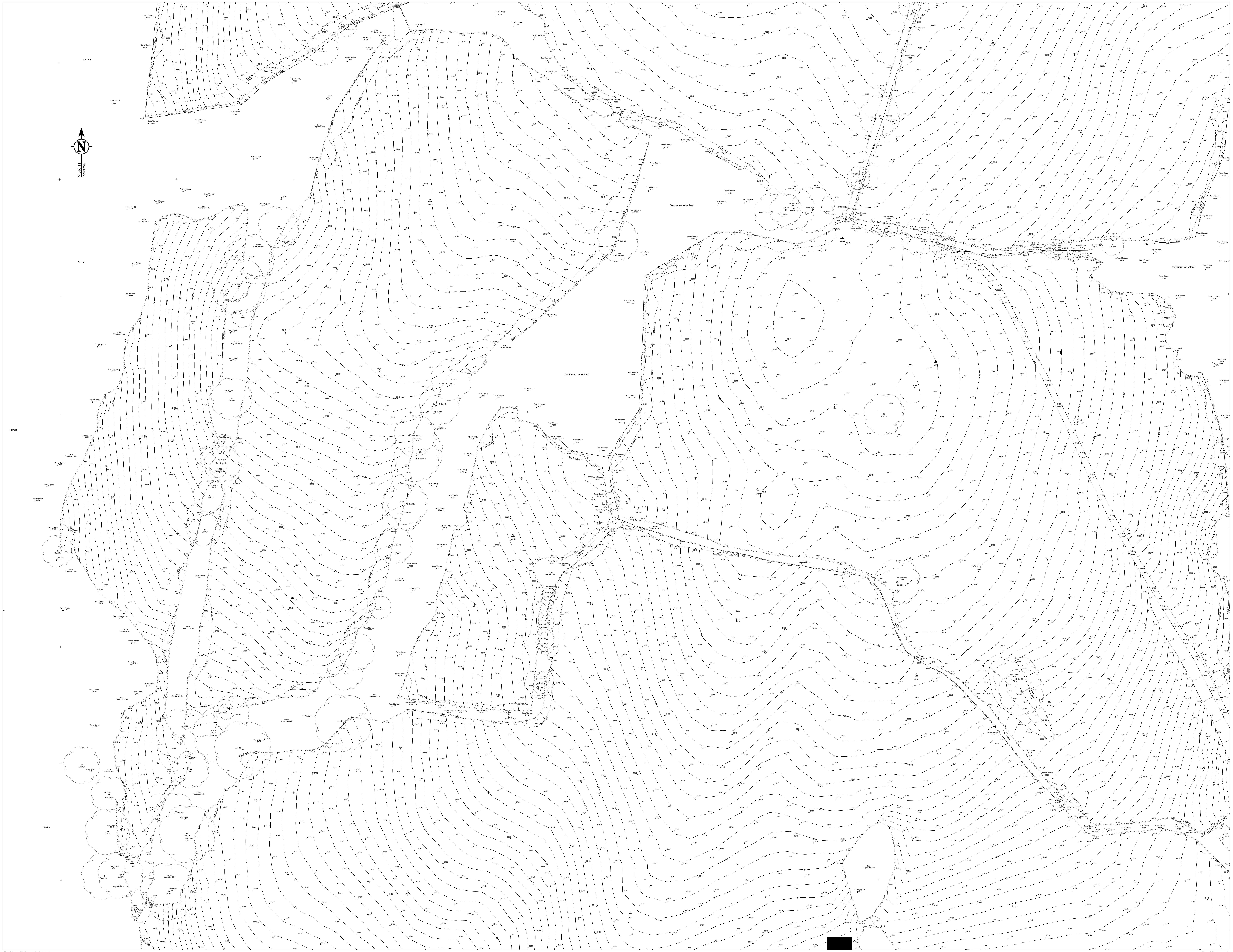


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Original Sheet Size A0H

# TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

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| | | | | △ | Survey Control Station |

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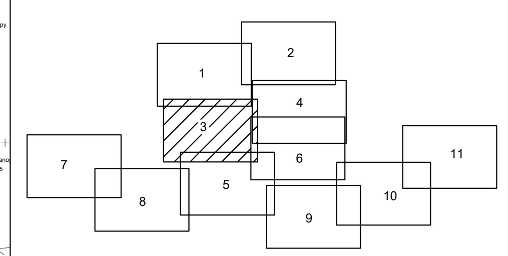


SURVEY CONTROL CO-ORDINATES

| STATIONS | EASTINGS | NORTHINGS | LEVEL | DESCRIPTION |
|---|---|---|---|---|

SURVEY GRID AND LEVEL DATUM

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| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|


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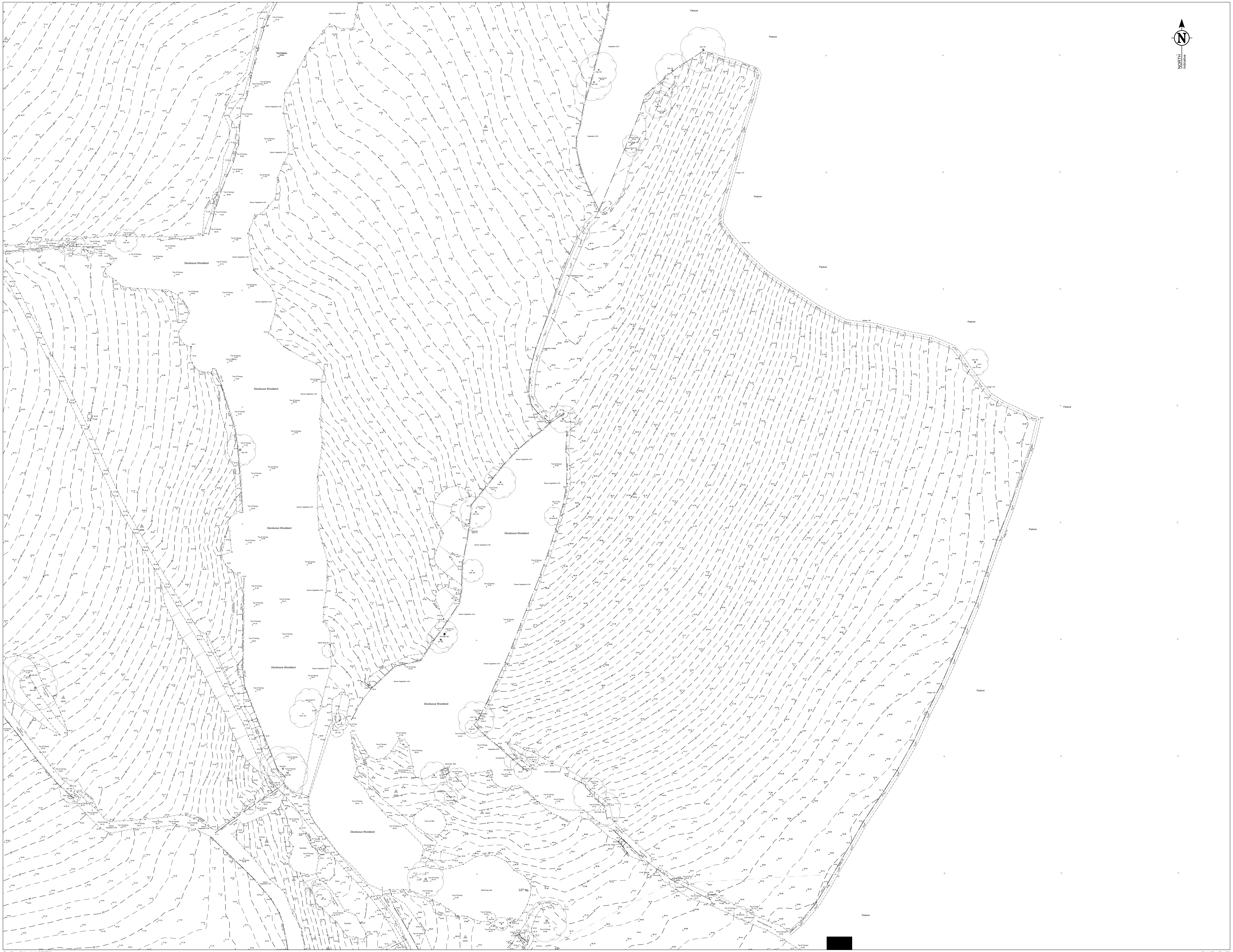
| | | | | |
|---|---|---|---|---|
| PROJECT TITLE<br>TORFAEN SOLAR FARM<br>TY COCH, NP44 7HF | | | | |
| DRAWING DETAIL<br>TOPOGRAPHICAL SURVEY<br>Sheet 3 of 11 | | | | |
| CLIENT<br>ELGIN ENERGY | | | | SCALE<br>1:500 |
| SURVEYOR<br>TG/JG/NW | SURVEY DATE<br>03/09/2020 | CHECKED BY<br>RAH | APPROVED BY<br>RAH | DWG STATUS<br>FINAL |
| DRAWING NUMBER<br>27002swg-03 | | | REVISION | ISSUE DATE<br>11/9/2020 |

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| | | | | △ | Survey Control Station |

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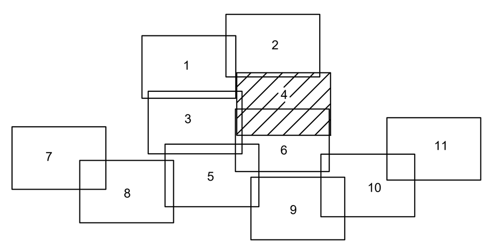


SURVEY CONTROL CO-ORDINATES

| STATIONS | EASTINGS | NORTHINGS | LEVEL | DESCRIPTION |
|---|---|---|---|---|

SURVEY GRID AND LEVEL DATUM

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SURVEY SOLUTIONS

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IPSWICH BRENTWOOD COVENTRY GLASGOW NORWICH NOTTINGHAM YEOVIL


PROJECT TITLE
TORFAEN SOLAR FARM
TY COCH, NP44 7HF

DRAWING DETAIL
TOPOGRAPHICAL SURVEY
Sheet 4 of 11

| CLIENT | | | | SCALE |
|---|---|---|---|---|
| ELGIN ENERGY | | | | 1:500 |
| SURVEYOR | SURVEY DATE | CHECKED BY | APPROVED BY | DWG STATUS |
| TG/JG/NW | 03/09/2020 | RAH | RAH | FINAL |
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| 27002swg-04 | | | | 11/9/2020 |

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THE SURVEY ASSOCIATION



Original Sheet Size A0H


## TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

### ABBREVIATIONS & SYMBOLS

| | | | | | |
|---|---|---|---|---|---|
| AH | Arch Head Height | ER | Earth Rod | RSD | Roller Shutter Door |
| A/B | Air Brick | ET | EP+Transformer | RSJ | Rolled Steel Joist |
| AR | Assumed Route | FB | Flower Bed | SI | Sign Post |
| AV | Air Valve | FBD | Floor Board Direction | SP | Arch Spring Point Height |
| BB | Belisha Beacon | FH | Fire Hydrant | SV | Stop Valve |
| BH | Bore Hole | FL | Floor Level | SW | Surface Water |
| BL | Bed Level | FP | Flag Pole | SY | Cable Stay |
| BO | Bollard | FW | Foul Water | Tac | Tactile Paving |
| BrP | Brace Post | GG | Gully Grate | TC | Telecom Cover |
| BS | Bus Stop | GV | Gas Valve | TH | Trial Pit |
| BU | Bush | HH | Head Height | THL | Threshold Level |
| B/W | Barbed Wire Fence | IC | Inspection Cover | TL | Traffic Light |
| BX | Box (Utilities) | IL | Invert Level | ToW | Top of Wall |
| C/B | Close Board Fence | I/R | Iron Railings | TP | Telegraph Pole |
| CH | Cill Height | KO | Kerb Outlet | TS | Traffic Signal Cover |
| CL | Cover Level | LP | Lamp Post | TV | Cable TV Cover |
| C/L | Chain Link Fence | MH | Manhole | UB | Universal Beam |
| C-Lev | Ceiling Level | MP | Marker Post | UC | Unknown Cover |
| Col | Column | NB | Name Board | UK | Unknown Tree |
| C/P | Chestnut Paling Fence | OHL | Overhead Line (approx) | UMG | Unmade Ground |
| CR | Cable Riser | Pan | Panel Fence | USB | Under Side Beam |
| C/W | Chicken Wire | PB | Post Box | UTL | Unable To Lift |
| DC | Drainage Channel | PM | Parking Meter | UTS | Unable To Survey |
| DH | Door Head Height | PO | Post | VP | Vent Pipe |
| Dil. | Dilapidated | P/R | Post & Rail Fence | WB | Waste Bin |
| DP | Down Pipe | P/W | Post & Wire Fence | WH | Weep Hole |
| DR | Drain | P/Wall | Partition Wall | WL | Water Level |
| EBx | Electric Box | RE | Rodding Eye | WM | Water Meter |
| EC | Electric Supply Cover | RL | Ridge Level | WO | Wash Out |
| EL | Eaves Level | RP | Reflector Post | (X.XX) | Floor to Ceiling Height |
| EP | Electric Pole | RS | Road Sign | (X.XX)F/C | Floor to False Ceiling Ht |
| | | | | △ | Survey Control Station |

### DRAWING NOTES

**Topographical Surveys**

Trees are drawn to scale showing the average canopy spread. Descriptions and heights should be used as a guide only.

All building names, descriptions, number of storeys, construction type including roof line details are indicative only and taken externally from ground level.

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**Measured Building Surveys**

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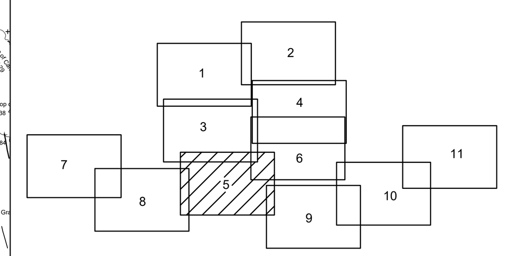
Sheet Layout




SURVEY CONTROL CO-ORDINATES

| STATIONS | EASTINGS | NORTHINGS | LEVEL | DESCRIPTION |
|---|---|---|---|---|

SURVEY GRID AND LEVEL DATUM

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| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|

SURVEY SOLUTIONS

LAND SURVEYING
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UNDERGROUND SURVEYING
SITE ENGINEERING
MONITORING

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survey-solutions.co.uk

IPSWICH BRENTWOOD COVENTRY GLASGOW NORWICH NOTTINGHAM YEOVIL

| | | | | |
|---|---|---|---|---|
| PROJECT TITLE<br>TORFAEN SOLAR FARM<br>TY COCH, NP44 7HF | | | | |
| DRAWING DETAIL<br>TOPOGRAPHICAL SURVEY<br>Sheet 5 of 11 | | | | |
| CLIENT<br>ELGIN ENERGY | | | | SCALE<br>1:500 |
| SURVEYOR<br>TG/JG/NW | SURVEY DATE<br>03/09/2020 | CHECKED BY<br>RAH | APPROVED BY<br>RAH | DWG STATUS<br>FINAL |
| DRAWING NUMBER<br>27002swg-05 | | | REVISION | ISSUE DATE<br>11/9/2020 |

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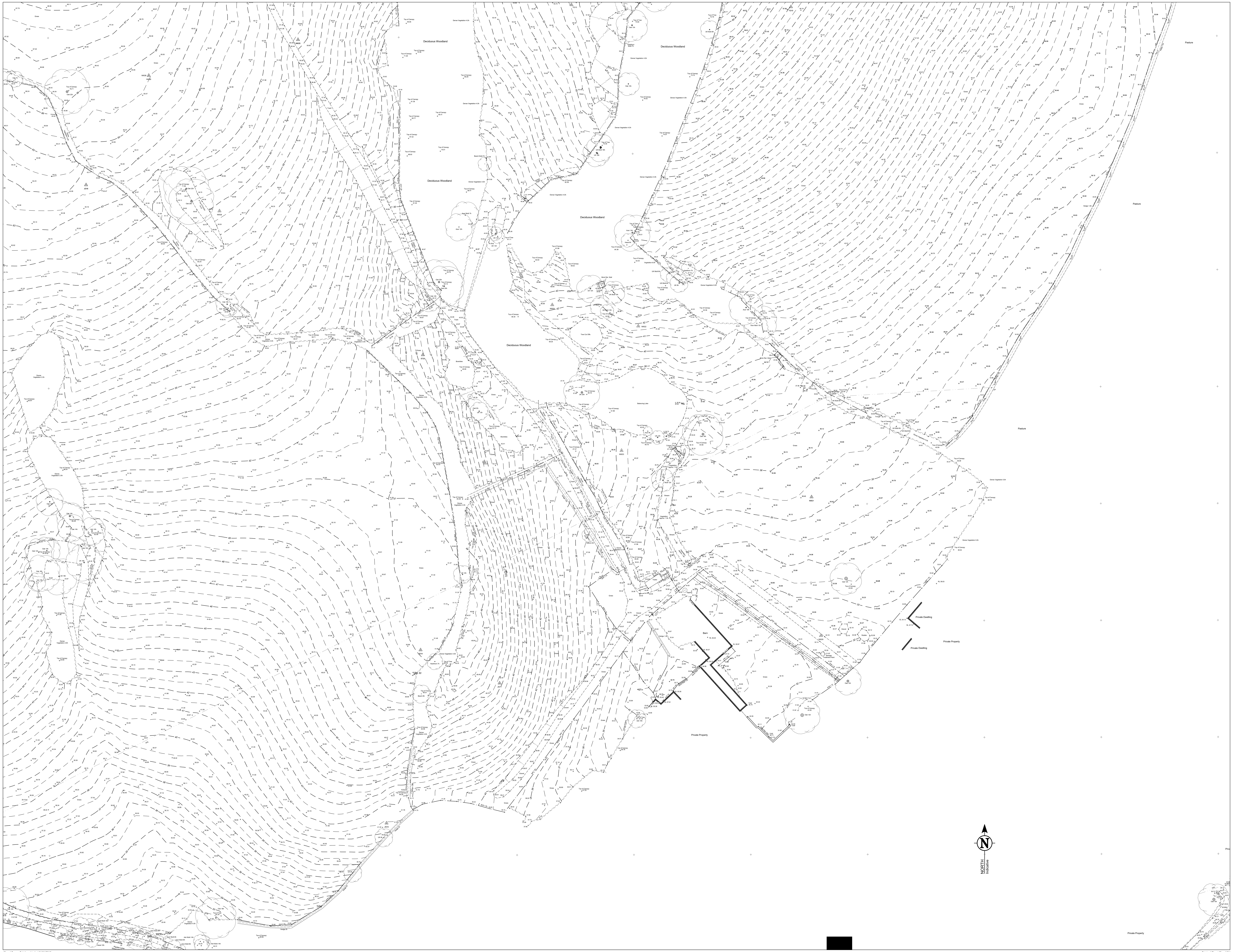


## TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

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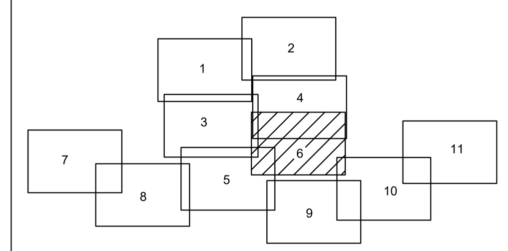


SURVEY CONTROL CO-ORDINATES

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IPSWICH BRENTWOOD COVENTRY GLASGOW NORWICH NOTTINGHAM YEOVIL

| | | | | |
|---|---|---|---|---|
| PROJECT TITLE<br>TORFAEN SOLAR FARM<br>TY COCH, NP44 7HF | | | | |
| DRAWING DETAIL<br>TOPOGRAPHICAL SURVEY<br>Sheet 6 of 11 | | | | |
| CLIENT<br>ELGIN ENERGY | | | | SCALE<br>1:500 |
| SURVEYOR<br>TG/JG/NW | SURVEY DATE<br>03/09/2020 | CHECKED BY<br>RAH | APPROVED BY<br>RAH | DWG STATUS<br>FINAL |
| DRAWING NUMBER<br>27002swg-06 | | | REVISION | ISSUE DATE<br>11/9/2020 |

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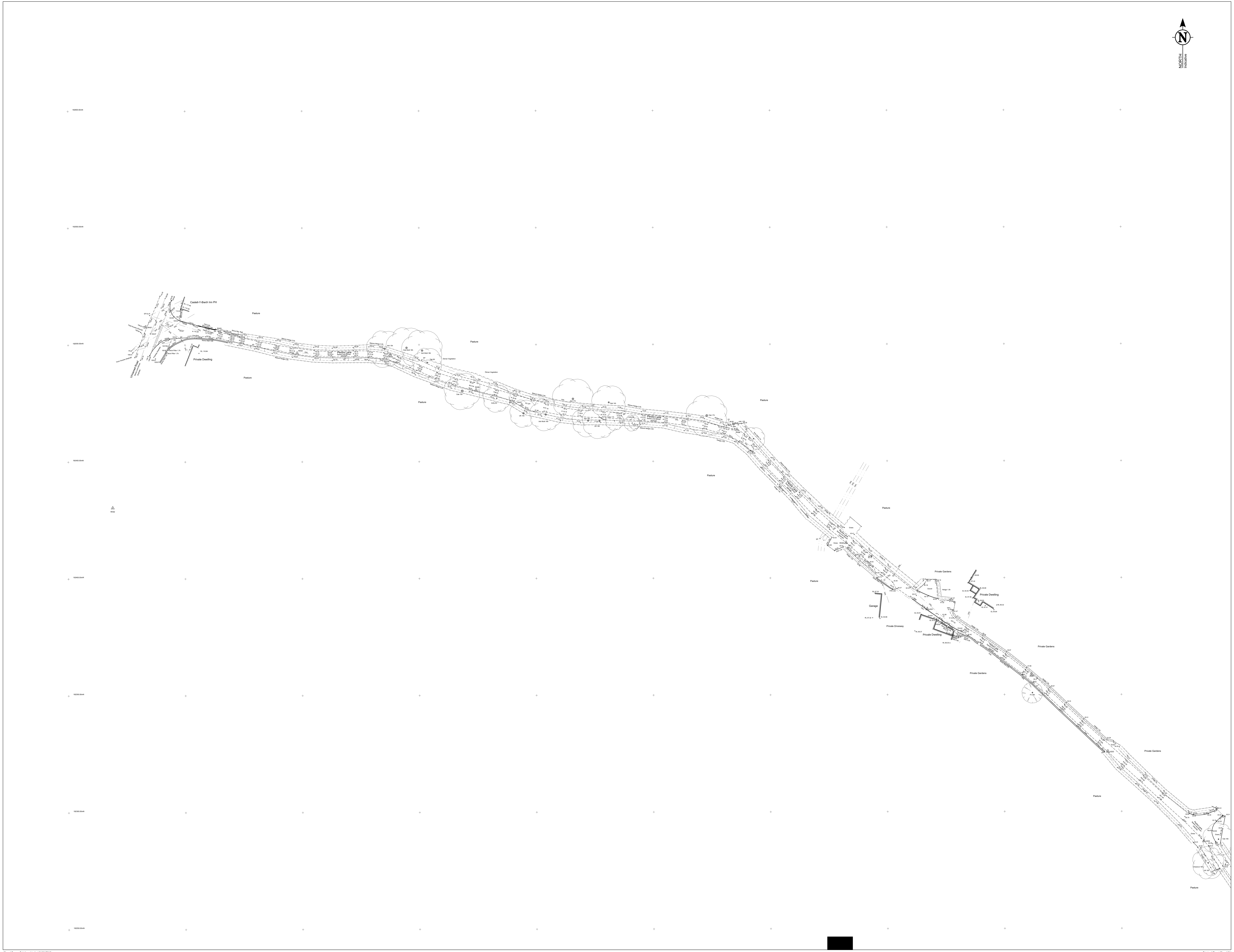


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Original Sheet Size A0H

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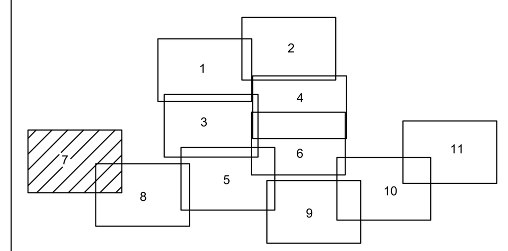


SURVEY CONTROL CO-ORDINATES

| STATIONS | EASTINGS | NORTHINGS | LEVEL | DESCRIPTION |
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SURVEY SOLUTIONS

LAND SURVEYING
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UNDERGROUND SURVEYING
SITE ENGINEERING
MONITORING

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IPSWICH BRENTWOOD COVENTRY GLASGOW NORWICH NOTTINGHAM YEOVIL

PROJECT TITLE
TORFAEN SOLAR FARM
TY COCH, NP44 7HF

DRAWING DETAIL
TOPOGRAPHICAL SURVEY
Sheet 7 of 11

| CLIENT | | | | SCALE |
|---|---|---|---|---|
| ELGIN ENERGY | | | | 1:500 |
| SURVEYOR | SURVEY DATE | CHECKED BY | APPROVED BY | DWG STATUS |
| TG/JG/NW | 03/09/2020 | RAH | RAH | FINAL |
| DRAWING NUMBER | | | REVISION | ISSUE DATE |
| 27002swg-07 | | | | 11/9/2020 |

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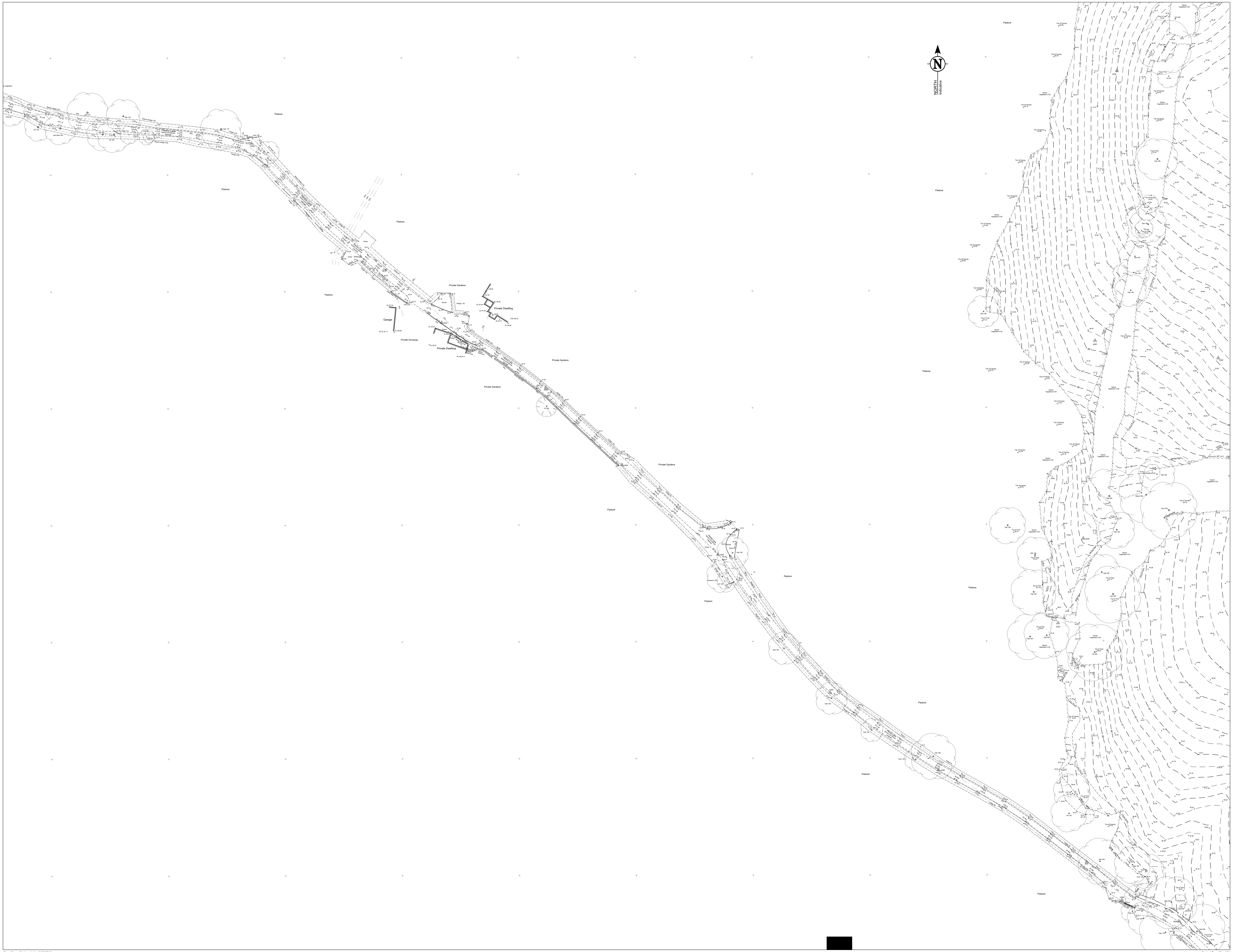


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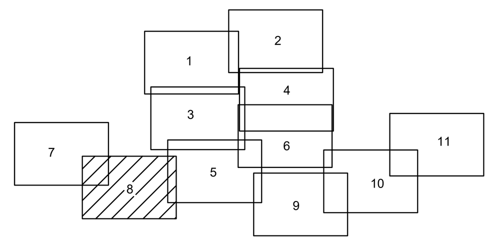


SURVEY CONTROL CO-ORDINATES

| STATIONS | EASTINGS | NORTHINGS | LEVEL | DESCRIPTION |
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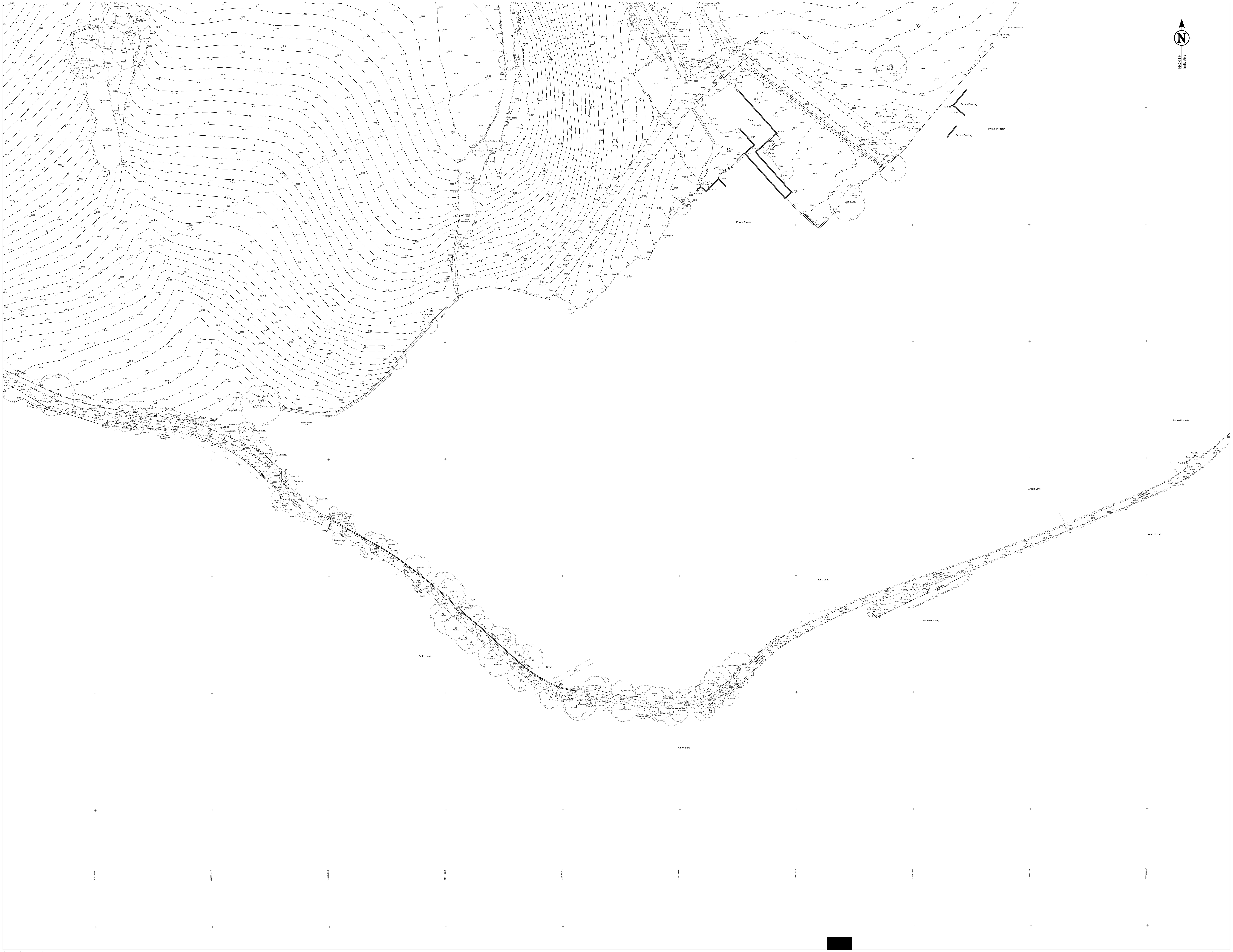


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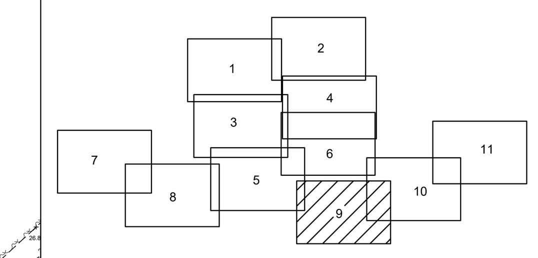
Do not scale from this drawing.

Sheet Layout




SURVEY CONTROL CO-ORDINATES

| STATIONS | EASTINGS | NORTHINGS | LEVEL | DESCRIPTION |
|---|---|---|---|---|

SURVEY GRID AND LEVEL DATUM

The coordinate system established for this survey is related to Ordnance Survey (OS) national grid at a single point using Smartnet, then orientated to grid north with a scale factor of 1.000.

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| REV | DESCRIPTION | DRAWN | APPR | DATE |
|---|---|---|---|---|

SURVEY SOLUTIONS

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MONITORING

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IPSWICH BRENTWOOD COVENTRY GLASGOW NORWICH NOTTINGHAM YEOVIL

PROJECT TITLE
TORFAEN SOLAR FARM
TY COCH, NP44 7HF

DRAWING DETAIL
TOPOGRAPHICAL SURVEY
Sheet 9 of 11

| CLIENT | | | | SCALE |
|---|---|---|---|---|
| ELGIN ENERGY | | | | 1:500 |
| SURVEYOR | SURVEY DATE | CHECKED BY | APPROVED BY | DWG STATUS |
| TG/JG/NW | 03/09/2020 | RAH | RAH | FINAL |
| DRAWING NUMBER | | | REVISION | ISSUE DATE |
| 27002swg-09 | | | | 11/9/2020 |

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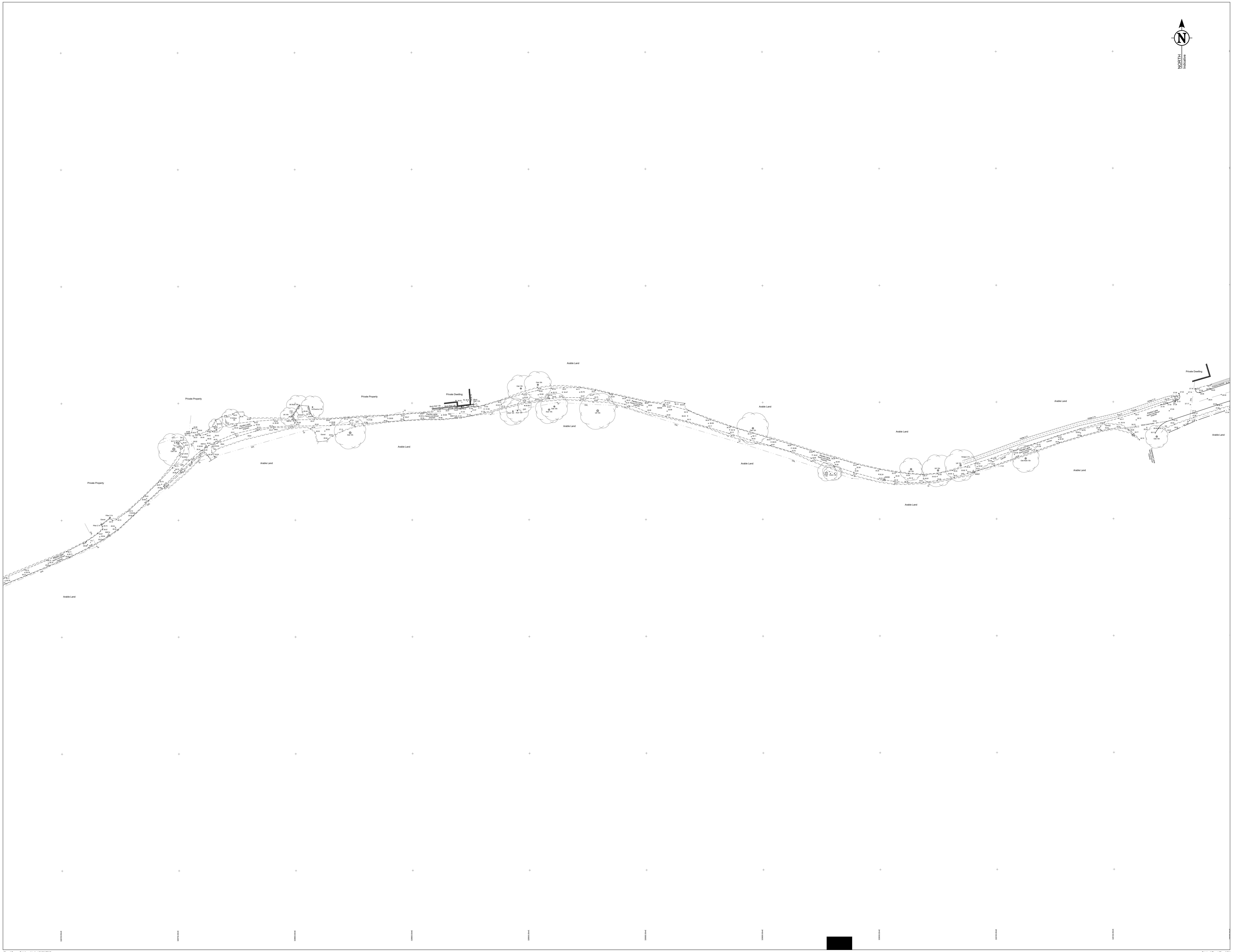


## TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

### ABBREVIATIONS & SYMBOLS

| | | | | | |
|---|---|---|---|---|---|
| AH | Arch Head Height | ER | Earth Rod | RSD | Roller Shutter Door |
| A/B | Air Brick | ET | EP+Transformer | RSJ | Rolled Steel Joist |
| AR | Assumed Route | FB | Flower Bed | SI | Sign Post |
| AV | Air Valve | FBD | Floor Board Direction | SP | Arch Spring Point Height |
| BB | Belisha Beacon | FH | Fire Hydrant | SV | Stop Valve |
| BH | Bore Hole | FL | Floor Level | SW | Surface Water |
| BL | Bed Level | FP | Flag Pole | SY | Cable Stay |
| BO | Bollard | FW | Foul Water | Tac | Tactile Paving |
| BrP | Brace Post | GG | Gully Grate | TC | Telecom Cover |
| BS | Bus Stop | GV | Gas Valve | TH | Trial Pit |
| BU | Bush | HH | Head Height | THL | Threshold Level |
| B/W | Barbed Wire Fence | IC | Inspection Cover | TL | Traffic Light |
| BX | Box (Utilities) | IL | Invert Level | ToW | Top of Wall |
| C/B | Close Board Fence | I/R | Iron Railings | TP | Telegraph Pole |
| CH | Cill Height | KO | Kerb Outlet | TS | Traffic Signal Cover |
| CL | Cover Level | LP | Lamp Post | TV | Cable TV Cover |
| C/L | Chain Link Fence | MH | Manhole | UB | Universal Beam |
| C-Lev | Ceiling Level | MP | Marker Post | UC | Unknown Cover |
| Col | Column | NB | Name Board | UK | Unknown Tree |
| C/P | Chestnut Paling Fence | OHL | Overhead Line (approx) | UMG | Unmade Ground |
| CR | Cable Riser | Pan | Panel Fence | USB | Under Side Beam |
| C/W | Chicken Wire | PB | Post Box | UTL | Unable To Lift |
| DC | Drainage Channel | PM | Parking Meter | UTS | Unable To Survey |
| DH | Door Head Height | PO | Post | VP | Vent Pipe |
| Dil. | Dilapidated | P/R | Post & Rail Fence | WB | Waste Bin |
| DP | Down Pipe | P/W | Post & Wire Fence | WH | Weep Hole |
| DR | Drain | P/Wall | Partition Wall | WL | Water Level |
| EBx | Electric Box | RE | Rodding Eye | WM | Water Meter |
| EC | Electric Supply Cover | RL | Ridge Level | WO | Wash Out |
| EL | Eaves Level | RP | Reflector Post | (X.XX) | Floor to Ceiling Height |
| EP | Electric Pole | RS | Road Sign | (X.XX)F/C | Floor to False Ceiling Ht |
| | | | | △ | Survey Control Station |

### DRAWING NOTES

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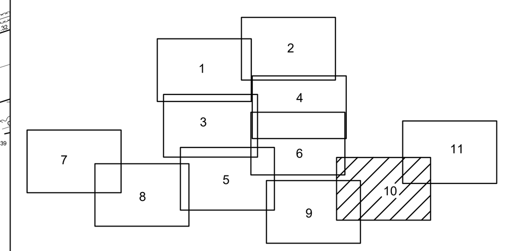


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DRAWING DETAIL
TOPOGRAPHICAL SURVEY
Sheet 10 of 11

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|---|---|---|---|---|
| ELGIN ENERGY | | | | 1:500 |
| SURVEYOR | SURVEY DATE | CHECKED BY | APPROVED BY | DWG STATUS |
| TG/JG/NW | 03/09/2020 | RAH | RAH | FINAL |
| DRAWING NUMBER | | | REVISION | ISSUE DATE |
| 27002swg-10 | | | | 11/9/2020 |

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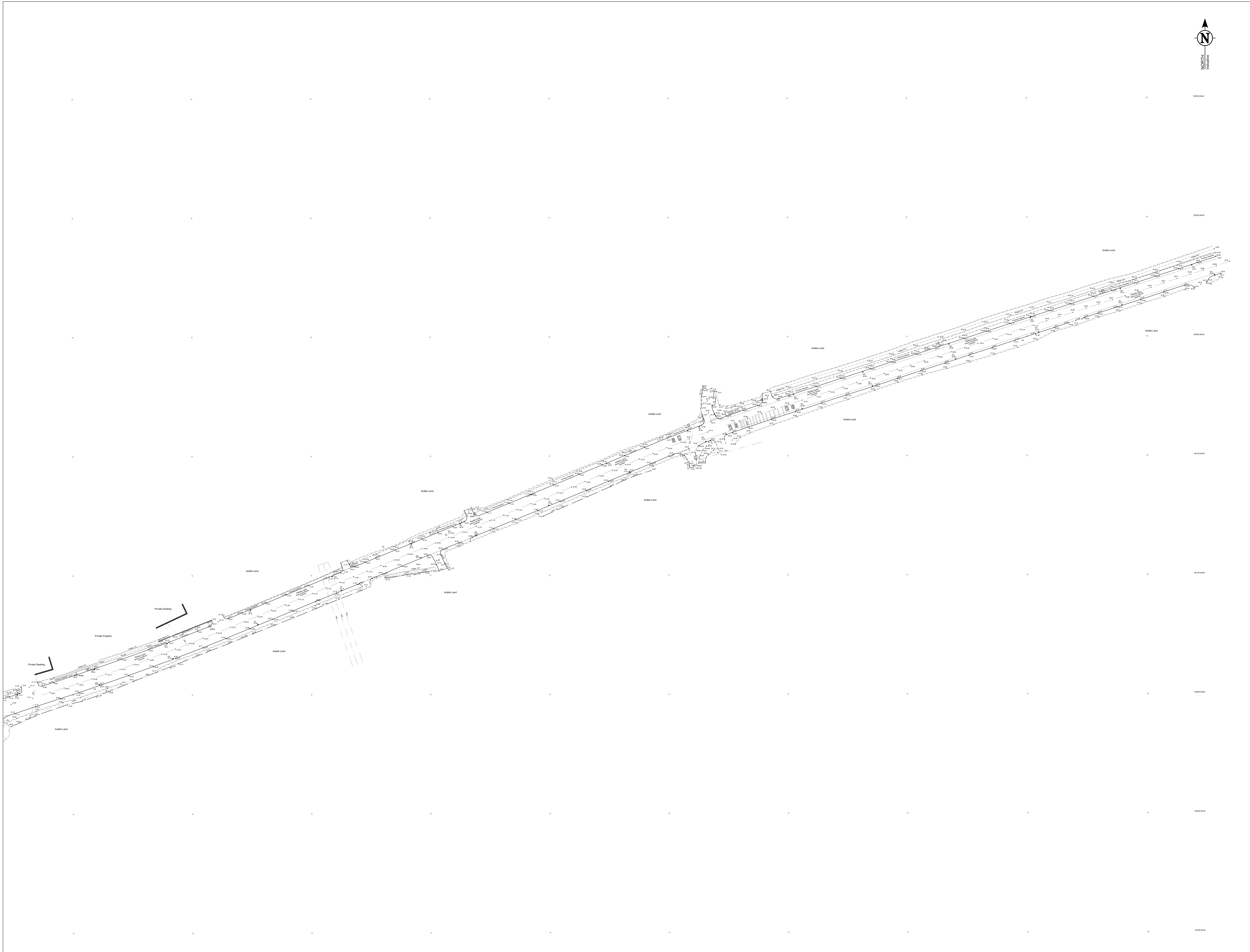
Original Sheet Size A0H

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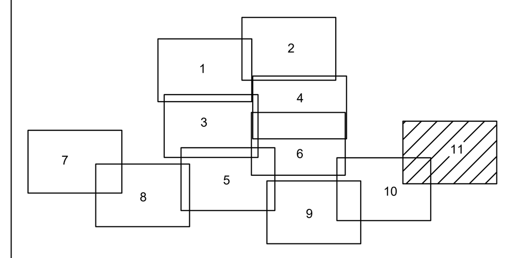


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TY COCH, NP44 7HF

DRAWING DETAIL
TOPOGRAPHICAL SURVEY
Sheet 11 of 11

| CLIENT | | | | SCALE |
|---|---|---|---|---|
| ELGIN ENERGY | | | | 1:500 |
| SURVEYOR | SURVEY DATE | CHECKED BY | APPROVED BY | DWG STATUS |
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| DRAWING NUMBER | | | REVISION | ISSUE DATE |
| 27002swg-11 | | | | 11/9/2020 |

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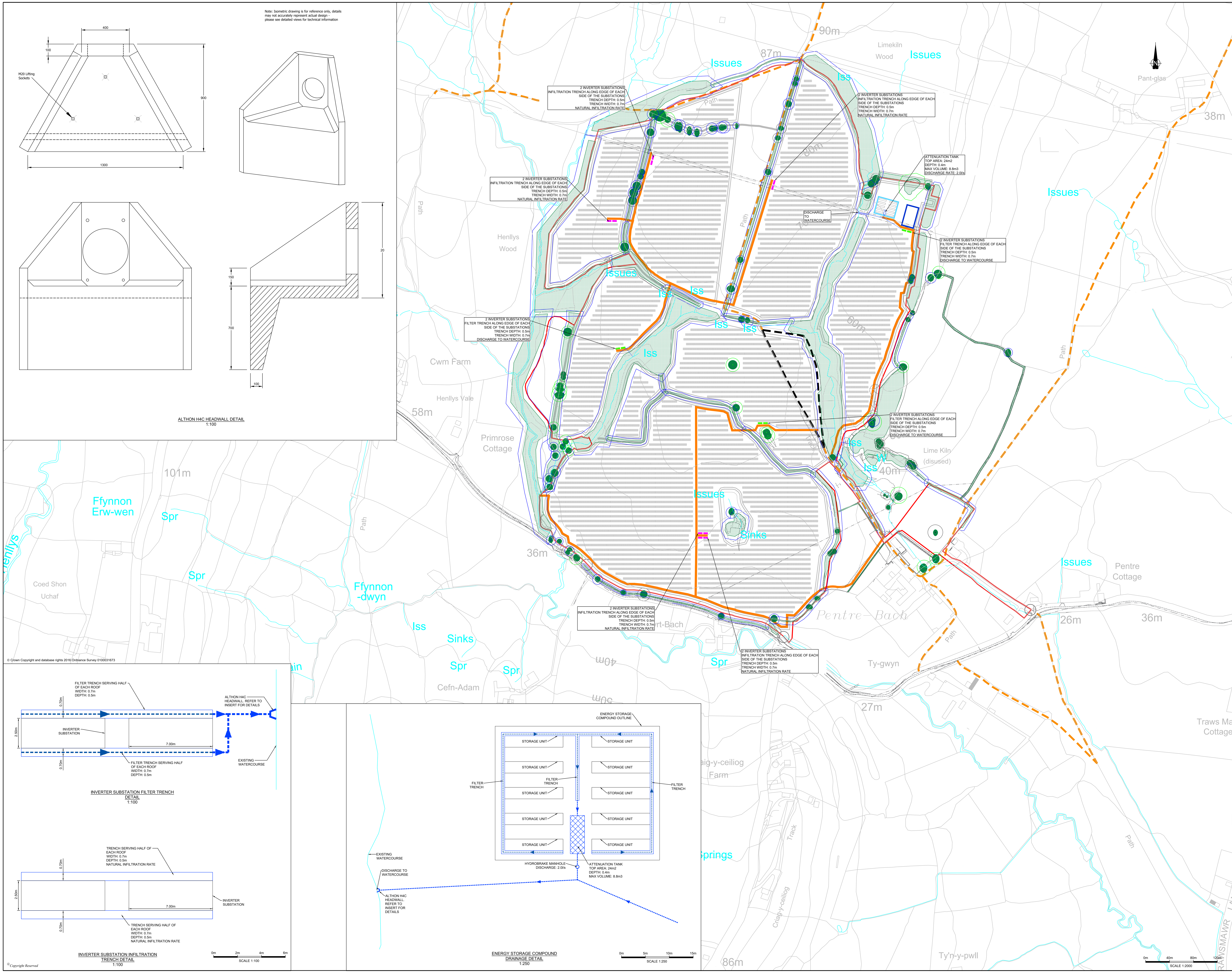


DO NOT SCALE FROM THIS DRAWING

KEY

- TOTAL SITE AREA
- ENERGY STORAGE COMPOUND
- SUBSTATION
- 3.5m WIDE ACCESS TRACK
- PUBLIC RIGHT OF WAY
- PUBLIC RIGHT OF WAY: TO BE DIVERTED
- PROPOSED NEW ROUTE OF PUBLIC RIGHT OF WAY
- INVERTER SUBSTATIONS DISCHARGING TO WATERCOURSE
- INVERTER SUBSTATIONS INFILTRATING TO THE GROUND
- ATTENUATION TANK
- EXISTING WATERCOURSE
- CATEGORY U (DEFECTIVE, NEGLIGIBLE OR REDUNDANT TREES)
- CATEGORY A (HIGH RETENTION VALUE)
- CATEGORY B (MODERATE RETENTION VALUE)
- CATEGORY C (LOW RETENTION VALUE)
- APPROXIMATE CROWN SPREAD OF INDIVIDUAL TREES

NOTES

1. BASED ON DRAWING 9007 AND 25922 PROVIDED BY BARTON WILLMORE.
2. PRELIMINARY INFILTRATION RATE. TO BE CONFIRMED AT THE DETAILED DESIGN STAGE.
4. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE STATED.
6. ALL LEVELS ARE IN METERS ABOVE ORDINANCE DATUM.
7. THE NOMINAL ROOT PROTECTION AREA (RPA) OF EACH TREE IS INDICATED BY A SOLID LINE USING THE COLOUR CODING ABOVE.
8. AT THE POINTS WHERE A DRAIN IS PROPOSED THROUGH THE MODERATE RETENTION VALUE AREA, A SUITABLE ROUTE MUST BE FOUND WITHOUT CAUSING DAMAGE TO THE TREES.
9. TO BE READ IN CONJUNCTION WITH CA11956-0002 V1.0- FLOOD CONSEQUENCE ASSESSMENT AND DRAINAGE STRATEGY, DATED JULY 2024.

| REVISION | DETAILS |
|---|---|
| A | FIRST ISSUE |

CLIENT: ELGIN ENERGY ES CO LIMITED

PROJECT: PENTRE BACH, TORFAEN

DRAWING TITLE: DRAINAGE STRATEGY

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| CA11956-003 | A | |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A0 | 1:2000 | 30/11/22 |

| DRAWN BY | CHECKED BY | APPROVED BY |
|---|---|---|
| CD | KW | EK |

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